Trade Liberalization and the Theory of Endogenous Protection: An Econometric Study of U.S. Import Policy

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Trade theorists continue to puzzle over their surprisingly small estimates of the impact of trade liberalization on imports. All explanations of the puzzle treat trade liberalization as a given. But the level of trade protection is not exogenous. The theory of endogenous protection predicts that higher levels of import penetration will lead to greater protection. This paper finds that when trade protection is modeled endogenously, its restrictive impact on imports is large, 10 times the size obtained from treating protection exogenously.

Trade theorists continue to puzzle over their surprisingly small estimates of the impact of trade liberalization on imports.[1] All explanations of the puzzle, including those that focus on the role of imperfect competition, treat trade liberalization *as a given*. But the level of trade protection is not exogenous. The theory of endogenous protection (see Brock and Magee 1978; Findlay and Wellisz 1982; Hillman 1982,

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[1] See Baldwin and Lewis (1978), Cline et al. (1978), Whalley (1985), Deardorff and Stern (1986), Bhagwati (1988), and Leamer (1988). In surveying the literature, Deardorff and Stern write that "studies of the [GATT] Tokyo Round negotiations have reached the same conclusion regarding their overall economic effects, namely, that the effects on *trade*, employment and economic welfare are likely to be small" (p. 60; italics added).

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1989; Mayer 1984; Baldwin 1985; Magee, Brock, and Young 1989) predicts that, in response to increased import competition, private domestic interests will intensify their lobbying activity for protection: higher levels of import penetration will lead to greater protection. Thus unless imports and protection are modeled as simultaneously determined endogenous variables, estimates of the impact of trade liberalization on imports will be biased downward. Previous studies ignore this simultaneity, a deficiency this paper attempts to remedy. The results are striking: when trade protection is modeled endogenously, its restrictive impact on imports is large, 10 times the size obtained from treating protection exogenously.

The main goal of this paper is to estimate the impact on U.S. imports of the elimination of all U.S. nontariff barriers to trade (NTBs) in manufacturing.[2] To this end, import and NTB equations are estimated simultaneously. The import equation captures the negative impact of NTBs on imports, and the NTB equation captures the positive impact of imports on NTBs. There is a long history of estimating both equations, yet with the exception of Ray (1981*b*), all previous studies have treated the two equations as separate research efforts.[3] This is surprising since the simple correlation of tariffs with imports is positive, a fact that often carries over to multiple regression settings (Leamer 1988). Leamer attributes this to the endogeneity of protection. This study concludes that in 1983, U.S. manufacturing NTBs reduced U.S. imports by $49.5 billion. This figure is very large: it represents 24 percent of U.S. manufacturing imports and is comparable in size to U.S. imports from Japan.

The second goal of this paper is to investigate the theory of endogenous protection. The theory correctly predicts that the more valuable protection is to private interests, the greater the degree of protection. Also, American business has had much more influence than organized labor in shaping U.S. import policy. Along the lines explored by Baldwin (1985), broad-based interests have had a moderately influential role in shaping policy.

The paper is organized as follows. Section I reviews the theory. Section II presents the results for a single specification. In Section

[2] Examples of NTBs include quantity restraints (e.g., quotas and voluntary export restraints), price restraints (e.g., antidumping duties and variable levies), and threats (e.g., countervailing investigations).

[3] Cross-industry trade equations have been estimated by many authors, including Baldwin (1971), Harkness (1978), and Bowen and Sveikauskas (1989). Cross-industry tariff and NTB equations have also been estimated by many authors, including Caves (1976), Helleiner (1977), Ray (1981*a*, 1981*b*), Finger, Hall, and Nelson (1982), Lavergne (1983), Marvel and Ray (1983), and Baldwin (1985). While Ray's (1981*b*) simultaneous equations approach informs the current paper, he failed to find any impact of NTBs on imports.

III, this specification is subject to Leamer's (1984) extensive sensitivity analysis.

I. Theory

This section describes the specifications of the NTB equation, the import equation, and the simultaneity of NTBs and imports.

A. *The NTB Equation*

The theory of endogenous protection states that the equilibrium level of protection is determined by supply and demand. Protection is demanded by interest groups that rationally weigh the costs and benefits of lobbying for protection and is supplied by politicians seeking to maximize self-interested objectives. The regressors in the NTB equation are measures of the costs and benefits of lobbying and measures of the supply of protection. They are listed in table 1 and detailed in the Data Appendix. In discussions of these regressors, it is useful to distinguish two narrow interest groups, business and labor, and one broad-based interest group.

TABLE 1

REGRESSORS IN THE NTB EQUATION

Seller concentration	Four-firm concentration ratio
Buyer concentration	Weighted average of the four-firm concentration ratios among buyers of an industry's output (consumers and downstream industries)
Seller number of firms	Number of companies scaled by industry sales
Buyer number of firms	Weighted average of the number of firms among buyers of an industry's output, scaled by industry sales
Scale	Caves's (1976) minimum efficient plant size, defined as the percentage of industry sales supplied by the median plant
Capital stock	Value of depreciable assets such as physical plant and machinery
Geographic concentration	Measure of the difference between population and industry production patterns across the 50 states
Unions	Percentage of workers unionized
Employment size	Number (unscaled) of workers in an industry
Tenure	Number of years the average worker in the industry has been with his or her current employer
Industry growth	Growth in industry sales, 1979–83
Occupation	Proportion of the industry work force in each occupation
Import penetration	Imports scaled by domestic consumption (domestic production plus net imports)
Δ(import penetration)	Import penetration in 1983 minus import penetration in 1980
Exports	Exports scaled by domestic consumption

Business

Olson (1965) stressed that where coordinating an effective lobby is costly, the level of protection is low. Greater seller concentration and a smaller seller number of firms alleviate the free-rider problem in coordinating a lobby, thus increasing the level of protection. Greater buyer concentration and a smaller buyer number of firms alleviate the free-rider problem faced by consumer and downstream groups, thus strengthening the lobby against protection. Barriers to entry have two effects. In a Stigler-style argument (see Stigler 1971), if entry barriers restrict both domestic and foreign rivals, then the barriers eliminate the need for protection, thus reducing the level of protection. If the entry barriers restrict only domestic entry, then the barriers increase the level of protection by making protection valuable as a way of excluding foreign rivals. Proxies for barriers to entry are scale and capital stock. Also, the less mobile capital is, the greater the quasi rents associated with protection. Capital is measured by capital stock. The passage of trade legislation depends on the voting process in Congress. Geographically concentrated industries carry few representatives, but each representative is vociferous in his or her support (Ray 1981*a*). Geographic concentration is relevant for all three interest groups.

Labor

A union is an existing lobby that, without incurring any setup costs, can be redirected toward lobbying for trade protection. Thus high union membership rates lead to high levels of protection. A large employment size increases the free-rider problem in organizing a lobby, thus reducing protection. On the other hand, it spells votes for politicians, thus increasing protection (Caves 1976). The longer the average worker's tenure is with his or her current employer, the greater the firm-specific human capital and the greater the quasi rents associated with protection.

Broad-based Interest Group

The theory of endogenous protection predicts that protection will be progressive in aiding the disadvantaged since such groups have a lower opportunity cost of lobbying (Magee et al. 1989).[4] An industry

[4] It is difficult to distinguish this prediction from predictions of other models such as Corden's (1974) conservative welfare function, Baldwin's (1985) welfare altruism, and tariffs as insurance. At issue is that narrowly self-interested agents recognize distant externalities and may respond to them (Posner 1974; Lindbeck 1985). For exam-

is disadvantaged if industry growth is slow or unemployment is high. It is also disadvantaged if a large share of its workers are in less skilled occupations.

To conclude, I emphasize that the theory of endogenous protection is not being tested since no alternative hypothesis is offered and since there is ambiguity about the signing of some of the regression coefficients. The issue is summarized by Posner (1974, p. 349): "And this illustrates the essential deficiency of the economic theory of regulation in its present form. At best it is *a list of criteria* relevant to predicting whether an industry will obtain favorable legislation. *It is not a coherent theory yielding unambiguous and therefore testable hypotheses*" (italics added). Thus, while the signs of the estimated coefficients cast a scrutinizing light on the theory of endogenous protection, no test is being attempted. Rather, the theory is being used to suggest an a priori reasonable list of regressors for the NTB equation. Informally, these regressors will be used to instrument NTBs in the import equation.

B. The Import Equation

The ideal trade model from which to derive the estimating equation for imports must satisfy two criteria. First, it must predict the pattern of trade. Second, it must be compatible with the theory of endogenous protection. There is a trade-off between the two criteria. The specific factors model and models of imperfect competition predict lobbying activity very well; however, they do not yield the precise and implementable predictions about the pattern of trade that the Heckscher-Ohlin model does. In particular, the specific factors model cannot predict trade without appealing to impossibly detailed data on supply elasticities (Jones and Neary 1984, p. 24), and imperfectly competitive models often exhibit a multiplicity of equilibria, each implying a different pattern of trade. In a paper primarily concerned with estimating a parameter of the import equation (i.e., the impact of NTBs on imports), the first criterion and with it the Heckscher-Ohlin model must figure prominently. Fortunately, the trade models are not all that polarized. The specific factors model is similar to the Heckscher-Ohlin model in the long run when all factors are mobile and in the short run if demand elasticities for the mobile factor are equal across industries. The imperfectly competitive models complement the Heckscher-Ohlin interpretation of interindustry trade, a

ple, trade protection reduces both unemployment (welfare altruism) and the tax burden of funding unemployment insurance (narrow self-interest). See Hillman (1989) for further discussion.

point made frequently by Helpman and Krugman (1985). Thus a factor endowment import equation is consistent with all three trade models.

C. *Simultaneity of Imports and NTBs*

The endogenous protection logic points to high levels of imports as a cause of protection, yet protection is directed at reducing imports. This feedback disguises the relationship between protection and imports. In a regression setting, one can isolate the two effects by simultaneously estimating an NTB equation and an import equation. The dependent variable in the import equation is import penetration, defined as gross imports divided by domestic consumption (domestic production plus net imports). The dependent variable in the NTB equation is the NTB coverage ratio, defined as the proportion of imports subject to an NTB. The data apply to 1983 U.S. manufacturing, with each observation representing an industry.[5]

Both import penetration and the NTB coverage ratio are nonnegative censored limited dependent variables. Thus the structural model to be estimated is the following simultaneous equations Tobit model (industry subscripts are omitted):

$$N = \begin{cases} M\gamma_M + \mathbf{X}_N\boldsymbol{\beta}_N + \varepsilon_N & M^* > 0, N^* > 0 \\ 0 & M^* > 0, N^* \leq 0 \\ 0 & M^* \leq 0, \end{cases}$$

$$M = \begin{cases} N\gamma_N + \mathbf{X}_M\boldsymbol{\beta}_M + \varepsilon_M & M^* > 0, N^* > 0 \\ \mathbf{X}_M\boldsymbol{\beta}_M + \varepsilon_M & M^* > 0, N^* \leq 0 \\ 0 & M^* \leq 0, \end{cases} \tag{1}$$

where $N^* = M\gamma_M + \mathbf{X}_N\boldsymbol{\beta}_N + \varepsilon_N$, $M^* = N\gamma_N + \mathbf{X}_M\boldsymbol{\beta}_M + \varepsilon_M$, N is an NTB coverage ratio, M is import penetration, $\mathbf{X}_N$ collects measures of the determinants of NTBs, $\mathbf{X}_M$ collects measures of factor endowments, and $(\varepsilon_N, \varepsilon_M)$ is a bivariate normal residual vector.

Import penetration enters the NTB equation in three ways. First, import penetration enters linearly and directly. Second, import penetration enters linearly but indirectly through Δ(import penetration)

[5] Data on NTBs are taken from the United Nations Conference on Trade and Development (UNCTAD) data base on trade control measures, which is the most comprehensive data set on NTBs available. See Gaston and Trefler (1992, table A.1) for a list of NTBs included in the data set. Although coverage ratios are frequently used (see Bhagwati 1988), this measure of NTBs comes under careful scrutiny in Sec. III below.

since Δ(import penetration) equals $M_{1983} - M_{1980,}$ where M_t is import penetration in year t. Third, import penetration enters nonlinearly and indirectly since in the region ($M^* \leq 0$, $N^* > 0$), $N = 0$ rather than $N = \mathbf{X}_N\boldsymbol{\beta}_N + \varepsilon_M$. That is, when import penetration is zero, NTBs are constrained to equal zero. The idea is that when import penetration is zero, protection has no value to domestic rent seekers so that there is no lobbying for NTBs. This nonlinearity is novel.

Tariffs have been neglected from the analysis on the grounds that the low levels of U.S. tariffs are increasingly being eclipsed by NTBs. In Section III below, detailed attention is given to tariffs. That section also addresses concerns about the endogeneity of other regressors in the import and NTB equations.

This section described a simultaneous equations model of import penetration and NTBs. In places, the translation of theory into data analysis was not as tight as I could have wished. Thus higher econometric standards and extensive sensitivity analysis are critical.

II. Econometric Estimates

This section presents estimates of the import and NTB equations. The structural parameters of equation (1) are estimated using full information maximum likelihood (FIML) estimation. Only a single specification is presented, the one described in the previous section. While any inferences drawn from a single specification must be tentative, in Section III the specification is subject to an extensive sensitivity analysis, and the main conclusions of this paper are shown to be robust to the choice of specification. Thus the inferences drawn in this section will be treated with greater confidence than would otherwise be warranted. The section is divided into three parts dealing with the NTB equation, the import equation, and the impact on imports of the elimination of all U.S. manufacturing NTBs.

A. *The NTB Equation*

Table 2 presents the results for the NTB equation when it is simultaneously estimated with the import equation. I follow Leamer (1984) in using beta coefficients to judge the predictive importance of regressors.[6] Import penetration has the expected positive sign but is statistically insignificant. However, the change in import penetration,

[6] Consider the model $y_i = \mathbf{X}_i\boldsymbol{\beta} + \varepsilon_i$ with prediction $\hat{y}_i = \mathbf{X}_i\hat{\boldsymbol{\beta}}$ (i indexes observations). Let $\mathbf{X}_i^{-j}$ be the $\mathbf{X}_i$ vector with element j replaced by the mean of regressor j. A beta coefficient for regressor j is the square root of $\Sigma_i(\mathbf{X}_i\hat{\boldsymbol{\beta}} - \mathbf{X}_i^{-j}\hat{\boldsymbol{\beta}})^2/\sigma_y^2$. The generalization to a group of regressors is immediate.

TABLE 2

NTB EQUATION

Dependent Variable: NTBs	Estimated Coefficient (1)	t-Statistic (2)	Beta Coefficient (3)	Sensitivity Analysis (4)
Comparative Advantage:				
Import penetration	.17	.46	.11	† ‡
Δ(import penetration)	3.31	2.58*	**1.74**	
Exports	−1.82	−5.26*	**−.94**	
Business:				
Seller concentration	.53	2.43*	**.42**	†
Seller number of firms	−.22	−1.86	**−.33**	
Buyer concentration	−1.13	−2.08*	**−.33**	
Buyer number of firms	−.06	−2.16*	**−.32**	
Scale	−1.83	−2.04*	**−.46**	
Capital stock	−.27	−2.02*	−.24	
Labor:				
Union	.10	.42	.05	† ‡
Employment size	.08	.31	.03	
Tenure	−.01	−.33	−.04	† ‡
Geographic concentration§	.11	.71	.07	‡
Broad-based:				
Occupation:				
Engineers, scientists	1.63	1.70	**.58**	
White-collar	.40	.67	**.34**	†
Skilled	−.31	−.61	−.21	†
Semiskilled	.15	.61	.16	†
Unskilled	.90	1.57	**.53**	†
Unemployment	1.22	1.96*	**.30**	
Industry growth	.03	.26	.03	† ‡

NOTE.—There are 322 observations, of which 144 have both positive NTBs and import penetration, 144 have zero NTBs and positive import penetration, and 34 have both zero NTBs and import penetration. Large beta coefficients (greater than .30) are set in boldface.

* Significant at the 5 percent level.

† The sign of the coefficient is sensitive to the choice of included regressors (see table 3 below and Sec. III*A*).

‡ The sign of the coefficient is sensitive to the omission of two-digit SIC observations (see Sec. III*C*).

§ Geographic concentration is relevant to all three interests.

Δ(import penetration), is statistically significant and has a very large beta coefficient. As expected, a rise in import penetration leads to greater protection. The coefficient on exports has the expected negative sign and has a very large *t*-statistic and beta coefficient. Export-oriented industries do not require protection either because they face no import competition or because, with intraindustry trade, NTBs will evoke unwanted foreign retaliation.

For the business interest, seller and buyer concentration are important as judged by *t*-statistics and beta coefficients. When seller concentration is small, lobbying is hampered by free-rider problems so that protection is low. When buyer concentration is large, protective demands are resisted by organized consumer and downstream groups.

The same free-rider logic implies that seller and buyer number of firms will have negative and positive coefficients, respectively. However, the coefficient on buyer number of firms is negative. This may be due to the high degree of correlation between the four regressors that capture the free-rider effects (seller and buyer concentration and seller and buyer number of firms). Estimation of parsimonious specifications—for example, using the ratio of seller to buyer regressors or using the difference between seller and buyer regressors—results in the expected signs for all the free-rider effects. Scale and capital stock have negative signs, an indication that by controlling entry of rivals, barriers to entry eliminate the need for protection.

Politicians insist that protection safeguards the livelihood of unemployed and less skilled workers in industries threatened by foreign competition. Indeed, high unemployment leads to a greater degree of protection. If NTBs protect less skilled workers, then the less skilled the occupation, the greater should be its coefficient.[7] Nothing like the expected pattern emerges. Engineers and scientists, the highest-income occupation, receives the most protection, while semiskilled labor, which forms the bulk of the less skilled labor force (see table A1 in the Data Appendix), receives very little protection. Further, the hypothesis that all the occupation coefficients are equal is accepted at the 1 percent level. This belies the ability of politicians to set policy exogenously. The remaining regressors, including all the labor interest regressors, are unimportant as judged by *t*-statistics and beta coefficients.

Given the presence of multicollinearity, it is possible that several regressors are each statistically insignificant and unimportant for prediction, yet as a group of regressors, they are both significant and important. Table 3 presents measures of importance for groups of regressors. Each of the 18 rows reports a different specification in which the regressors listed are omitted from the NTB equation.[8] The first measure of importance is a beta coefficient for the group of omitted regressors. The second is the likelihood ratio test statistic for the hypothesis that all the regressors in the group have zero coefficients. As predicted by endogenous protection theory, the compara-

[7] The five occupation regressors sum to one so that no intercept is included. As a result, the sign but not the relative size of these coefficients is confounded with the sign of the intercept.

[8] That is, the table reports summary statistics for 18 specifications. Space precludes presenting the 18 specifications in full. However, if in one or more of these specifications a coefficient switched sign, then this is noted in table 2 by a dagger (†) in col. 4. For example, since scale is correlated with concentration and the number of firms, it is of interest that the scale coefficient does not switch sign when the concentration regressors, number of firm regressors, or both are omitted.

TABLE 3

MEASURES OF IMPORTANCE FOR GROUPS OF REGRESSORS

Regressors Omitted from the NTB Equation	Measures of Importance[a]: Beta Coefficient (1)	Measures of Importance[a]: Likelihood Ratio Test (2)	Sensitivity Analysis:[b] γ_N (3)
Comparative Advantage[c]	2.29	223.1**	−.34
Import penetration	.11	1.8	−.49
Δ(import penetration)	1.74	78.5**	−.48
Exports	.94	26.7**	−.51
Import penetration, Δ(import penetration)	1.91	119.0**	−.45
Business[c]	.79	39.7**	−.50
Concentration	.50	15.2**	−.50
Number of firms	.52	15.2**	−.50
Concentration, firms	.73	34.5**	−.50
Scale, capital stock	.53	10.5**	−.51
Concentration, firms, scale, capital	.78	38.5**	−.50
Labor[c]	.10	.9	−.51
Union, employment size, tenure	.06	.4	−.51
Broad-based[c]	.42	16.1*	−.52
All occupations	.33	6.7	−.51
White-collar, engineers, and scientists	.49	4.5	−.51
Unskilled, semiskilled	.41	4.8	−.50
Unskilled, semiskilled, unemployment	.55	13.3**	−.52

NOTE.—Each row represents a different specification in which the regressors listed in the row are omitted from the NTB equation.

* Significant at the 5 percent level.

** Significant at the 1 percent level.

[a] Beta coefficients pertain to groups of regressors (see n. 6).

[b] For each specification (row), this column presents the estimate of γ_N, the coefficient on NTBs in the import equation. If this coefficient varies across specifications, then it is sensitive to the choice of specification (see Sec. IIIA).

[c] All the regressors associated with comparative advantage or a special interest (see table 2) are omitted.

tive advantage regressors taken together are very important. They have a large beta coefficient of 2.29 and a significant likelihood ratio test statistic of 223.1. The impression conveyed by the table is that the labor interest has had little input into the shaping of U.S. trade legislation. For all the labor regressors the beta coefficient is only 0.10, and the likelihood ratio test statistic of 0.9 is insignificant. In contrast, the business interest has had considerable influence. There has been relatively little empirical work on the importance of broad-based interest groups. The broad-based interest has enjoyed moderate influence, a result consistent with Baldwin's (1985) conclusion.

TABLE 4

THE IMPORT EQUATION

DEPENDENT VARIABLE: IMPORT PENETRATION	ESTIMATED COEFFICIENT (1)	*t*-STATISTIC (2)	BETA COEFFICIENT (3)	SENSITIVITY ANALYSIS (4)	γ_N[a] (5)
NTBs (γ_N)	−.51	−11.56*	**−.80**		
Capital:					
Physical capital	−2.01	−4.44*	**−.44**		−.52
Inventories	1.71	1.69	.17		−.46
Labor:					
Engineers, scientists	.54	.98	.07	†	−.55
White-collar	−1.70	−4.90*	**−.45**		−.50
Skilled	−1.27	−3.44*	**−.34**		−.55
Semiskilled	−.59	−2.01*	−.15		−.52
Unskilled	.40	1.98*	.20		−.54
Land:					
Cropland	.26	.61	.11	‡	−.53
Pasture	.85	1.77	.15		−.53
Forest	1.19	.15	.01	† ‡	−.53
Subsoil:					
Coal	1.62	.39	.02		−.51
Petroleum	−.16	−.78	−.05	†	−.61
Minerals	1.29	.39	.02		−.50
Constant	.81	15.89*	.00		

NOTE.—There are 322 observations, of which 144 have both positive NTBs and import penetration, 144 have zero NTBs and positive import penetration, and 34 have both zero NTBs and import penetration. Large beta coefficients (greater than .30) are set in boldface.

* Significant at the 5 percent level.

† The sign of the coefficient is sensitive to the choice of regressors in the NTB equation (see table 3 and Sec. IIIA).

‡ The sign of the coefficient is sensitive to the omission of two-digit SIC observations (see Sec. III*C*).

[a] Alternative estimates of the coefficient on NTBs. Each row represents a different specification in which the regressor listed in the row is endogenized by estimating a separate equation for it. If the estimate of γ_N differs significantly from −.51 then there is evidence of regressor endogeneity. In every case the Hausman test rejects endogeneity (see Sec. III*B*).

B. The Import Equation

Table 4 presents the results for the import penetration equation when simultaneously estimated with the NTB equation. The independent variables are NTBs and factor shares. For each industry and each factor, factor shares are the total (in an input-output sense) factor earnings generated by producing one dollar of final industry output. See the Data Appendix for details. Except for the inclusion of measures of protection, the equation is very similar to the single-equation specifications of Harkness (1978) and Bowen and Sveikauskas (1989).

The coefficients of the factor shares are very sensible. The regressors with the largest *t*-statistics and beta coefficients all have the expected signs and are the ones commonly identified as sources of comparative advantage. (A negative sign indicates a source of comparative advantage.) These are physical capital, white-collar labor, and skilled labor. With the exception of engineers and scientists, the labor share coefficients show the expected pattern: the more skilled the occupation, the more it is a source of comparative advantage. There are only two unexpected results among the capital and labor coefficients. First, inventories are a source of comparative disadvantage. Second, engineers and scientists are not a source of comparative advantage, reflecting the fact that the United States not only exports but also imports "high-tech" manufactures.

Judged by beta coefficients and t-statistics, the capital and labor shares are generally important whereas the land and subsoil shares are not. This is to be expected. Land is not used much in manufacturing, so it should not be thought of as a source of either comparative advantage or disadvantage in manufacturing. Subsoil factors are heavily traded internationally, so, as Leamer (1984, p. 22) demonstrated, they too should not be thought of as a source of either comparative advantage or disadvantage. Thus the factor share results are sensible.

Nontariff barriers have the predicted negative impact on import penetration. The coefficient has a very large t-statistic and a very large beta coefficient. Thus, contrary to inferences drawn from many of the models that ignore the endogeneity of protection, it appears that NTBs have substantially restricted imports. The magnitude of the reduction in imports is examined in the next section.

C. *Simultaneity Bias and Estimates of the Restrictiveness of NTBs*

The important novelty in table 4 is the estimate of γ_N, the simultaneous equations estimate of the impact of NTBs on imports. In treating tariffs and NTBs as exogenously set policy instruments, previous studies have ignored the literature on endogenous protection and thus have yielded downward-biased estimates of the impact of protection on imports. If NTBs are exogenous, the import equation can be estimated separately from the NTB equation. In this case, the import equation reduces to a single-equation Tobit model. Table 5 displays both the simultaneous equations estimate of γ_N (from table 4) and the single-equation Tobit estimate. Viewed in isolation, the single-equation results elicit confidence in the estimate of γ_N. The estimate has the predicted negative sign, it is statistically significant, and the model has a high R^2 of .58. However, when these results are compared with the simultaneous equations results, the striking feature is that the simultaneous equations estimate of γ_N is over 10 times larger than its single-equation counterpart. In addition, the simultaneous

TABLE 5

EVIDENCE OF SIMULTANEITY BIAS

DESCRIPTION OF THE MODEL	IMPORT EQUATION* γ_N (1)	t-Statistic (2)	R^2 (3)	TRADE LIBERALIZATION (4)†	(5)‡
Simultaneous equations	−.511	−11.56	.80	1.65%	\$49.5
Single equation, Tobit	−.044	−2.01	.58	.19%	\$5.5
Single equation, OLS§	−.081	−2.71	.49	. . .	. . .

* γ_N is the coefficient on NTBs in the import equation. The R^2 is the usual one based on positive-NTB observations and with $E[M_i|M_i^* > 0]$. The expectation is not conditional on NTBs, so the R^2 also reflects errors in predicting NTBs.

† The average percentage point change in import penetration as a result of eliminating all U.S. NTBs in manufacturing. It is calculated as $\Sigma\Delta M_i/144$, where ΔM_i is defined in the text and the summation is taken over the 144 industries with positive NTBs.

‡ The increase in imports (billions of 1983 dollars) as a result of eliminating all U.S. NTBs in manufacturing.

§ Ordinary least squares is estimated using observations with nonzero import penetration. It is presented as a simple data summary.

equations t-statistic is very large and the R^2 has risen to .80. This is indicative of simultaneity bias. Indeed, with the Hausman (1978) specification test, the null hypothesis of no simultaneity bias is resoundingly rejected ($\chi^2 = 148$).[9] Thus there is abundant evidence of simultaneity bias.

Estimation of the import and NTB equations allows one to calculate the amount by which NTBs have restricted U.S. manufacturing imports. This is most directly computed as the percentage point change in import penetration. Since the estimated equations are nonlinear, this is calculated as

$$\Delta M_i = E[M_i|M_i^* > 0, N_i^* = N_i] - E[M_i|M_i^* > 0, N_i^* = 0].$$

The term ΔM_i quantifies the amount by which U.S. import penetration in industry i would increase if all U.S. manufacturing NTBs were eliminated. I emphasize that this is not the usual trade liberalization experiment: NTBs are not being treated as an exogenously set policy instrument. Rather, the experiment is *conditional* on the elimination of NTBs.

The average value of ΔM_i for industries with positive NTBs is .0165. Thus if U.S. manufacturing NTBs were eliminated, the average import penetration for these industries would rise by 1.65 percentage points from 13.8 percent to 15.4 percent. A clearer impression is formed when the change is expressed as a dollar figure for

[9] More precisely, the rejected null hypothesis is that γ_N is consistently estimated from the import equation alone, i.e., H_0: $E[\varepsilon_{Mi}|N_i] = 0$. Simultaneity bias can also be examined in terms of recursiveness, i.e., H_0: $\gamma_M = \rho = 0$, where γ_M is the coefficient on imports in the NTB equation and ρ is the correlation between ε_{Mi} and ε_{Ni}. Recursiveness is also rejected.

the increase in imports. Under Cline et al.'s (1978) assumption that each dollar increase in imports replaces one dollar of domestic production, imports would rise by $49.5 billion.[10] That is, manufacturing imports would rise by 24 percent from their 1983 level of $203 billion to an unprotected level of $252 billion. This is an enormous increase, comparable in size to U.S. imports from Japan and implying an ad valorem tariff equivalent of at least 20 percent.[11]

It is well known (Baldwin and Lewis 1978; Cline et al. 1978; Whalley 1985; Deardorff and Stern 1986; Bhagwati 1988) that unless markets are explicitly modeled as being imperfectly competitive, the estimates of the impact of trade liberalization on imports will be very small. The same holds true in this study, provided that protection is treated exogenously. In the single-equation Tobit case, where NTBs are treated exogenously, the elimination of all U.S. manufacturing NTBs would increase imports by only $5.5 billion. Of the studies that do not explicitly model imperfect competition, Whalley (1985) is the one most similar to mine in that he also examines the impact of the unilateral elimination of all U.S. NTBs. Treating NTBs exogenously, he finds that imports would increase by $7.1 billion,[12] a figure very similar to mine of $5.5 billion. This provides additional confirmation of my claim that the small estimates of the impact of trade liberalization found in previous studies can be attributed to treating protection exogenously.

III. Sensitivity Analysis

Econometric studies employ a host of strong assumptions about the orthogonality of the residuals, the behavior of omitted variables, normality, measurement error, and so on. As these assumptions are not completely credible, a data analysis using them need not be taken seriously unless the resulting inferences are demonstrated to be insensitive to reasonable changes in these assumptions. In this section

[10] Let m_i, x_i, and y_i be gross imports, gross exports, and domestic production, respectively. By definition, $M_i = m_i/(y_i + m_i - x_i)$. If $\Delta x_i = 0$ and Cline et al.'s (1978) conservative assumption that $\Delta y_i = -\Delta m_i$ is used, then $\Delta m_i = (y_i + m_i - x_i)\Delta M_i$. Summing over i yields a figure of $\Sigma \Delta m_i$ = $49.5 billion. Less conservatively, if domestic production is unchanged ($\Delta y_i = 0$), the figure rises to $56.3 billion.

[11] This is the ad valorem tariff equivalent of a quota set at $203 billion, i.e., the percentage change in the supply price needed to equate the supply and demand prices at an output of $203 billion. The 20 percent figure is based on conservative manufacturing import and export elasticities of −2.0 and 1.0, respectively. Less conservatively, for import and export elasticities of −4.0 and 1.5, respectively, the tariff equivalent rises to 37.5 percent. See Goldstein and Khan's (1985) survey of estimates of U.S. trade elasticities for manufacturing.

[12] The figure is an imputation for the seven-region model using Whalley's tables 7.6 and 10.2 and is converted into 1983 dollars.

the most likely assumptions to be violated are identified and relaxed. The conclusion emerges that the inference about the impact of protection on imports is remarkably robust to changes in these assumptions.

A. *Choice of Instruments*

The theory of endogenous protection correctly predicts that the determinants of trade policy will be hidden from public scrutiny, thus making specification of the NTB equation especially difficult. Unfortunately, misspecification of the NTB equation can spill over to the import equation and undermine the estimates of γ_N and the impact of NTBs on imports. In the language of instrumental variables, the regressors in the NTB equation form a set of instruments for NTBs, and we are concerned that the coefficient on the instrumented NTBs, γ_N, is sensitive to the choice of instruments. Table 3 above addresses this concern. Recall that the table presents the results of 18 different specifications of the NTB equation, with each specification containing a different set of regressors in the NTB equation (i.e., a different set of instruments). For each specification, the estimate of γ_N appears in column 3 of the table. The estimate is sensitive to the omission of all the comparative advantage regressors at once ($\gamma_N = -.34$). However, this is not surprising since setting γ_M to zero causes this specification to fail to model most of the simultaneity posed by the theory of endogenous protection. For the remaining specifications, the estimates of γ_N vary between $-.52$ and $-.45$. Thus the estimates of γ_N are insensitive to reasonable choices of instruments.

B. *Regressor Exogeneity and Estimator Consistency*

The estimate of the impact of NTBs on imports, γ_N, may be biased and inconsistent because of the presence of endogenous regressors in the import and NTB equations. For example, high levels of import penetration reduce seller concentration, so concentration may not be an exogenous regressor. To test for exogeneity, one must specify the process generating the regressors suspected of being endogenous (Engle, Hendry, and Richard 1983; Newey 1985). Let i index observations, let M_i be imports, N_i be NTBs, and $\mathbf{Z}_i$ be a vector of regressors suspected of being endogenous. The vector $\mathbf{Z}_i$ is assumed to be generated by a normal linear process

$$\mathbf{Z}_i\mathbf{\Gamma} = M_i\boldsymbol{\theta}_M + N_i\boldsymbol{\theta}_N + \mathbf{X}_i\boldsymbol{\beta}_X + \mathbf{E}_i, \tag{2}$$

where, from an analogy to two-stage least squares, $\mathbf{Z}_i$ is "instrumented" using the remaining exogenous regressors in the import and

NTB equations, $\mathbf{X}_i$. Since the parameters of equation (2) are nuisance parameters, attention is confined to the reduced form of equation (2). This reduced form and the import and NTB equations are simultaneously estimated using FIML.

Consider the exogeneity of the regressors in the import equation. Under the Heckscher-Ohlin model, an NTB affects product prices, which in turn affect input prices (the Stolper-Samuelson theorem) and hence factor costs per unit of output (i.e., the regressors in the import equation). If so, then all the regressors in the import equation are endogenous. Unfortunately, when $\mathbf{Z}_i$ contains even three of these regressors, the number of parameters quadruples and there are almost as many parameters as nonzero observations. A parsimonious alternative is needed: I examine the hypothesis of endogeneity separately for each of the regressors in the import equation. Column 5 of table 4 reports the impact on γ_N of endogenizing one at a time the regressors of the import equation. For example, when physical capital is treated endogenously, the estimate of γ_N is $-.52$. This is almost identical to the estimate of $-.51$ reported earlier. Formally, the Hausman test based on the difference between these two estimates of γ_N resoundingly rejects the hypothesis of inconsistency because of the endogeneity of physical capital. As inspection of table 4 confirms, the same conclusion holds for each of the regressors in the import equation.[13]

Consider the exogeneity of the regressors in the NTB equation. When the regressors are endogenized one at a time, in each case the Hausman test rejects the hypothesis of inconsistency because of endogeneity. This will come as no surprise since in a linear setting with instrumental variables estimation, Spencer and Berk (1981) showed that the sensitivity analysis of the previous section is the basis for a Hausman test. Thus there is little evidence that endogeneity of the regressors in the import and NTB equations leads to biased, inconsistent estimates of γ_N.

C. *Sensitivity to Outliers*

Examination of the residuals reveals that there are a few outliers in the NTB equation in the form of industries that receive much more

[13] To endogenize more than one regressor at a time, an inconsistent but computationally feasible estimator is three-stage least squares using only observations with positive imports and NTBs. For example, when the three regressors in the import equation with the largest t-statistics are simultaneously endogenized, the estimate of γ_N is $-.70$. When none of these is endogenized, the estimate is almost identical at $-.66$. Thus in a three-stage least squares setting, the estimate of γ_N is insensitive to simultaneously endogenizing more than one regressor at a time.

protection than predicted. To check that these outliers do not unduly influence my estimates, I adopt the procedure of Belsley, Kuh, and Welsch (1980), who recommend deleting observations one at a time and reporting the consequences. When the data set is large, the effect of a single observation is likely small. To control for sample size, all observations contained in a single two-digit standard industrial classification (SIC) industry are omitted simultaneously. As there are 20 two-digit industries in manufacturing, the procedure involves 20 specifications. The results are encouraging. Over the 20 specifications the coefficient of NTBs in the import equation, γ_N, varies between $-.53$ and $-.48$. When this is measured against the full-sample estimate of $-.51$, it is clear that the estimate of the impact of NTBs on imports is not sensitive to the omission of outliers.

Many of the other coefficient estimates are more sensitive to the omission of observations. In column 4 of table 2 (the NTB equation) and column 4 of table 4 (the import equation), coefficients whose signs are sensitive to the omission of observations are indicated by a double dagger (‡).

D. *Omission of Tariffs*

Tariffs have been omitted from the analysis on the grounds that U.S. tariffs are too low to have had a big impact on imports. To investigate tariffs, I adopt Ray's (1981*a*) procedure of treating tariffs as regressors in both the NTB and import equations. The argument for treating tariffs as predetermined regressors is that applied tariff rates do not diverge much from the General Agreement on Tariffs and Trade (GATT) rates set during the Tokyo Round and that these GATT rates are themselves simple functions of even older rates. The results appear in table 6. Row 1 presents the earlier results carried over from table 4. Row 2 presents the results of including tariffs as a regressor. It is apparent that including tariffs has no effect on the conclusions drawn in this paper.

To further investigate tariffs, the model of this paper was reestimated using tariffs instead of NTBs. The results are reported in row 3. As expected, the impact of tariffs on imports is much smaller than the impact of NTBs on imports. If all manufacturing tariffs were eliminated, the industries with positive tariffs would experience an average rise in import penetration of 0.35 percentage points. In dollar terms, U.S. imports would rise by $7.7 billion. However, since tariffs and NTBs are positively correlated, by the usual omitted-variable bias calculation, these figures likely overestimate the impact of tariffs.

TABLE 6

EXAMINATION OF TARIFFS AND COVERAGE RATIOS

Dependent Variable	Import Equation γ_N (1)	Import Equation R^2 (2)	Trade Liberalization (3)*	Trade Liberalization (4)†
1. NTBs	−.51	.80	1.65%	$49.5
2. NTBs‡	−.51	.80	1.64%	$48.9
3. Tariffs	−2.38§	.91	.35%	$7.7
4. Tariff coverage	−1.07§	.90	.41%	$9.3

NOTE.—The model of this paper (eq. [1]) was reestimated using different dependent variables.

* The average percentage point change in import penetration as a result of eliminating all U.S. NTBs or tariffs in manufacturing.

† The increase in imports (billions of 1983 dollars) as a result of eliminating all U.S. NTBs or tariffs in manufacturing.

‡ Tariffs are included as a regressor in both the NTB and import equations. In cols. 3 and 4 of row 2, only NTBs are eliminated, not tariffs.

§ To facilitate comparisons, the dependent variable is scaled to have the same variance as NTBs.

E. *Coverage Ratios*

The NTBs are measured as a coverage ratio. Let i index industries, let m_i denote gross imports, let $w_i = m_i/\Sigma_i m_i$ be an import weight, and let n_i be a binary indicator of the presence ($n_i = 1$) or absence ($n_i = 0$) of an NTB. An NTB coverage ratio is defined as $\Sigma_i n_i w_i$.[14] A coverage ratio is constructed in the same way as an average tariff, the latter being defined as $\Sigma_i \tau_i w_i$, where τ_i is the ad valorem tariff rate. Thus the drawbacks of average tariff rates spill over to coverage ratios. Most prominent among these is that the aggregation weights w_i are themselves a function of protection. In particular, if a tariff or NTB is prohibitive, then $w_i = 0$ and the tariff or NTB receives a zero weight. *The surprise here is that the existence of prohibitive NTBs does not bias the estimates reported in this paper.* To see this, recall that throughout the paper NTBs were constrained to equal zero when imports were zero (see eq. [1] and the accompanying discussion). Suppose that estimation proceeded on the basis of an initial report that there are no prohibitive NTBs in the data set. If the report were later revised, from equation (1) it is apparent that the parameter estimates would not change. The revised report would have efficiency implications only. Thus the presence of prohibitive NTBs does not bias my estimates of the impact of protection on imports.

[14] The basic issue in measuring NTBs and tariffs is the choice of aggregation weights. Nontariff barriers and tariffs must be aggregated because data on their potential determinants are available only at the four-digit SIC level (448 items), whereas NTBs and tariffs are applied at the tariff-line level of about 10,000 items. Only import data are comparably disaggregated.

The advantage of average tariffs over NTB coverage ratios is that tariffs of equal height are more likely to have similar effects than NTBs of equal height. I provide two diagnostic checks of the implicit assumption that coverage ratios of equal height have equal effects. First, NTBs were disaggregated into three types: price-oriented NTBs (e.g., variable levies or dumping duties), quality-oriented NTBs (e.g., quotas, voluntary export restraints, or the multifiber arrangement), and threat-oriented NTBs (e.g., countervailing investigations). The model of this paper was reestimated three times. Each time, the dependent variable, aggregated NTBs, was replaced by one of the three disaggregated measures of NTBs. The resulting estimates of γ_N were $-.56$, $-.36$, and $-.47$ for price-, quantity-, and threat-oriented NTBs, respectively. All these coefficients are large and, for the purposes of this paper, seem close enough to $-.51$ to justify aggregating NTBs.

The second diagnostic check of the implicit assumption that coverage ratios of equal height have equal effects uses average tariffs as a benchmark. Define a tariff coverage ratio as $\Sigma_i t_i w_i$, where $t_i = 1$ if $\tau_i > 0$ and $t_i = 0$ if $\tau_i = 0$. If inferences drawn from tariff coverage ratios and average tariffs are similar, then the implicit assumption is not unacceptable. The correlation between average tariffs and tariff coverage ratios is an encouraging .78. In table 6 above, rows 3 and 4 report estimates of the model of this paper with NTBs replaced by average tariffs and tariff coverage ratios, respectively. Clearly, the key inferences are very similar for both average tariffs and tariff coverage ratios. Thus the main conclusion of this paper is robust to the measure of protection.

This section identified and relaxed a set of assumptions used to estimate the impact of NTBs on imports. It was shown that the estimate is remarkably insensitive to the choice of assumptions.

IV. Conclusions

Trade theorists have long puzzled over their surprisingly small estimates of the impact of trade liberalization on imports. While most explanations target the role of imperfect competition, this paper offers a very different explanation: previous studies treated protection exogenously, thus ignoring the theory of endogenous protection. By modeling protection endogenously, I showed that in 1983, U.S. manufacturing NTBs reduced U.S. imports by $49.5 billion. This represents 24 percent of U.S. manufacturing imports and is 10 times the estimate derived from treating NTBs exogenously. When protection was treated exogenously, my estimate of the impact of protection on imports was small and comparable to estimates reported in earlier studies (e.g., Baldwin and Lewis 1978; Cline et al. 1978; Whalley 1985; Deardorff and Stern 1986). Thus it is the endogeneity of protection that separates the results of this paper from the results of earlier studies.

The paper also offered empirical insights into the determinants of U.S. trade policy. The theory correctly predicted that the more valuable protection is to private interests, the greater the degree of protection. I found that American business has had much more influence than organized labor in shaping U.S. import policy. Also, along lines explored by Baldwin (1985), broad-based interests have had a moderately influential role in shaping policy.

Appendix

The Data

Data on NTBs are taken from the UNCTAD data base on trade control measures. Data on tariffs are taken from the GATT. All data were aggregated to the level of the Bureau of Economic Analysis input-output classification. The sample accounts for 88 percent of all manufacturing sales. The following abbreviations are used: CM for the 1982 *Census of Manufactures*, ASM for the 1983 *Annual Survey of Manufactures*, and CPS for the March 1983 *Current Population Survey*.

The NTB Equation

In the CM, for each industry, plants are grouped according to employment size. Scale is the average sales per plant as a proportion of industry sales for the median group. The four-firm concentration ratio and number of firms are taken from the CM. Weights for buyer concentration and buyer number of firms are taken from the 1977 input-output total (direct plus indirect) table with diagonal elements set to zero. Geographic concentration is defined as $\Sigma_{j=1}^{50} |(\text{VA}_{ij}/\Sigma_{j=1}^{50} \text{VA}_{ij}) - (\text{POP}_j/\Sigma_{j=1}^{50} \text{POP}_j)|$, where VA_{ij} is value added in industry i and state j and POP_j is population in state j. Value-added data are taken from the ASM. Employment size and capital stock are also taken from the ASM. Union, unemployment, and occupation data are taken from the CPS. A worker is unemployed in an industry if her longest job between March 1982 and March 1983 was in that industry. Occupation data are detailed below.

The Import Equation

Factor shares are total (direct plus indirect) shares calculated using the 1977 input-output table for the United States. All factor shares are measured as service flows per year. The exception is labor, which is measured as the number of workers. Factors were aggregated on the basis of technology (and income for labor): with SAS clustering routines, to the extent that the factor shares of two factors were similar across industries (and to the extent that the two labor occupations earned similar incomes), the factors were aggregated.

TABLE A1

Occupation Aggregates

Labor	Average Income ($)	Labor Force (%)	Occupations
Unskilled	13,002	7	Handlers, equipment cleaners, helpers, laborers; farming, forestry, fishing; services
Semiskilled	13,862	37	Machine operators, assemblers, inspectors; transportation and material moving equipment operators
Skilled	20,498	19	Precision production, craft, and repair
White-collar	22,876	31	Executive, administrative and managerial; sales; clerical; health and teaching
Engineers and scientists	31,314	5	Engineers, architects, surveyors; natural scientists, mathematicians, computer analysts

Labor

For each industry, the CPS reports the respondent's occupation, earnings, and industry of employment. Occupation aggregates are shown in table A1.

Capital

Physical capital is the sum of depreciation charges and rentals. Physical capital and inventories are taken from the ASM and various 1982 Commerce Department censuses. To convert inventories into a service flow, the inventory data were multiplied by 10 percent.

Cropland

Cropland acreage by industry is taken from the 1982 *Census of Agriculture*. The value of land services is defined as total acreage × $1,122 × .09 ($1,122 is the census value per acre of land and buildings for SIC industries 011, 013, and 016–019). Following Harkness (1978), I multiplied by .09 to convert the stock into a service flow.

Pasture

Pasture was calculated in the same ways as cropland, using SIC industries 021, 024, 025, 027, and 028; using an average value per acre of land and buildings of $609; and multiplying by Harkness's 6 percent. (The 10 percent, 9 percent, and 6 percent figures have no impact on the results since all they do is multiply regressors by a constant.)

Coal, Petroleum-Gas, and Minerals

For these factors, I followed Harkness in assuming that each factor is used directly in only one industry; for example, coal deposits are used only in coal mining. Iron, stone-clay-glass, chemicals, and nonferrous mining were aggregated into minerals. The value of these services was calculated as value added less (i) the value of labor, (ii) voluntary employer payments and social security, (iii) the value of services from physical capital and inventories, and (iv) financing costs. Data are taken from the 1982 *Census of Mining.* Financing costs were calculated as follows. From the 1983 *Internal Revenue Service Sourcebook,* calculate for all of mining (debtor + cash + investments − current liability)/(value added), which equals .40. For a particular branch of mining this figure was multiplied by value added in that branch.

Forests

This was calculated the same as mining, using data supplemented by the *U.S. Statistical Abstract,* 1983.

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