

PROTECTION FOR SALE WITH NATURAL BARRIERS TO TRADE

Russell Emmett Triplett

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Approved by:

Patrick Conway

Timothy McKeown

Anusha Chari

Alfred Field

David Guilkey

ABSTRACT

RUSSELL EMMETT TRIPLETT: Protection for Sale with Natural Barriers to
Trade

(Under the direction of Patrick Conway)

This dissertation adopts a political-economy perspective to disentangle the mutual endogeneity of imports and protectionist trade policy. The theoretical contribution is an extension of the “Protection for Sale” model that includes heterogeneous firms, monopolistic competition and fixed costs of trade. The relationship between the import-penetration ratio and the degree of protection is shown to be nonmonotonic and does not depend on exogenous variation in political activity. Rather, variation in the fixed costs of trade produces industries that differ in their vulnerability to import competition and consequently place different values on protection. This effect is illustrated in both small-country and large-country versions of the model. The empirical contribution consists of a novel application of indirect inference and nonlinear GMM to estimate the structural parameters using U.S. data. Most notably, the estimates suggest that the U.S. government values political contributions from import-competing industries at approximately thrice the rate it values consumer welfare.

To Suzanne, Caroline, Jonathan and Mason:

I love you.

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LIST OF ABBREVIATIONS

2SLS	Two-stage Least Squares
CES	Constant Elasticity of Substitution
FOC	First-order Condition
GB	Gawande and Bandyopadhyay (2000)
GH	Grossman and Helpman (1994)
GM	Goldberg and Maggi (1999)
GMM	Generalized Method of Moments
NTB	Non-tariff Barriers
OLS	Ordinary Least Squares
PAC	Political-action Committee
PFS	Protection for Sale
SIC	Standard Industrial Classification
TFP	Total Factor Productivity
WTO	World Trade Organization

LIST OF SYMBOLS

α	Relative weight government places on political contributions
e	Import elasticity
F	Fixed cost of trade
κ	Pareto distribution shape parameter
σ	Elasticity of substitution
τ	Ad-valorem tariff
Z	Import-penetration ratio

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

What is the relationship between imports and protectionist trade policies?

The standard approach to this question in the international trade literature is to treat trade policies as exogenous variables and focus on the effects of changes in trade policies on other economic variables. In this view, an episode of trade liberalization raises the level of imports much as would a fall in transportation or transaction costs. Yet unlike transportation costs, trade policies are inherently political; they are the outcome of a decision-making process that is in turn influenced by the very economic variables the policies are designed to shape. Thus, this dissertation considers the question by emphasizing the counterfactual claims inherent in any causal explanation of trade and trade policies. This is the approach of the political economy and public choice literature, where trade policies are endogenously determined by a policy maker maximizing a weighted objective function

incorporating both consumer welfare and political contributions by import-competing industries.

The goal of this dissertation is to disentangle the mutual endogeneity of imports and protection. From a theoretical perspective, this goal is accomplished through the derivation and exploration of a political-economy model of trade in which trade policy and trade levels are simultaneously determined. From an empirical perspective, this goal is accomplished through the estimation of a structural model drawn from the theory, where two different econometric strategies are employed to aid inference. The remainder of this chapter offers a detailed review of the existing theoretical and empirical literature.

Chapter 2 introduces a new theoretical model designed to disentangle the simultaneous relationship between imports and protection. It marries the political apparatus of the “Protection For Sale” framework of Grossman and Helpman (1994) to a model of trade in the tradition of Melitz (2003), featuring heterogeneous firms, monopolistic competition, free entry, variable trade costs and fixed trade costs. In this type of model, domestic firms compete with foreign firms, consumers view

domestic and foreign varieties as imperfect substitutes, and barriers to trade affect both the extensive margin of trade (the number of foreign varieties competing in the home market) and the intensive margin of trade (the market share of a given foreign firm). This model provides a richer economic environment than appears in the existing political-economy literature, generating industries whose structure and organization vary even in the absence of political trade barriers. Thus, this model affords us the opportunity to explore counterfactual scenarios—what would an industry look like and how much foreign competition would it face without political trade barriers—that influence decision making. The crux of the model is the simultaneous existence of ‘natural’ barriers to trade (barriers that are beyond the control of economic or political decision-makers) and political trade barriers (barriers that are set by the authority of the government and are subject to political pressure). Chapter 2 offers a series of comparative static effects (using both small- and large-country assumptions) that point up three important contributions to the literature: a negative relationship (or substitution effect) between the fixed cost of trade and the equilibrium level of protection; a non-monotonic relationship between

the equilibrium levels of the import-penetration ratio and protection; and the simultaneous determination of imports, protection, industrial organization and political contributions, all conditioned on the extent of ‘natural’ trade barriers.

Chapter 3 offers an empirical assessment of the theoretical model. The empirical model consists of four structural equations that simultaneously determine the level of protection, the import-penetration ratio, the import elasticity and the extensive margin of trade (the ratio of foreign to domestic varieties), all drawn from the theoretical model in chapter 2. Unfortunately, we are unable to write the corresponding reduced-form equations, and the nonlinearities and simultaneity that characterize the model complicate inference using standard techniques. Thus, we pursue two estimating strategies that address these hazards differently, checking for robustness, testing specifications and testing hypotheses in each.

The first estimation strategy is a novel application of the method of indirect inference. More common in the time-series literature, indirect inference is nevertheless beginning to appear in applied microeconomics, and to our knowledge this dissertation represents the first application to a model of trade. This technique

uses the coefficient estimates from an auxiliary model as targets for a simulation-based matching algorithm. The algorithm searches over possible values of the structural parameters and selects those that minimize the distance between the coefficient estimates of the auxiliary model and the corresponding coefficient estimates that emerge in a simulated version of the structural model. Gouriéroux et al. (1993) show that this algorithm produces estimates that are consistent and \sqrt{n} asymptotically normal for any fixed number of simulations. As Li (2010) notes, this is an especially attractive feature of indirect inference as it allows us to test hypotheses using standard methods for comparing constrained and unconstrained values of the objective function.

The second empirical strategy appears in appendix 1 of chapter 3. It consists of an application of nonlinear GMM to the same empirical model. Nonlinear GMM is an instrumental-variables estimator, so unlike the method of indirect inference, it relies on a set of exogeneity assumptions. Due to data limitations, we are unable to instrument all four endogenous variables. Rather, we move the extensive margin of trade to the right-hand side and treat it as an exogenous regressor. This has the

potential to bias the resulting estimates, so our GMM results are best viewed in comparison to those produced by the indirect inference approach. Insofar as they produce different results, we interpret that difference as evidence of bias.

The model is estimated using original data from Gawande and Bandyopadhyay (2000), consisting of a single cross-section of U.S. manufacturing industries classified according to the 4-digit SIC. This data is then augmented by a number of variables capturing industry characteristics and a measure of the extensive margin of trade. The parameter estimates are within the ranges predicted by theory. Most notably, our estimates suggest that the U.S. government values political contributions from import-competing industries at approximately three times the rate it values consumer welfare. This finding differs statistically and substantively from previous research.

Literature Review

The political-economy approach to economic policy making is at least as old as Schattschneider's (1935) seminal work on the political 'logrolling' that produced the Smoot-Hawley tariff. He showed how individual legislators with particular

sectoral and sectional interests could take advantage of the institutional structures of Congress, trade votes one for another and end up passing what has become a paragon of short-sighted economic policy. His central theme—how special interests can win out over the common good—has continued to motivate the political-economic literature right up to the present.

Two other early pioneers in this tradition are Olson (1965) and Caves (1976). Both of these authors recognize that most economic policies create winners and losers. Accordingly, they each explore and conjecture why some sectors and segments of the economy are able to influence economic policy more than others. Caves's 'adding machine' model emphasized raw voting strength—those sectors with the most employees should have a disproportionate ability to emphasize policy. Hence he predicted that the level of protection across industries would be positively correlated with the number of employees in each industry. By contrast, Olson argued that the variation in industries' effectiveness in shaping economic policy depended on their ability to organize effectively. Interest groups face a coordination problem whereby individual members have an incentive to free-ride on the efforts of

others. Olson suggested that smaller, more concentrated industries would be better able to overcome these organizational barriers and thus lobby the government with greater success.

This difference in emphasis—between voters on the one hand and lobbying on the other—gave rise to the two main branches within the literature on the political economy of trade. Mayer’s (1984) foundational ‘median-voter’ model links the determination of trade policy to the economic preferences of voters. In a world where democratic decision making reflects voting strength and voters have single-peaked preferences, economic policy should reflect the preferences of the median voter. Set in the context of a standard Heckscher-Ohlin model of trade, the median voter approach suggests that trade policy will almost always be biased in favor of labor. Hence, capital-abundant countries are predicted to adopt policies that inhibit trade while labor-abundant countries are predicted to adopt policies that promote trade. Dutt and Mitra (2001) extend the median-voter approach to account for changes in factor ownership. They predict that an increase in inequality will lead to

more restrictive trade policies in capital-abundant countries and less restrictive trade policies in labor-abundant countries.

The median voter model has received only limited empirical support (Dutt and Mitra 2001), and it is poorly suited for explaining industry-level variation in protection (Helpman 1997). The second branch of the political-economy literature, the interest-group approach, has made much more progress on this score and as a result has become the dominant paradigm. In this framework, interest groups with preferences over trade policies lobby the government and offer political contributions. These contributions are used by the government (or parties within the government) to be elected and/or reelected. The differences within this branch of the literature reflect different ways of conceptualizing political competition and the translation of contributions into policy.

Findlay and Wellisz's (1982) model postulates a 'tariff formation function.' The incumbent government's choice of tariff is the outcome of a lobbying competition between opposing lobbies, where each lobby chooses a level of political contributions to maximize its own net benefit. The equilibrium tariff is the result of

the noncooperative game played by the lobbies. In similar fashion, Hillman (1982) presents a ‘political support function’ in which the government must balance the interests of an industry lobby seeking protection against losses to consumer utility. In this approach, the government trades political contributions from the lobby against the dissatisfaction of the larger electorate. Notably, in both these cases, the form of the tariff equation is assumed rather than derived.

Magee, Brock and Young (1989) [MBY] conceptualize interest-group competition within a framework of political parties vying for power. Their economy consists of two goods and two factors in a Heckscher-Ohlin framework. Under standard small-country and competitive assumptions, MBY appeal to the Stolper-Samuelson results to generate political activity. Rather than modeling industry-specific lobbying efforts, MBY envision a political battle between capital and labor. The political process mirrors the economy—two organized interest groups, representing capital and labor respectively, lobby two political parties that compete in elections.

An important assumption in this model is the existence of a large segment of voters, unorganized and unaffiliated, whom the political parties must sway in order to win elections. The parties can ‘buy’ votes using the campaign contributions solicited from the lobbies, but the voters dislike distortionary policies, so the parties must balance the effects of their proposed trade policy against the contributions they receive. The result is a three-stage game in which the parties choose policy platforms designed to maximize their probability of winning the election, the lobbies then choose contributions designed to maximize the incomes of their members and the voters act non-strategically. Put differently, the parties play a Nash game against each other, the lobbies play a Nash game against each other, and the parties are Stackelberg leaders with respect to the lobbies.

Grossman and Helpman (1994) [GH] set the stage for much of the current literature on the political economy of trade policy. Their “Protection For Sale” [PFS] model has become a workhorse in the interest-group literature. GH combine a simple model of trade with a common-agent menu auction in which industrial lobbies simultaneously “buy” trade protection from the government with political

contributions. The government must weigh policies among different sectoral lobbies (as in Findlay and Wellisz 1982) and balance industry interests against consumer interest (as in Hillman 1982 and MBY 1989). There are no voters, no political parties and no elections. However, the most remarkable aspect of the model is that, unlike its predecessors, the PFS framework endogenously determines the functional relationship between lobbying contributions, trade policy and social welfare. GH provide micro-foundations, drawn from contract theory, for the form of the political contribution function and the modified objective function of the government.

The political aspects of the PFS framework are widely acknowledged as innovative, but the underlying model of trade and the economy is remarkably simple. The GH model features a small open economy with Ricardo-Viner technology: n goods are produced using mobile labor and specific factors, and one numeraire good produced under constant returns to scale using only labor. Individuals have quasi-linear preferences, own labor and at most one specific factor, and receive redistributed tariff revenues. The owners of at least some of the specific factors are able to overcome the collective action problem and organize politically,

forming a lobby to represent their industry. These lobbies seek to influence government policy so as to maximize the aggregate utility of its members. The government sets trade policy to maximize a combination of social welfare and political contributions from the lobbies.

The interaction between the government and the lobbies takes the form of a menu-auction where the government is the common agent. In the first stage, lobbies set their contribution schedules, specifying a level of political contributions for each possible vector of trade policies. Lobbies take into account the government's objective function and take as given the contribution schedules of all other lobbies. Assuming differentiability of the schedules, GH demonstrate that the lobbies can do no better than to offer truthful (regret free) contribution schedules, and this restriction pins down a unique equilibrium.¹ These contribution schedules are linear combinations of the utility of all lobby members less a constant determined in equilibrium.

¹ The derivation draws heavily on Bernheim and Whinston (1986).

In the second stage, the government chooses a policy vector given the contribution schedules of the lobbies. The government's objective function is a weighted sum of social welfare and political contributions. The equilibrium trade policies are then determined by the government's first order condition and typically take the form²

$$\frac{t_j}{1+t_j} = \left(\frac{I_j - a_L}{(1-\alpha) + a_L} \right) \left(\frac{1}{e_j} \right) \left(\frac{1}{Z_j} - 1 \right) \quad (1.1)$$

where j indexes industries, α is the weight placed on political contributions relative to social welfare, I_j is an indicator variable taking the value 1 if the industry is organized politically and 0 if it is not, a_L is the proportion of the population that belongs to a politically organized industry, e_j is the (absolute) price elasticity of import demand, and Z_j is the import-penetration ratio, defined here as the ratio of the value of imports to total industry consumption.³

² The notation used here is consistent with usage in chapters 2 and 3.

³ Goldberg and Maggi (1999) point out that the same expression emerges from a Nash bargaining game where trade policies are chosen to maximize the joint surplus of all parties.

The tariff equation in (1.1) offers predictions regarding the relationship between tariff levels, political structure, political organization and industry characteristics. Specifically, tariffs rise when governments place less weight on consumer welfare and when a smaller proportion of the population is organized. Conversely, free trade ensues when the government is concerned with consumer welfare exclusively, or when all consumers belong to organized industries; in the latter case, there are no unorganized groups to exploit and political rivalry results in lobbies perfectly offsetting each other. The effect of the import elasticity follows from standard Ramsey-rule logic—welfare loss is minimized by taxing goods with lower demand elasticities.

The difference between organized and unorganized industries is central to the predictions of the original article. Assuming $a_L < 1$, the level of protection falls with increases in the import-penetration ratio for organized industries ($I_j = 1$), while unorganized industries are unable to buy protection.⁴ The import-penetration ratio serves as a measure of the relative stakes of protection—the higher is domestic

⁴ Strictly speaking, the model predicts that unorganized industries are characterized by import subsidies.

output, all else equal, the higher are the potential benefits of protection to a given industry. Conversely, the higher is the level of imports, all else equal, the higher are the costs of protection to consumers and hence for the government. This result seems counterintuitive, as we would expect increased imports to trigger greater demand for protection. It is important to recognize, however, that equation (1.1) is neither a demand nor a supply equation *per se*. Rather, it is an equilibrium condition linking endogenous variables. In equilibrium, industries with higher import-penetration ratios are associated with lower tariffs both because lower tariffs permit greater flows of imports *and* because greater flows of imports raise the price of protection to the industry lobbies. Similarly, industries with lower import-penetration ratios are associated with higher tariffs both because higher tariffs reduce imports *and* because smaller flows of imports lower the price of protection.

Prior to GH, several authors offered empirical evidence in support of a *positive* correlation between the import-penetration ratio and the level of protection

(e.g., Leamer 1988; Trefler 1993; Lee and Swagel 1996).⁵ These early empirical efforts consisted largely of reduced-form estimations only loosely connected to theory. Importantly, however, through the use of extensive instrumentation, they offered evidence on the simultaneity of tariffs and imports, and demonstrated the bias inherent in treating either trade policies or trade levels as exogenous. Accordingly, this dissertation explicitly addresses the simultaneity problem while also grounding the estimating equations firmly in theory.

Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000) represent the first attempts to estimate the PFS protection equation using U.S. data. Both papers use the NTB coverage ratio at the three-digit level of aggregation as a measure of protection, and they use the same data on corporate political contributions to classify politically organized and unorganized industries. They also employ many of the industry-level variables appearing in Trefler (1993), including measures of market structure, firm concentration and skill composition of employees, as instruments for the import-penetration ratio and for the measure of political

⁵ For example, in Trefler's (1993) preferred specification, the coefficient on the import-penetration ratio is positive in the tariff equation but statistically insignificant while the coefficient on the *change* in the import-penetration ratio is positive and significant.

organization. Notably, although both papers are faithful to GH in their empirical specification of the protection equation, the estimating equations for the import-penetration ratio and political organization are only loosely connected to theory.

These two studies differ in their treatment of political contributions: Goldberg and Maggi estimate a discrete threshold level of contributions that is then used to sort industries into organized and unorganized groups, while Gawande and Bandyopadhyay include an auxiliary regression of political contributions in an attempt to distinguish trade-related contributions which is then used to form the organizational dummy. Another contrast between the two papers involves Gawande and Bandyopadhyay's extension of the model to include a consideration of the role of intermediate inputs, an innovation that does not appear in Goldberg and Maggi. Finally, these two papers treat the import elasticity differently. Goldberg and Maggi recognize that the import elasticity should be considered an endogenous variable, but they are reluctant to specify a separate reduced-form equation. Instead, they move it to the left-hand side in their protection equation, effectively scaling their measure of NTBs by the import elasticity. Gawande and Bandyopadhyay, by contrast, are

more concerned with measurement error associated with using previously published elasticities. They estimate a separate error-in-variables equation in order to correct the original elasticity numbers from Sheills et al (1985), and then treat the corrected estimates as an exogenous regressor.

Goldberg and Maggi (1999) present maximum likelihood estimates for the coefficients that correspond to equation (1.1). When an industry is politically organized, the coefficient estimate on the import-penetration ratio in their preferred specification is -0.0106 with a standard error of 0.0053. When an industry is not politically organized, the coefficient estimate on the import-penetration ratio in their preferred specification is 0.0093 with a standard error of 0.0040. Using these values, the implied parameter estimates are $a_L = 0.883$ and $\alpha = 0.021$, corresponding to a very high proportion of the population being represented by organized industries and a very low weight in the government's objective function on political contributions.

Gawande and Bandyopadhyay (2000) present 2SLS estimates for the coefficients that correspond to equation (1.1). When an industry is politically organized, the coefficient estimate on the composite import-penetration

ratio/elasticity term in their preferred specification is -3.145 with a standard error of 1.575. When an industry is not politically organized, the coefficient estimate on the composite import-penetration ratio/elasticity term in their preferred specification is 3.088 with a standard error of 1.532. Using these values, the implied parameter estimates are $a_L = 0.981$ and $\alpha = 0.905$, corresponding to a very high proportion of the population being represented by organized industries and a roughly even weighting in the government's objective function between consumer welfare and political contributions.

The parameter estimates generated in these two papers, while different in important ways, are nevertheless consistent with the PFS predictions: (i) all else equal, politically organized industries enjoy higher levels of protection; (ii) the relationship between protection and the import-penetration ratio is negative for organized industries; and (iii) the relationship between protection and the import-penetration ratio is positive for unorganized industries.

The appeal and tractability of GH's tariff equation combined with the promise of these early results led to many new empirical applications of the PFS

framework. Gawande and Bandyopadhyay (2000) and Gawande and Krishna (2005) extend the model to include intermediate inputs and estimate the tariff equation in the presence of upstream and downstream political rivalry. Eicher and Osang (2002) conduct non-nested tests of the PFS tariff equation against a tariff formation function in the spirit of Findlay and Wellisz (1992). They conclude that differences in organization rather than differences in contributions are the key determinants of protection. Mitra et al. (2002, 2006) estimate the tariff equation on Turkish data, McCalman (2004) examines Australian tariffs, Grether et al. (2001) examines protection in Mexico and Belloc (2007) applies the model to trade policy in the E.U. Matschke and Sherlund (2006) study the role of labor unions in the tariff-setting process, Facchine et al. (2006) apply the model to quota protection while Kee et al. (2005) and Gawande and Krishna (2005) investigate foreign lobbying. Each of these extensions of the PFS framework provides empirical evidence that is generally supportive of GH's main predictions: organization matters, and among organized industries, there is a negative correlation between import-penetration and protection.

Although now firmly entrenched as the dominant paradigm, the PFS framework is not without its critics. Indeed, as the model is extended in new ways, some anomalies grow in prominence. For example, although the coefficient estimates in most applications are consistent with the predictions of the model, the implied parameter values for the political weights and proportion of the population that is organized seem unrealistic and at times contradictory. That is, the coefficient estimates often suggest that a large proportion of the population is organized, yet the estimated weight on political contributions is rather small. Empirical work contemporaneous with the time period studied by GM and GB suggests that the deadweight losses due to trade policy were considerably larger than total political contributions, leading to the expectation that the government weighs contributions quite heavily (see Hufbauer et al., 1986 and Stern, 1988).⁶

A second example concerns the distinction between organized and unorganized industries. The methodologies used to delineate these two categories have come under heavy criticism and classification errors involving such a crucial

⁶ Gawande and Krishna (2003) and Mitra et al. (2006) elaborate on this point.

explanatory variable may be responsible for some of the confusing parameter estimates mentioned above. Imai et al. (2008*a*, 2008*b*) offer just such a critique, arguing that the PFS model conditions the structural relationship between industry-level characteristics and political contributions, though most empirical applications ignore this restriction. Specifically, political contributions are endogenous to the model—some industries that are organized may nevertheless choose small contribution levels. In this case, it is a mistake to classify such an industry as “unorganized.” Imai et al. (2008*c*) offer a quantile-based test of the PFS predictions that does not depend on classification according to political organization. Contrary to the results offered by GM and GB, they find a positive relationship between the import-penetration ratio and trade protection; a result more consistent with the pre-GH empirical literature mentioned above.

Mitra et al. (2006) are similarly troubled by the (mis-)classification of industries according to political organization. They approach the problem by experimenting with the PFS protection equation assuming *all* industries that receive positive protection and/or make political contributions are politically organized.

This specification limits the degrees of freedom such that the authors must estimate α given a_L (or vice versa). Nevertheless, they are able to generate parameter combinations that are much more “reasonable” using U.S. and Turkish data—that is, if the population is assumed to be highly mobilized and organized, then the parameter estimate for the lobby weight is also high, while if the population is assumed to be mostly unorganized, then the lobby weight is correspondingly low.

This recognition of the endogenous nature of political organization and contributions shifts our focus onto industry-level characteristics that might simultaneously determine political activity, trade levels and trade policies. Treﬂer (1993) included concentration ratios, median ﬁrm scale and a Herfindahl measure in his approach to endogenous tariffs, appealing to Olson’s (1965) familiar collective action logic. These same variables are often included as instruments in many of the empirical applications mentioned above, though their theoretical importance remains unexamined. Indeed, although the size and structure of industries are surely correlated with (average) productivity, productivity differences are relegated to the error term in the PFS framework. As a result, these variables appear to be poor

instruments, and the absence of theory renders the interpretation of coefficients on these variables problematic.

Karacaovali (2006) is a distinctive article that addresses the endogenous relationship between trade policy and industry productivity. He is concerned about the widespread practice of treating trade policies as exogenous when examining their effect on average productivities. Karacaovali modifies the PFS framework to accommodate differences in total factor productivity and derives a tariff equation that predicts higher tariffs for industries with higher TFP. The logic is simple—the marginal benefit of protective trade policies is higher when it applies to more output and more productive processes. He examines this relationship empirically in the context of Colombian trade reforms and is able to show that during an economy-wide liberalization, sectors with higher productivities continue to enjoy relatively higher levels of protection, and sectors with greater increases in productivity have lower reductions in tariffs. His results demonstrate that the endogenous relationship between trade policy and productivity serves to strengthen the impact of trade

liberalization on average productivities, implying that studies treating trade policy as exogenously determined are systematically underestimating this effect.

One important avenue for connecting industry-level characteristics to trade policy is to extend and elaborate the process of lobby formation. Mitra (1999) offers a formal treatment of this process. When political organization (lobby formation) is subject to fixed costs, then firms must balance the benefits of organization against the costs of joining the lobby. Accordingly, changes in trade policies alter the incentives facing firms and so affect the number of organized industries in equilibrium. When considering the effect of industry-level characteristics, Mitra illustrates that high capital stocks, low demand elasticities, less geographic dispersion and fewer members all raise the net benefit of organizing and hence raise the probability of lobby formation.

Bombardini (2008) further extends this lobby-formation framework to a model with heterogeneous firms. Again, fixed costs of organization drive the result—larger firms find it more advantageous to pay to form lobbies, so the model predicts that industries populated by a higher share of larger firms are more likely to engage

in political activity. Bombardini also provides empirical evidence in support of this prediction—industries characterized by a larger proportion of relatively large firms ultimately receive higher levels of protection.

In summary, the existing literature devoted to extending and testing the PFS framework consists of numerous successful applications of the tariff equation that generate empirical support for GH’s key prediction—that there is a negative correlation between the import-penetration ratio and the level of protection among politically organized industries. This finding seems to be at odds with empirical work outside of the PFS tradition that finds a weak positive relationship between the level of imports and the level of protection. Yet these two findings are not mutually contradictory. Within the PFS model, an exogenous shock to imports will trigger the expected increase in political contributions by an organized industry in the pursuit of a higher tariff. Hence the *demand* for protection exhibits a positive relationship between imports and tariffs. However, the higher tariff in turn lowers the import-penetration ratio and raises the welfare cost to the government thereby generating the observed negative correlation in equilibrium.

Yet this is a discussion about *effects*. The central question remains: How and why does the constellation of the level of protection, the level of import-penetration and the level of political contributions differ across industries? What are the *causes*, or put differently, what are the relevant sources of exogenous variation? For all its creativity and inventiveness, the original PFS framework is too simple to offer us the opportunity to explore the necessary counterfactual scenarios. Other researchers have recognized this shortcoming with respect to the political apparatus, extending and improving our understanding of political organization and lobby formation. This dissertation addresses the simplicity of the underlying economic model by offering a new perspective on the sources of industry heterogeneity and the consequences for political contributions, trade policy and trade flows.

We offer two broad contributions to the literature. In chapter 2 we construct a new model of endogenous trade policy using a richer and more sophisticated theory of trade than has been employed in the past. The vast majority of the literature uses either the Heckscher-Ohlin or Ricardo-Viner (specific factors) model of trade. By contrast, we employ a “new-new” model of trade, characterized by imperfect

competition and heterogeneous firms. As a result, our model generates industries that differ in their vulnerability to foreign competition and hence in their demand for protection. This is not due to exogenous differences in political organization as appears in the original PFS framework. Rather, it is due to more fundamental industry characteristics—in particular, variation in natural barriers to trade. By natural barriers to trade, we mean the fixed costs associated with entering new markets and engaging in trade across national borders.

In chapter 3 we offer a structural estimation of the model’s key parameters. Unlike much of the previous empirical research that is only loosely connected to theory, our estimating equations are derived directly from the theoretical model. We successfully employ an empirical methodology—indirect inference—that is new to the fields of international trade and political economy and that is well-suited for dealing with the many complex endogenous relationships that characterize the model. Finally, our estimation results speak directly to two of the important issues mentioned in the above review. First, using the same indicator of political organization employed in previous studies, we show that there is no significant

distinction between these two subgroups of industries, suggesting that the explanatory power that has been previously attributed to this variable is misplaced. Second, we estimate the relative weight the government places on the political contributions of import-competing interests when setting trade policy and show that it substantively and significantly differs from previously published results.

CHAPTER 2

THEORY

The “Protection for Sale” (PFS) literature has long considered industry-level characteristics to be important for the endogenous determination of trade policy, yet the parsimony of the PFS framework has left much of the associated empirical work open to criticism.¹ There is growing recognition that trade policy, trade levels, political activity and industrial organization are all simultaneously determined, but the simple economic model underlying the existing PFS framework—a small, open economy populated by identical, perfectly competitive firms that produce homogeneous goods for either domestic consumption or export, but never both—is not equipped to handle so many endogenous variables in a satisfactory manner. In this chapter we marry the PFS political architecture to an economic model adapted from Melitz (2003) featuring a small, open economy populated by heterogeneous

¹ See chapter 1 for details.

firms producing differentiated goods for (possibly) multiple monopolistically competitive markets. Importantly, the model simultaneously determines the level of imports, the level of trade protection, the level of political contributions and the industrial organization of each industry as a function of consumer preferences, the distribution of production technology and fixed costs of trade.

The crux of the model is the simultaneous existence of ‘natural’ barriers to trade and trade policy, where industries faced with low levels of natural protection pursue high levels of policy protection in equilibrium, and vice versa. This effect is shown to operate in both small- and large-country versions of the model. The result drives other important comparative static effects, including a nonmonotonic relationship between the equilibrium levels of the import-penetration ratio and policy protection. As a result, this chapter offers a new explanation for the coincident observations of both positive and negative correlations between imports and protection. Rather than being based on differences in political organization, we argue that this nonmonotonic relationship is driven by industry-level variation in natural barriers to trade.

Model Preliminaries

We begin with a small, open economy with population L .² Two types of goods are produced and consumed: a homogeneous good (sector $j = 0$) and M differentiated-goods sectors indexed by j . Each differentiated sector consists of a continuum of firms of mass N producing varieties indexed by i . Consumers have utility

$$U(q_0^c, q_{ij}^c) = q_0^c + \sum_{j=1}^M \mu_j \ln[D_j]; \quad D_j = \left((N_c^j)^{-\frac{\gamma}{\sigma}} \int_{\Omega_j} (q_{ij}^c)^\gamma di \right)^{\frac{1}{\gamma}} \quad (2.1)$$

where q_0^c is individual consumption of the homogenous good and q_{ij}^c is individual consumption of variety i in sector j . Let Ω_j represent the subset of available varieties in sector j that the individual consumes. The parameter μ_j measures the intensity of preferences for goods in sector j relative to all other sectors; in equilibrium, μ_j equals total expenditures on all varieties in sector j by an individual.

The parameter σ is the elasticity of substitution among varieties, where $\gamma = \frac{\sigma-1}{\sigma}$ and

² The precise meaning of a small-country assumption is not altogether obvious in models of this type. We follow Demidova and Rodriguez-Clare (2007) in assuming that small-country actors (including the government) take foreign demand and foreign entry as given.

$\sigma > 1$. Quasi-linear utility guarantees no income effects, and each sector enters utility in a symmetric fashion with no cross-sector effects. This is a CES utility function, but the inclusion of the N_c^j term generalizes the love-of-variety feature. As explained in Baldwin and Robert-Nicoud (2007), the parameter χ measures the intensity of preference for variety. Most users of CES utility functions assume $\chi = 0$, implying consumers have an unbounded love of variety. As a result, optimal trade policy would need to balance the ‘pro’ and ‘anti’ variety effects against other welfare effects. Here, we assume $\chi = 1$ thereby neutralizing the love-of-variety feature. Consequently, just as in the PFS paradigm, governments will not target variety when setting policy.

Individuals draw income from three sources. First, each individual is endowed with one unit of labor that generates w . Second, all tariff revenues (TR) are redistributed equally across all individuals in the population. Third, each individual is endowed with one unit of generic capital. Consequently, the individual budget constraint can be written as

$$w + \frac{TR}{L} + \pi_{ij} = q_0^c p_0 + \sum_{j=1}^M \int_{\Omega_j} q_{ij}^c p_{ij} di. \quad (2.2)$$

Maximization of (2.1) subject to (2.2) and multiplying by L yields the familiar CES aggregate demand function for any variety

$$q_{ij}(p_{ij}) = \frac{E_j}{P_j^{1-\sigma}} p_{ij}^{-\sigma} \quad (2.3)$$

where $E_j = L\mu_j$ is aggregate expenditure on all varieties in sector j and $P_j^{1-\sigma}$ is the price index in sector j . Substituting (2.3) and (2.2) into (2.1) gives the expression for indirect utility

$$V(p_{ij}, I) = w + \frac{TR}{L} + \pi_{ij} + \sum_{j=1}^M \mu_j (\ln[D_j] - 1). \quad (2.4)$$

The homogeneous good (numeraire) is produced under perfect competition, constant returns with unit labor costs and is freely traded, pinning down wages across all sectors at $w = 1$. All firms in the differentiated sectors require a fixed start-up cost of f_e^j units of capital. Individuals have a choice as to where to invest their capital endowment. They can invest it in a risk-free asset that generates zero excess return. In this case individuals are guaranteed to be able to consume their entire capital endowment. Alternatively they can use it to start a firm in one of

several differentiated-goods sectors. In this case individuals are entitled to all operating profits. Once the capital is invested in a start-up, the individual (firm owner) draws a blueprint for a variety that is tied to a specific productivity. If the firm owner draws a high productivity (low marginal cost), he/she will be able to compete in one or more markets, generating positive operating profits and hence a nonzero excess return on the investment. On the other hand, if the firm owner draws a low productivity (high marginal cost), he/she will not be able to compete in any markets—this firm shuts down and the firm owner loses his/her capital investment. We assume the risk-free asset generates zero excess return, $\tilde{r} = 0$. Each successful firm will generate a different level of sales and profits, so the return to capital will vary across firms, $r_i > 0$, while a firm failure will cost the entire capital investment, $r_i = -1$.

We further assume a large enough population to ensure perfectly elastic supplies of labor and capital. This gives the model a strong partial-equilibrium appearance: factor supplies have no effect on factor returns, and relative factor supplies have no effect on trade. Nevertheless, the monopolistically competitive

markets generate endogenously determined returns to capital, and free entry implies that the *expected* return to capital in any differentiated sector is $1 + \tilde{r}$. In equilibrium, investing in a start-up firm in any sector should be just as attractive, but no more attractive, than investing in a start-up firm in any other sector *or* investing capital in the risk-free asset.

Following Melitz (2003), we assume the productivities are distributed Pareto such that the marginal costs c are drawn from

$$G(c) = \frac{c^\kappa}{\bar{c}^\kappa} \quad c \in [0, \bar{c}], \quad (2.5)$$

where \bar{c} is the scale parameter (upper bound) and κ is the shape parameter. Firms are heterogeneous in the sense that they have different marginal costs associated with producing different varieties. Hence i indexes firms and varieties, and we can write marginal costs as a one-to-one function of varieties, $c(i) = c_i$.

Profits for the firm in sector j producing variety i with cost c are

$$\pi^{i,j} = \pi_H^{i,j} + \pi_X^{i,j} = q_H^{i,j}(p_H^{i,j} - c_i) - f^j + q_X^{i,j}(p_X^{i,j})\left(\frac{p_X^{i,j}}{\tau_X^j \psi_X^j} - c_i\right) - F^j. \quad (2.6)$$

Firm owners receive all gross profits from domestic sales, π_H , and all gross profits from foreign sales, π_X . All home firms selling in the domestic market must pay a fixed market-entry cost of $f^j > 0$ units of labor. Selling in the foreign market involves an additional set of variable and fixed costs. All home firms selling in the foreign market must pay a fixed market-entry cost of $F^j > f^j > 0$ units of labor, and all exports face an ad-valorem tariff $1 + t_X^j = \tau_X^j$ and iceberg transportation costs $1 + s_X^j = \psi_X^j$. Note that these fixed market-entry costs, tariffs and transport costs are sector-specific, but common across all firms within a sector.

Firms maximizing profits set constant markups and charge prices

$$p_H^{i,j} = \frac{c_i}{\gamma} \quad p_X^{i,j} = \frac{c_i \tau_X^j \psi_X^j}{\gamma}. \quad (2.7)$$

Consequently, the quantity sold, the revenues and the gross profits from selling in the domestic market are, respectively,

$$q_H^{i,j} = \frac{E_H^j \gamma (c_i)^{-\sigma}}{(\Delta_H^j)^{1-\sigma}} \quad r_H^{i,j} = \frac{E_H^j (c_i)^{1-\sigma}}{(\Delta_H^j)^{1-\sigma}} \quad \pi_H^{i,j} = \frac{r_H^{i,j}}{\sigma} - f^j, \quad (2.8)$$

where,

$$(\Delta_H^j)^{1-\sigma} = \int_{N_{HH}^j} (c)^{1-\sigma} dG(c) + (\tau_F^j \psi_F^j)^{1-\sigma} \int_{N_{FH}^j} (c)^{1-\sigma} dG(c). \quad (2.9)$$

The integrals in (2.9) are defined over the number of home firms that successfully compete in the home market, N_{HH}^j , and the number of foreign firms that successfully export to the home market, N_{FH}^j . They are subsets of the total number of firms that enter each market, N_H^j and N_F^j , such that $N_{HH}^j = N_H^j G(c_H^j)$ and

$N_{FH}^j = N_F^j G(c_F^j)$. Using this notation, we can write the extensive margin of trade—

the number of different varieties enjoyed by consumers in the home market—as

$N_C^j = N_{HH}^j + N_{FH}^j$. Analogously, the number of home firms that successfully export

to the foreign country, N_{HX}^j , is also a subset of the total number of firms entering

the home market, $N_{HX}^j = N_H^j G(c_X^j)$. The quantity exported to the foreign market,

the revenues and the gross profits from exporting are, respectively,

$$q_X^{i,j} = \Gamma(c_i \tau_X^j \psi_X^j)^{-\sigma} \quad r_X^{i,j} = \Gamma(c_i \tau_X^j \psi_X^j)^{1-\sigma} \quad \pi_X^{i,j} = \frac{r_X^{i,j}}{\sigma \tau_X^j \psi_X^j} - F^j. \quad (2.10)$$

The Γ in these expressions is a consequence of the small-country assumption. It represents an exogenous demand shifter that corresponds to the demand for the home country's exports in foreign markets.

The small country assumption also assures that changes in the home country will not affect entry decision in the foreign country, hence the total number of foreign firms, N_F^j , is exogenous to the model. Foreign firms seeking to export to the home market are assumed to have a similar production and cost structure as home firms. Specifically, they are heterogeneous with respect to their marginal costs and they must also pay symmetric fixed market-entry costs F^j , as well as tariffs τ_F^j and transport costs ψ_F^j . As a result, the quantities, prices, revenues and profits of foreign firms are, respectively,

$$\begin{aligned} q_F^{i,j} &= \frac{E_H^j \gamma (c_i \tau_F^j \psi_F^j)^{-\sigma}}{(\Delta_H^j)^{1-\sigma}} & p_F^{i,j} &= \frac{c_i \tau_F^j \psi_F^j}{\gamma} \\ r_F^{i,j} &= \frac{E_H^j (c_i \tau_F^j \psi_F^j)^{1-\sigma}}{(\Delta_H^j)^{1-\sigma}} & \pi_F^{i,j} &= \frac{r_F^{i,j}}{\sigma \tau_F^j \psi_F^j} - F^j. \end{aligned} \quad (2.11)$$

Setting $\pi_H^j = 0$ defines a cutoff value for the marginal cost in sector j , c_H^j , and setting $\pi_X^j = 0$ defines a second cutoff value, c_X^j . Thus, firms in the home country are sorted into three types: those that draw marginal costs in the range $[0, c_X^j]$ will successfully export and sell in the domestic market, while firms drawing marginal costs in the range $(c_X^j, c_H^j]$ will sell only in the domestic market, and firms with

marginal costs in the range $(c_H^j, \bar{c}]$ shut down prior to any production. In addition,

foreign firms selling in the home market are also subject to this sorting process.

Setting $\pi_F^j = 0$ defines a cutoff value c_F^j for foreign marginal costs such that any

foreign firm with marginal costs in the range $[0, c_F^j]$ will successfully sell in the home

market. Using the expressions for gross profits, these cutoffs can be written as

$$\begin{aligned} (c_H^j)^{1-\sigma} &= \frac{(\Delta_H^j)^{1-\sigma}}{E_H^j} f^j \sigma \\ (c_X^j)^{1-\sigma} &= \Gamma F^j \sigma (\tau_X^j \psi_X^j)^\sigma \\ (c_F^j)^{1-\sigma} &= \frac{(\Delta_H^j)^{1-\sigma}}{E_H^j} F^j \sigma (\tau_F^j \psi_F^j)^\sigma. \end{aligned} \tag{2.12}$$

Let R_H^j and R_F^j represent the total value of domestic sales and imports in

sector j such that $L_H \mu_j = E_H = R_H^j + R_F^j$, while R_X^j represents the total value of

exports in sector j . Then we can write

$$\begin{aligned} R_H^j &= N_H^j \int_0^{c_H^j} r_H^j g(c) dc = N_{HH}^j \frac{E_H^j}{(\Delta_H^j)^{1-\sigma}} \frac{\kappa}{\kappa - \sigma + 1} (c_H^j)^{1-\sigma} \\ R_F^j &= N_F^j \int_0^{c_F^j} r_F^j g(c) dc = N_{FH}^j \frac{E_H^j}{(\Delta_H^j)^{1-\sigma}} \frac{\kappa}{\kappa - \sigma + 1} (c_F^j \tau_F^j \psi_F^j)^{1-\sigma} \\ R_X^j &= N_H^j \int_0^{c_X^j} r_X^j g(c) dc = N_{HX}^j \Gamma \frac{\kappa}{\kappa - \sigma + 1} (c_X^j \tau_X^j \psi_X^j)^{1-\sigma}, \end{aligned} \tag{2.13}$$

where we assume $(\kappa - \sigma + 1) > 0$ as a regularity condition. This condition effectively

places an upper bound on the elasticity of substitution σ that depends directly on

the value of the shape parameter for the Pareto distribution κ : the greater the skew in the distribution of firms, the larger the range of permissible substitution elasticities. Using (2.12) and (2.13) we can further define the import-penetration ratio for sector j in the home country as³

$$Z^j = \frac{R_F^j}{E_H^j} = \frac{N_{FF}^j F^j \tau_F^j \psi_F^j}{L_H \mu_j}. \quad (2.14)$$

Let $E[\pi_H^j]$ and $E[\pi_X^j]$ represent the expected gross profits of home firms from selling in the domestic and foreign markets, respectively. Then the expected return on capital invested in sector j in the home country is

$E[\pi^j] = G(c_H^j)E[\pi_H^j] + G(c_X^j)E[\pi_X^j]$. Using (2.8) - (2.12) we can write

$$\begin{aligned} G(c_H^j)E[\pi_H^j] &= \int_0^{c_H^j} \pi_H^j g(c)dc = G(c_H^j)F^j \frac{\sigma-1}{\kappa-\sigma+1} \\ G(c_X^j)E[\pi_X^j] &= \int_0^{c_X^j} \pi_X^j g(c)dc = G(c_X^j)F^j \frac{\sigma-1}{\kappa-\sigma+1}. \end{aligned} \quad (2.15)$$

Free entry in each sector and the assumption of a risk-free outside option guarantees

³ In the standard PFS models the import-penetration ratio is written as the ratio of imports to domestic output. Here it is the ratio of imports to total expenditure in that sector. In any case,

$$\frac{Z^j}{1-Z^j} = \frac{R_{FF}^j}{R_{HH}^j}.$$

that the expected excess return to any unit of capital equals zero. Using (2.15) this condition becomes

$$G(c_H^j)f^j \frac{\sigma-1}{\kappa-\sigma+1} + G(c_X^j)F^j \frac{\sigma-1}{\kappa-\sigma+1} = f_e^j. \quad (2.16)$$

The Effects of Exogenous Trade Barriers

Having spelled out the details of the economy, featuring heterogeneous firms, free entry, variable trade costs and fixed trade costs, it is instructive to review the comparative static effects of an exogenous rise or fall in barriers to trade. That is, this section demonstrates the *economic* effects in the absence of politics, so as to establish the similarity of our model to that of the contemporary trade literature. These results will then be useful reference points against which to compare results from the full model with endogenous trade policy. The two exogenous changes of interest are (i) a rise or fall in the composite of the two variable trade costs facing importers $\tau_F^j \psi_F^j$, and (ii) a rise or fall in the fixed costs of trade, F^j . To ease notation, we will drop the sector superscript j and refer to the composite of the variable trade costs as Θ . In addition, the functional forms we have adopted lend themselves to the calculation and interpretation of elasticities when presenting

comparative static effects. Let ε_y^x denote the ratio of the percentage change in x to the percentage change in y . Then we define all elasticities below in the usual way

$$\varepsilon_x^y = \frac{dy}{dx} \frac{x}{y}.$$

Claim 1: An increase in the variable trade cost composite Θ leads to a fall in the import-penetration ratio, $\varepsilon_{\Theta}^Z < 0$. This effect appears along the intensive margin as foreign firms reduce the quantity of exports to the home country, $\varepsilon_{\Theta}^{q_F} < 0$, and it appears along the extensive margin as fewer foreign firms are able to compete in the home market, $\varepsilon_{\Theta}^{N_{FF}} < 0$. (See appendix B for Proof).

This is a standard result in most heterogeneous-firms models and can be brought about by a change in either the tariff or the transportation cost. The effect is monotonic—if variable trade costs continue to rise, the level of trade will eventually reach a point of prohibition (no trade). Similarly, if variable trade costs continue to fall, the level of trade will eventually reach its maximum at the free-trade solution $\Theta = 1$.

The effect of the tariff on relative prices has real effects that mirror those in standard trade models. For example, consider two firms $i = 1, 2$ in a given industry

j that are identical except that firm 1 is a home firm and firm 2 is a foreign firm. In the absence of any trade barriers these two firms would charge the same prices and sell the same quantities. Introducing a positive tariff $\tau > 1$ on foreign goods causes the foreign firm to raise its price by the entire value of the tariff (see equation (2.11)) while the home firm keeps its price constant due to the constant markup nature of pricing (see equation (2.7)). As a result, the relative price of firm 2 to firm 1 is given by the value of the tariff, $\frac{p_2}{p_1} = \tau$. Consumers respond to the increase in the relative price of good 2 by substituting away from it, $\frac{dq_2}{d\tau} < 0$, and towards more home varieties such as good 1, $\frac{dq_1}{d\tau} > 0$. The average price across all goods in the consumption bundle also rises, causing the consumer to enjoy a smaller aggregate quantity of goods for the same level of aggregate expenditure. The consumer's expenditure share on goods in sector j is constant by assumption, so the only expenditure switching that takes place is between different varieties within the same sector.

On the production side the home firm (1) increases its total sales at the same price and margin and so raises its level of profits, $\frac{d\pi_1}{d\tau} > 0$. Moreover, some previously noncompetitive home firms will find that they can now compete successfully in the home market as a result of the tariff, and the increased profitability of home firms will induce entry in the form of more individuals paying the start-up cost. By contrast, the foreign firm (2) finds that its sales and profits are both reduced, $\frac{d\pi_2}{d\tau} < 0$, representing a decrease in trade along the intensive margin. In addition, some foreign firms will find that they are no longer able to successfully compete in the home market and so will exit the market, representing a decrease in trade along the extensive margin.

Claim 2: An increase in the fixed cost of trade leads to a fall in the import-penetration ratio, $\varepsilon_F^Z < 0$. This effect is the result of a fall in trade along the extensive margin, $\varepsilon_F^{N_{FF}} < 0$, that outweighs the increase in trade along the intensive margin, $\varepsilon_F^{q_F} > 0$. (See appendix B for Proof).

In this case a rise in the fixed costs facing foreign firms reduces the number of viable importers. As a result, all remaining firms (home and foreign) increase their quantity supplied to the home market to make up for the lost foreign varieties. This in turn induces entry by new home firms, with the result that the sector is now composed of a larger number of home firms, each producing a larger quantity of goods than before, and a smaller number of foreign firms, each producing a larger quantity of goods than before. The net effect is an unambiguous and monotonic fall in the import-penetration ratio—the higher fixed cost shifts market share to home firms.

Endogenous Tariffs

We turn now to the endogenous determination of tariffs. The preceding model must be modified to include a single policy maker (the government) that sets the tariff in each sector and sector-specific lobbies that use the joint profits of all firms in a sector to ‘purchase’ protection. In this version of the model, firms again face three kinds of barriers—two are ‘natural’ in the sense that they are exogenous (the transport cost ψ_F and the fixed cost F), while the third is subject to

manipulation by the policy maker (the tariff τ). As we explain below, the extent of natural barriers within a sector serves to influence the cost-benefit analysis of its lobby when determining what level of protection to purchase.

Social welfare in the home country is the aggregated version of (2.4) and takes the form

$$\begin{aligned} SW &= L V(p_{ij}, I) \\ &= L + \sum_{j=1}^M TR^j + L \sum_{j=1}^M E[\pi^j] + L_H \sum_{j=1}^M \mu_j \left(\ln[(N_{HF}^j)^{\frac{1}{1-\sigma}} \frac{\gamma \mu_j}{\Delta_H^j}] - 1 \right). \end{aligned} \quad (2.17)$$

As in the original PFS framework, we assume the existence of sector-specific lobbies that represent all operating firms within a sector. GH posited that some sectors successfully organize while others do not, and the key prediction of their model is built on this exogenous distinction. By contrast, we assume all industries successfully organize and offer political contributions in exchange for tariff protection. The level of contributions is therefore an endogenous outcome determined in equilibrium. We adopt this assumption for two reasons. First, we prefer to let the model determine which industries have the strongest incentives to make political contributions rather than arbitrarily denoting some industries as

‘unorganized.’ Indeed, some industries may in the limit choose to make zero political contributions and so mimic an ‘unorganized’ industry. Second, in the data used in chapter 3, all industries are observed to make nonzero PAC contributions. Accordingly, we prefer to model the variation across contributions, rather than to automatically associate low contributions with a lack of political organization.

A more comprehensive approach would endogenize both the decision to organize and the size of the political contribution, conditional on successful organization. For example, suppose there was some threshold cost of organization that would serve to delineate organized and unorganized industries. This configuration would then give rise to a coordination game among individual firms within each industry. Each firm would have to decide how much it would be willing to contribute towards the formation of a lobby based on its expected benefits from the lobby’s political activities and contributions. However, each firm would also have an incentive to free ride on the efforts of the remaining firms because the benefits of the tariff cannot be limited to contributors. Thus each firm’s optimal strategy would depend not only on expected benefits of the tariff, but also on the

expected contributions of its peer firms. This game can become quite complicated, as we would not expect a symmetric equilibrium in industries populated by heterogeneous firms. In other words, industrial organization (average firm size, dispersion of firm sizes, market concentration, etc.,) would be expected to influence political organization and contributions, and at the same time the resulting tariffs would influence industrial organization. Mitra (1999) and Bombardini (2008) are two examples of efforts to formalize this process. We discuss extensions to the present model along these lines in chapter 4.

Lobbies set truthful contribution schedules taking the form

$$PC^j(\tau_F^j) = \Pi^j(\tau_F^j) - B^j, \quad (2.18)$$

where Π^j represents the total profits earned by all operating firms in industry j in the home country and B^j is a constant determined in equilibrium. Hence the political contributions used to purchase protection are simply some portion of total industry profits. Lobbies do not care about consumer prices as they perceive their sector to be too small to have appreciable effects in the aggregate—this is the “ice-cream clause” as noted in Baldwin (2006); it corresponds to example 3 in GH. This

specification removes any rivalry from the industry lobbies, and it implies that they need only contribute just enough to satisfy the government's participation constraint. Specifically, the lobbies set their B 's such that the government is just indifferent between the equilibrium outcome that would emerge in the absence of the lobby and the equilibrium outcome with the preferred tariff.

Note the contribution schedule reflects the benefits of high home tariffs on foreign imports. Further, note that a change in tariffs affects the profits of all existing firms and, by altering the cost cutoffs, influences entry and selection into markets. Combining (2.16) and the simplifying assumption $f_e^j = 1$ for all j lets us write

$$\Pi^j(\tau_F^j) = N_H^j(\tau_F^j) \quad (2.19)$$

The important point here is that the effect of the tariff on total industry profits, and therefore on political contributions, runs parallel to the effect of the tariff on entry. Moreover, any other exogenous change that induces new firms to enter the industry will also raise total industry profits.

A government that accepts political contributions in the fashion above chooses tariffs to maximize a weighted political support function where α is the relative weight placed on political contributions from any sector. When $\alpha = 0$ the government does not value political contributions, when $\alpha = 1$ the government values political contributions on an equal basis with consumer welfare, and when $\alpha > 1$ the government values political contributions relatively more than consumer welfare. The quasi-linear utility function and partial-equilibrium nature of this model permits the government to set tariffs sector by sector without any spillover effects. Thus, for any sector j , the government's problem takes the form

$$\max_{\tau_F^j} \left\{ \text{SW}(\tau_F^j) + (\alpha) \text{PC}^j(\tau_F^j) \right\} \text{ s.t. } \tau_F^j \geq 1. \quad (2.20)$$

Note that the wage is independent of any sector's tariff and the expected return to capital is determined by the free-entry condition. The government does not observe each individual's capital return, but knows that on average the excess return is zero for all values of the tariff. Consequently, from the government's perspective, the only components of social welfare that are functions of the tariff are the redistributed

tariff revenue and consumer surplus (through the price index). This results in first-order conditions for each sector j that take the form⁴

$$\frac{L\mu_j}{1-\sigma} \frac{(\Delta_H^j)^{1-\sigma}}{N_{HF}^j} \frac{d\left(\frac{N_{HF}^j}{(\Delta_H^j)^{1-\sigma}}\right)}{d\tau_F^j} + \frac{dTR^j}{d\tau_F^j} + (\alpha) \frac{dN_H^j}{d\tau_F^j} \leq 0. \quad (2.21)$$

The first term on the left-hand side captures the effect of the home tariff on consumer surplus. In this model, with the love-of-variety effect neutralized, consumer surplus unambiguously falls with a rise in the home tariff. This is because consumers only care about the average price in each industry--and tariffs raise average prices. The second term on the left-hand side captures the effect of the home tariff on tariff revenue in each industry. This term follows a typical pattern—for very low levels of the tariff, incremental increases will increase tariff revenue, while for high levels of the tariff, incremental increases will decrease tariff revenue. The third term on the left-hand side captures the effect of the home tariff on

⁴ The first-order conditions will equal zero for any nonzero equilibrium tariff. If the constraint binds, $\tau_H^j = 1$, then the conditions may not be satisfied as a strict equality.

political contributions via total industry profits. This term is always positive—a higher home tariff raises the profitability of home firms and encourages entry.⁵

The complexity of this model requires that some of the parameters be restricted so that we can focus attention on interior solutions. For example, a trading equilibrium featuring incomplete specialization requires positive demand for the homogeneous good at home and abroad. This requirement effectively restricts the value of μ_j for each sector (or rather, the sum across sectors). That is, there is an upper bound on $\sum_{j=1}^M \mu_j$ so that consumers do not spend all of their income on the differentiated products. Similarly, there is a lower bound on the fixed cost of domestic market entry, f^j , such that the domestic cost cutoff, c_H^j , does not coincide with the upper limit of the cost distribution. The implication would be that all entering firms would be successful in this industry, effectively violating the free-entry condition.

⁵ The uniqueness of the optimal tariff is guaranteed by the concavity of the government's objective function. This feature is demonstrated numerically in appendix A.

Comparative Statics of Endogenous Tariffs

In particular, we are most interested in the comparative static effects of variation in the fixed costs of trade F . We focus attention on fixed costs for two key reasons. First, fixed costs play a crucial role in the literature relating firm heterogeneity to trade flows and trade volumes (e.g., Bernard and Jensen 1999, 2001; Tybout 2003; Helpman, Melitz and Yeaple 2004), yet they are entirely absent from the literature on endogenous tariffs. By the fixed costs of trade we mean the fixed costs associated with entering a new market. These can involve the costs associated with modifying domestic models for foreign tastes, adapting packaging for foreign markets, minimum freight and insurance charges, and constructing and maintaining marketing, distribution and service networks for a foreign clientele. These fixed costs of trade might also reflect information costs associated with learning about foreign demand as well as mastering and monitoring foreign bureaucratic procedures relating to customs, product standards and the enforcement of contracts. These costs can be substantial—in a detailed study of the Colombian chemicals industry,

Das, Roberts and Tybout (2001) generate estimates for the firm-level cost of entering foreign markets that range from \$730,000 to \$1.6 million.

Second, in models of the type considered here, fixed costs affect all of the endogenous variables of interest—trade, tariff lobbying and industry-level productivity measures—and so offer a truly exogenous source of variation across industries. The higher is the fixed cost of trade for any sector j , the more costly it is to enter the foreign market relative to entering the domestic market. This is a “natural” barrier to trade in the sense that it is not the direct outcome of a government policy decision and is therefore not susceptible to the usual channels of political influence. Consequently, whether and to what extent firms and industries operate behind high natural barriers influences how they weigh the costs and benefits of lobbying for trade protection.

Claim 3: An increase in the fixed cost of trade leads to a fall in the equilibrium tariff, $\varepsilon_F^\tau < 0$. Sectors that face increased import competition via a fall in a natural barrier to trade turn to the government and purchase tariff protection

as a substitute. This effect is illustrated in figure 2.1.⁶ (See appendix C for further numerical demonstrations).

Sectors which are already shielded from import competition in the form of a high F find the gains from tariff protection to be especially expensive—the marginal benefits (in the form of higher industry profits) are small while the government requires a large compensating contribution to offset further restriction of trade. By contrast, sectors with low F face much greater competition from foreign firms. These sectors have more to gain from marginal increases in tariff protection, and the government requires a relatively smaller contribution to enact the tariff. The net result is that the equilibrium home tariff is monotonically decreasing in F .

This result is not typical in the contemporary trade literature. In Melitz-style models, the effects of changes in variable trade costs are completely independent of the effects of changes in fixed trade costs. By contrast, in combining the model of trade with a model of endogenous protection, we have transformed the variable trade

⁶ All figures in this chapter were generated by solving the model numerically and then varying the natural barrier to trade F . The parameters were set to $\sigma = 3.9$, $\kappa = 3.5$, $\alpha = 1$, $\bar{c} = 1$, $f = 1$, $f_e = 1$ and the exogenous variables were set to $N_f = 500$, $E = 5000$, $X = 100$.

cost into an endogenous variable. Accordingly, claim 3 specifies the nature of the effect of changes in the fixed trade cost on the equilibrium value of the variable trade cost.

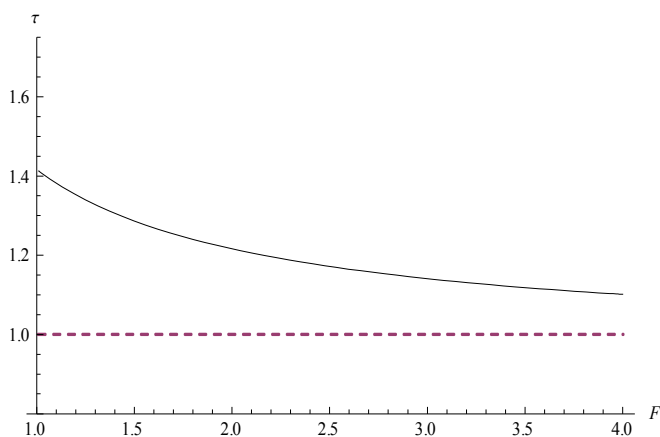


Figure 2.1

We next consider the relationship between the fixed cost of trade and the import-penetration ratio. This involves two conflicting effects—an increase in the fixed cost of trade reduces the level of imports, but as explained above it also raises the ‘price’ of tariff protection resulting in a lower equilibrium tariff. The net effect on the import-penetration ratio can be positive or negative, depending on the current level of the fixed trade cost.

Claim 4: An increase in the fixed cost of trade will lead to an increase in the import-penetration ratio, $\varepsilon_F^Z > 0$, for relatively low values of F —specifically, over that range of F for which the intensive-margin effect outweighs the extensive-margin effect, $|\varepsilon_F^{qF}| > |\varepsilon_F^{N_{FF}}|$. Conversely, an increase in the fixed cost of trade will lead to a decrease in the import-penetration ratio, $\varepsilon_F^Z < 0$, for relatively high values of F —specifically, over that range of F for which the extensive-margin effect outweighs the intensive-margin effect, $|\varepsilon_F^{qF}| < |\varepsilon_F^{N_{FF}}|$. This effect is illustrated in figure 2.2. (See appendix C for further numerical demonstrations.)

The relationship between the import-penetration ratio and F is nonmonotonic. When the extent of natural barriers is already high, an exogenous shock that increases imports (such as a fall in the natural barrier) triggers increased sectoral lobbying for tariffs. But restoring the prior level of imports requires a tariff level whose marginal cost, in the form of greater political contributions, outweigh the marginal benefits for total industry profits. This is because trade is already low to begin with—a further reduction has little impact on market share or profits, but a marginal increase in trade matters to consumers (and therefore the government)

relatively more. The result is that an industry that enjoys high natural barriers to trade effectively “accommodates” the import shock by allowing the equilibrium level of the import-penetration ratio rise.

By contrast, when the extent of natural barriers is already low, an exogenous shock that increases imports (such as a further fall in the natural barrier) again triggers new sectoral lobbying. In this case, however, the marginal benefits of the tariff to the lobby exceed the marginal costs in the form of political contributions required to compensate the government. As a result, the lobby “purchases” a tariff level that is even higher than the level that would be required to restore the prior level of imports. Accordingly, an industry with low natural barriers to trade tends to “overcompensate” for the shock thereby causing the equilibrium level of the import-penetration ratio to fall.

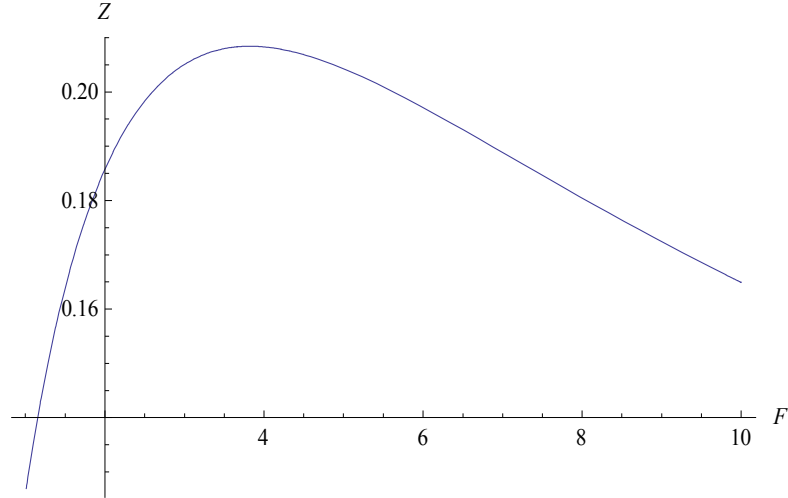


Figure 2.2

This nonmonotonic relationship can also be conceptualized in terms of the extensive and intensive margins of trade. When a change in natural barriers causes a relatively greater change along the extensive margin of trade than it does along the intensive margin of trade, then the direct effect of the change in the natural barrier determines the direction of the change in the import-penetration ratio. This is the case when the natural barrier is especially high—an exogenous shock that increases imports has an especially strong effect on the entrance of new foreign firms into the domestic market. Even though the import-competing industry lobbies and the tariff is raised, it does not completely offset the increase in imports. On the other hand, when a change in natural barriers causes a relatively greater change along the

intensive margin of trade than it does along the extensive margin of trade, then the indirect effect of the change in the natural barrier, through the tariff, determines the direction of the change in the import-penetration ratio. When the natural barrier is low, an exogenous shock that increases imports will have its strongest effect on the per-firm quantity of imports. In this case, when the import-competing industry lobbies and is granted protection, the new tariff rate more than offsets the increase in imports. The maximum level of the import-penetration ratio occurs at a threshold value of F where the extensive-margin effect and the intensive-margin effect completely offset.

Considering endogenous tariffs and the level of trade together provides insight into an active debate within the empirical literature. A common result is the distinction between two sub-groups of industries, one characterized by a positive relationship between import-penetration and tariffs and the other characterized by a negative relationship between import-penetration and tariffs (e.g., Goldberg and Maggi 1999 and Gawande and Bandyopadhyay 2000). In the original PFS framework, these groups are delineated according to political organization. Yet some

authors have criticized this interpretation on the grounds that political organization and contributions are also endogenous to the model (e.g., Imai 2008*a*, 2008*b*). In the model presented here, both patterns emerge—industries characterized by relatively high natural barriers to trade (above the threshold) will generate a positive correlation between import penetration and tariff protection, while industries characterized by relatively low natural barriers to trade (below the threshold) will generate a negative correlation between the level of trade and tariff protection. This configuration is illustrated in figure 2.3. Note that this pattern emerges in our model even though *all* industries are assumed to be politically active.

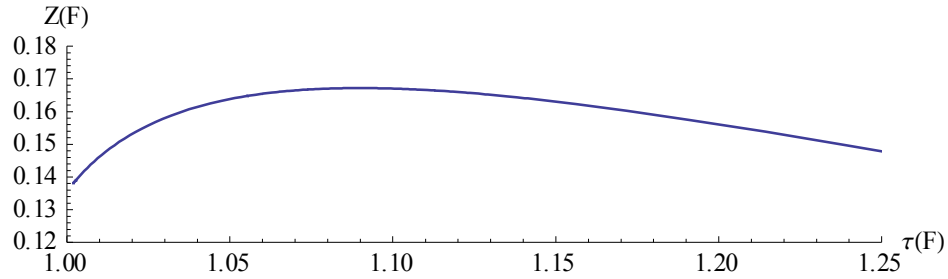


Figure 2.3

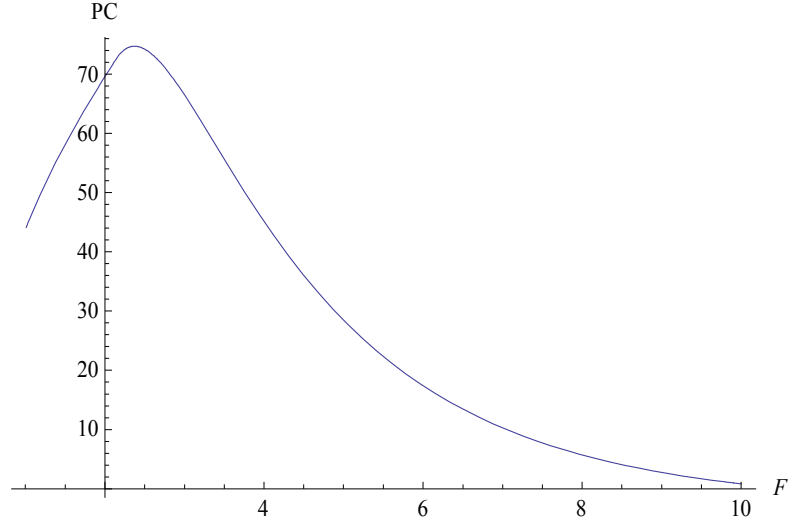


Figure 2.4

Examination of the endogenous political contributions yields additional insight. Generally, as F falls, political contributions rise, as illustrated in figure 2.4.⁷ Recall that contributions come out of the total profits earned by all firms in an industry, and they are set by lobbies so as to make the government's participation constraint bind. In the influential empirical work of Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000), the method used for delineating organized and unorganized industries was to construct a cutoff level of political contributions above

⁷ Contributions begin to fall again at very low levels of F . This is because in this low range, average prices are actually increasing with increased imports—the effect of the rise in the foreign export cutoff on the average price begins to outweigh the fall in the domestic cutoff because of the large share of imported varieties in the domestic consumption basket. This corresponds to a situation in which there is “too much trade,” even from the perspective of utilitarian social welfare, so the lobbies need not contribute as much to compensate the government and acquire tariff protection.

which industries were coded as ‘organized.’ In both papers, it was precisely these ‘organized’ industries (relatively larger contributions) that exhibited a negative relationship between tariff protection and import-penetration. Consequently, these empirical results were interpreted as offering support for the central hypotheses of the PFS model. Yet when we consider the pattern illustrated by figures 2.3 and 2.4 together, a new explanation emerges. In this model, all industries are organized, all industries make political contributions and all industries receive tariff protection. The crux is that all three of these endogenous outcomes are driven by variation in F . Industries on the upper end of the fixed-cost spectrum value tariffs less, contribute less and thus permit increases in imports as F falls. As a result, the tariff rises along with the import-penetration ratio, not because the industry is unorganized, but because it continues to enjoy a degree of ‘natural’ protection. Conversely, industries on the lower end of the fixed-cost spectrum value tariffs more, contribute more and succeed in lowering the level of imports as F falls. As a result, the tariff rises while the import-penetration ratio falls, not because the industry is organized, but because

it does not enjoy much ‘natural’ protection and so must actively lobby for political protection.

This explanation for the endogenous relationship between imports and tariffs offers a unifying framework for reconciling the early empirical work of Leamer (1988), Trefler (1993) and Lee and Swagel (1996), who find a positive relationship, and that of Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000), who identify a negative relationship. In our model both occur and are dependent on the degree to which an industry enjoys ‘natural’ protection in the form of high fixed costs of trade.

When considering the effects of trade and protection on industry-level productivity, it is natural to examine the changes in the domestic marginal-cost cutoff, c_H , as illustrated in figure 2.5. Recall that when this variable increases, more domestic firms find it easier to compete in the home market. Moreover, these previously uncompetitive firms have higher marginal costs (lower productivities) than the average for the industry. Conversely, when c_H decreases, fewer home firms are able to successfully compete in the home market, and those that exit have higher

marginal costs (lower productivities) than the average for the industry. Hence, a familiar prediction in heterogeneous-firm models is that increased trade flows will have a pro-competitive effect, lowering c_H and raising the average productivity of the industry (e.g., Melitz 2003). We see this in our model as well; just as the relationship between the fixed cost of trade and the import-penetration ratio is nonmonotonic, so the relationship between the domestic cost cutoff c_H and the fixed cost of trade is also nonmonotonic.

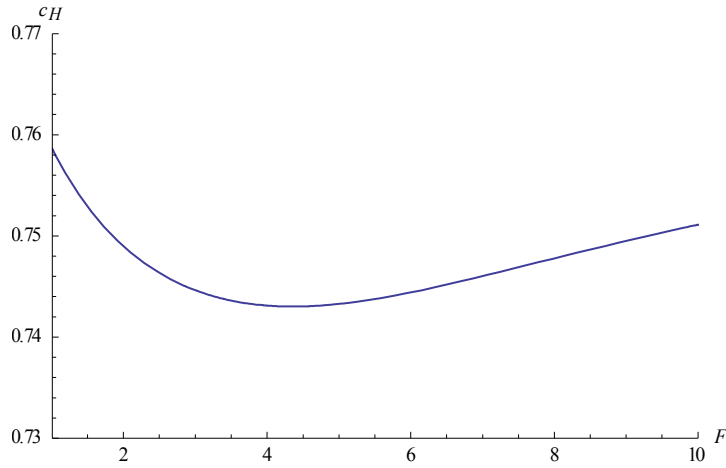


Figure 2.5

A fall in F will reduce the domestic cutoff (raise average productivity) because it encourages more foreign competition and forcing the least productive domestic firms to exit. But a fall in F also triggers more lobbying and a higher tariff, providing protection for many of these same least productive firms. The net effect on average productivity is nonmonotonic and inversely related to the import-penetration ratio. When the natural barrier to trade is high, we would expect to observe a positive relationship between tariff protection and average productivity. These industries are simultaneously acquiring greater tariff protection *and* increasing their average productivity—precisely because the new tariff is not large enough to stymie all of the new imports. By contrast, for industries with low natural barriers, we would expect to observe a negative relationship between tariff protection and average productivity. These industries are acquiring high enough tariffs to reduce the level of imports thereby protecting their least-productive firms.

In this model, then, the most productive industries are characterized by the highest levels of trade, but they are expected to have neither the highest *nor* the lowest tariffs. Moreover, just as these most productive industries are characterized

by intermediate-level tariffs, so too are they characterized by intermediate levels of political contributions. In other words, some industries are less productive because of ‘natural’ barriers to trade which substitute for tariff protection and require little or no political contributions. Other industries are less productive because of their rent-seeking activities—in the absence of ‘natural’ barriers, these industries actively lobby for tariff protection, offer larger political contributions and thereby reduce the level of trade. The most productive sectors occupy that space wherein changes in ‘natural’ barriers to trade are just offset by changes in political barriers.

The Large-Country Case

A consequence of the small-country assumption is that the home government does not act strategically with respect to foreign economic variables. In this section we reformulate the model to capture the international dimension of trade policy.

The large-country version of the model features a “two-level” endogenous tariff game in the spirit of Putnam (1988), Mo (1994) and Grossman and Helpman (1996), where the home governments act strategically with respect to domestic lobbies and with respect to the foreign government. The results show that the substitution

effect between the fixed cost of trade and the endogenous tariff that formed the centerpiece of the previous section is not limited to the small-country case.

Consider a two-country model where the home country is the same as above and the foreign country has symmetric utility functions, production functions, cost distributions and political structures. We denote home variables with the subscript H and foreign variables with the subscript F . We add foreign versions of the same modeling equations, with a few notable exceptions. First, the expressions for home country exports to the foreign country in (2.10) must be rewritten so as to represent foreign demand explicitly, thereby adding the price index in the foreign country as an additional endogenous variable. The new expressions take the form

$$q_{HX}^{i,j} = \frac{E_F^j (c_i \tau_F^j \psi_F^j)^{-\sigma}}{(\Delta_F^j)^{1-\sigma}} \quad r_{HX}^{i,j} = \frac{E_F^j (c_i \tau_F^j \psi_F^j)^{1-\sigma}}{(\Delta_F^j)^{1-\sigma}} \quad \pi_{HX}^{i,j} = \frac{r_{HX}^{i,j}}{\sigma \tau_F^j \psi_F^j} - F^j. \quad (2.22)$$

Second, the derivation of the cost cutoff for home firms to export in (2.12) must reflect the same endogenous price index in the foreign country, and we need to add the derivation of the cost cutoff for foreign firms to sell in their domestic market.

The new expressions take the form

$$\begin{aligned}
(c_F^j)^{1-\sigma} &= \frac{(\Delta_F^j)^{1-\sigma}}{E_F^j} f^j \sigma \\
(c_{HX}^j)^{1-\sigma} &= \frac{(\Delta_F^j)^{1-\sigma}}{E_F^j} F^j \sigma (\tau_F^j \psi_F^j)^\sigma.
\end{aligned} \tag{2.23}$$

Third, the expressions for the total value of domestic sales and imports in (2.13) are similarly updated. The new expressions take the form

$$\begin{aligned}
R_F^j &= N_F^j \int_0^{c_F^j} r_F^j g(c) dc = N_{FF}^j \frac{E_F^j}{(\Delta_F^j)^{1-\sigma}} \frac{\kappa}{\kappa - \sigma + 1} (c_F^j)^{1-\sigma} \\
R_{FX}^j &= N_F^j \int_0^{c_{FX}^j} r_F^j g(c) dc = N_{FX}^j \frac{E_H^j}{(\Delta_H^j)^{1-\sigma}} \frac{\kappa}{\kappa - \sigma + 1} (c_{FX}^j \tau_H^j \psi_H^j)^{1-\sigma} \\
R_{HX}^j &= N_H^j \int_0^{c_{HX}^j} r_{HX}^j g(c) dc = N_{HX}^j \frac{E_F^j}{(\Delta_F^j)^{1-\sigma}} \frac{\kappa}{\kappa - \sigma + 1} (c_X^j \tau_F^j \psi_F^j)^{1-\sigma}.
\end{aligned} \tag{2.24}$$

Finally, we must add a free-entry condition for the foreign country that determines

the number of foreign firms seeking entry. This expression is analogous to (2.16)

and takes the form

$$G(c_F^j) f^j \frac{\sigma - 1}{\kappa - \sigma + 1} + G(c_{FX}^j) F^j \frac{\sigma - 1}{\kappa - \sigma + 1} = f_e^j. \tag{2.25}$$

The foreign government chooses its tariff to maximize an objective function

that is symmetric to that of the home government in (2.20) and takes the form

$$\max_{\tau_F^j} \left\{ \text{SW}_F(\tau_F^j, \tau_H^j) + (\alpha) \text{PC}_F^j(\tau_F^j, \tau_H^j) \right\} \quad \text{s.t. } \tau_F^j \geq 1 \tag{2.26}$$

Note that both tariffs now enter the objective functions of both governments. In the large-country model, each government recognizes that it can affect the price index and entry in the *other* country. Moreover, each government recognizes that the *other* tariff can affect the price index and entry in its own country. Consequently, we interpret both government's first-order conditions as reaction functions of the form $\tau_H^j(\tau_F^j)$ and $\tau_F^j(\tau_H^j)$. The Nash equilibrium vector of tariffs is then determined by solving these reaction functions simultaneously.

Once again we turn to numerical methods to solve the model.⁸ Figure 2.6 graphs the reaction function of the home government. It is downward sloping, capturing the idea that the home government finds it optimal to lower its own tariff when faced with a higher foreign tariff. That is, the home and foreign tariffs act as “strategic substitutes,” as in Brander and Spencer’s (1985) influential work on oligopoly and trade policy. The common element is that the strategic decision-makers are Cournot players—faced with increased competition and market penetration from abroad, the best response for the home player is to accommodate

⁸ Unless otherwise noted, the graphs in this section are drawn for $\sigma = 3.0$, $\kappa = 3.5$, $\alpha_H = \alpha_F = 1$, $\bar{c} = 1$, $f = 1$, $F = 2$, $f_e = 1$, $E_H = E_F = 10000$.

the foreign player.⁹ In our model this property emerges because of the tariff's effect on entry—a higher foreign tariff not only protects its own domestic market, but it also promotes foreign exports to the home country by encouraging new foreign start-ups. Consequently, a higher foreign tariff raises the welfare cost to the home government of raising its own tariff.

The three curves are drawn for different values of F , the fixed cost of trade facing firms in either country. Increases in the fixed cost of trade shift the reaction function inward, all else equal. This is consistent with the logic of our previous results—the fixed cost of trade is a substitute for tariffs. A higher fixed cost of trade leads the home government to choose a lower tariff for any given foreign tariff because industries already shielded by a high fixed cost of trade value tariffs less (and so offer less in political contributions) than industries with a low fixed cost of trade.

⁹ This is in contrast to models with upward-sloping reaction functions characterized by Bertrand competition as in Eaton and Grossman (1986).

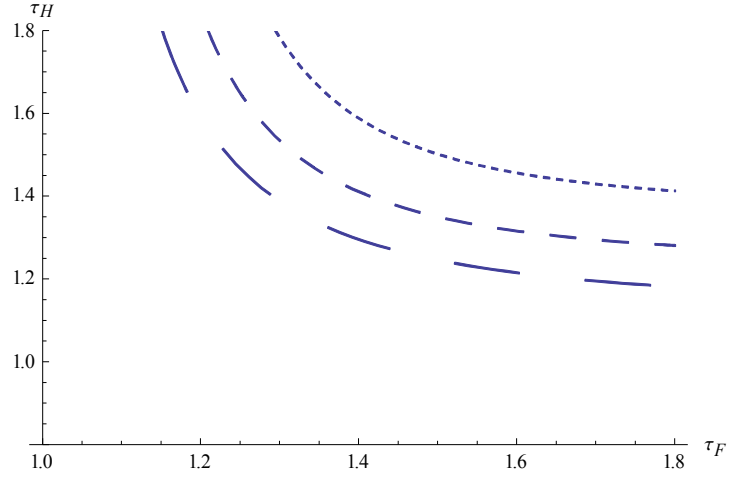


Figure 2.6

Figure 2.7 graphs the reaction function of the home government for different values of α_H , the weight the home government places on political contributions.

The dashed curves are drawn for positive values of α_H , where increases in the value of α_H shift the reaction function outward, all else equal. This is consistent with our previous results—the more the home government cares about political contributions (and therefore industry profits), the higher the tariff it will choose for any given foreign tariff.

The horizontal line with the smallest dashes in figure 2.7 is drawn for a home government that places no weight on political contributions ($\alpha_H = 0$). This curve illustrates the idea that utilitarian governments, who care only about consumer

welfare, can never do better than to adopt free trade regardless of the size of the foreign tariff. This is because consumers only care about average prices in this model, and raising the home tariff always increases average prices in the home market. It is interesting to note that this is a slight departure from what we observed in the small-country model. There, even a utilitarian government might choose a positive tariff as a second-best response to the distortions created by imperfect competition. In the large-country case, however, this optimal-tariff rationale disappears because a rise in the home tariff reduces entry in the foreign country. This has an anti-competitive effect—markups of the surviving firms rise.

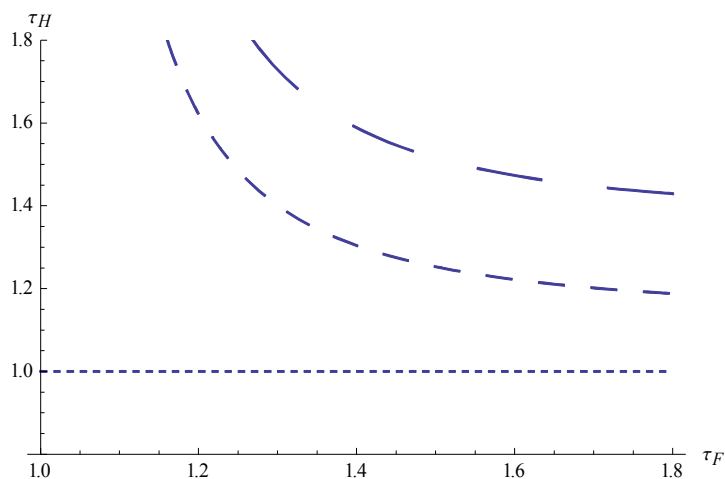


Figure 2.7

A Nash equilibrium is defined as that vector (τ_H^j, τ_F^j) that simultaneously solves the system of first order conditions given by

$$\begin{cases} \frac{L_H \mu_j}{1 - \sigma} \frac{(\Delta_H^j)^{1-\sigma}}{N_{CH}^j} \frac{d\left(\frac{N_{CH}^j}{(\Delta_H^j)^{1-\sigma}}\right)}{d\tau_H^j} + \frac{dTR_H^j}{d\tau_H^j} + (\alpha_H) \frac{dN_H^j}{d\tau_H^j} \leq 0 \\ \frac{L_F \mu_j}{1 - \sigma} \frac{(\Delta_F^j)^{1-\sigma}}{N_{FC}^j} \frac{d\left(\frac{N_{FC}^j}{(\Delta_F^j)^{1-\sigma}}\right)}{d\tau_F^j} + \frac{dTR_F^j}{d\tau_F^j} + (\alpha_F) \frac{dN_F^j}{d\tau_F^j} \leq 0 \end{cases} \quad (2.27)$$

The equilibrium vector is that combination of the home and foreign tariff that simultaneously satisfy each government's reaction function. These endogenous tariffs are therefore optimal in the sense that they maximize their respective government objective functions (the domestic game) and they represent a best-response to the other government's tariff (the international game).

It is important to note this equilibrium need not be optimal from a global perspective. Let us define a vector of tariffs to be globally optimal if it maximizes the sum of the two countries' welfare functions. Figure 2.8 graphs the symmetric case where global welfare is measured on the vertical axis and the (identical) tariff is measured on the horizontal axis. From this graph it is easy to see that global welfare is maximized (and in the symmetric case each country is better off) when

both countries adopt free trade. This is the classic noncooperative result—in the absence of a commitment mechanism, the lack of trust leads each government to a tariff equilibrium that is optimal and yet costly from a welfare perspective. This result holds across all values of the parameters, including α_H ; even governments that value political contributions can be made better off if both countries adopt free trade. This result is consistent with the work of Bagwell and Staiger (1999; 2002) who argue that multilateral institutions such as the WTO are designed to help countries conclude mutually advantageous trade agreements that are not necessarily optimal from the perspective of any single country. The remainder of this section explores the connection between country and industry characteristics and equilibrium tariffs.

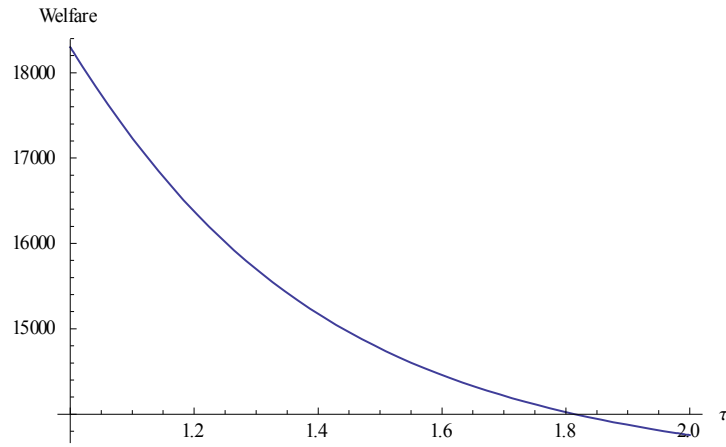


Figure 2.8

We first consider identical home and foreign countries where the home reaction function is graphed as the narrow curve and the foreign reaction function is graphed as the broad curve. The intersection of the two represents the optimal tariff vector.

Figure 2.9 illustrates the comparative static effect of σ , the elasticity of substitution, on the equilibrium tariffs. An increase in σ shifts both reaction functions outward, all else equal, resulting in a higher pair of equilibrium tariffs. This is because industries for which consumers have a higher elasticity of substitution among varieties are less competitive and hence the marginal benefits of tariffs are magnified in each country.

Figure 2.10 illustrates the comparative static effect of κ , the shape parameter on the Pareto distribution. An increase in κ shifts both reaction functions inward, all else equal, resulting in a lower pair of equilibrium tariffs. This is because κ captures the skew in the distribution of productivities, with higher values indicating a larger proportion of high-cost firms in the industry. Higher values of κ have a pro-competitive effect thereby lowering the marginal benefit of tariffs in each country.

As discussed above, lower values of F and higher values of α cause reaction functions to shift outward, and figures 2.11 and 2.12 illustrate this for both countries. Accordingly, industries with a lower fixed cost of trade are characterized by higher tariffs, and governments that place a higher value on political contributions choose higher tariffs.

Figure 2.13 illustrates an asymmetric change—an increase in the size of the home country relative to the foreign country. A relatively larger country has two key features—a larger domestic market and a larger resource (capital) pool with which to start new firms. This size advantage triggers a “home-market” effect that

raises the marginal benefit of tariffs, all else equal. As a result, the reaction function for the home government shifts outward. At the same time, the relatively smaller country experiences a fall in the marginal benefits of tariffs, all else equal. This causes the reaction function for the foreign government to shift inward. The new equilibrium tariff vector reflects this new asymmetry—the home country chooses a higher tariff while the foreign country chooses a lower tariff.

Finally, figure 2.14 illustrates another asymmetric change—an increase in the weight placed on political contributions by the home country. As discussed above, an increase in α_H shifts the reaction function for the home country outward. It has no effect on the reaction function of the foreign country. In the new equilibrium, the home country both values higher tariffs *and* is able to force the foreign government to move along its own curve to a lower foreign tariff.

In summary, our exploration of the theoretical model with a large-country assumption confirms the central insights provided by the small-country version. In particular, when the fixed cost of trade falls, industries seek higher tariffs from the government and are willing to offer greater political contributions, as before. The

government takes the deal, even though it knows that its own tariff policy will have spill-over effects onto the foreign government. In equilibrium, lower natural barriers in both countries lead the governments to enact higher tariffs that balance the domestic interests and are also best responses to each other. More generally, the comparative static effects of changes in the elasticity of substitution σ , the shape parameter on the Pareto distribution κ , the relative weight the government places on political contributions from producer interests α , and the fixed cost of trade F are similar in both the large- and small-country cases. This is true even though the large-country version involves an additional layer of strategic interaction.

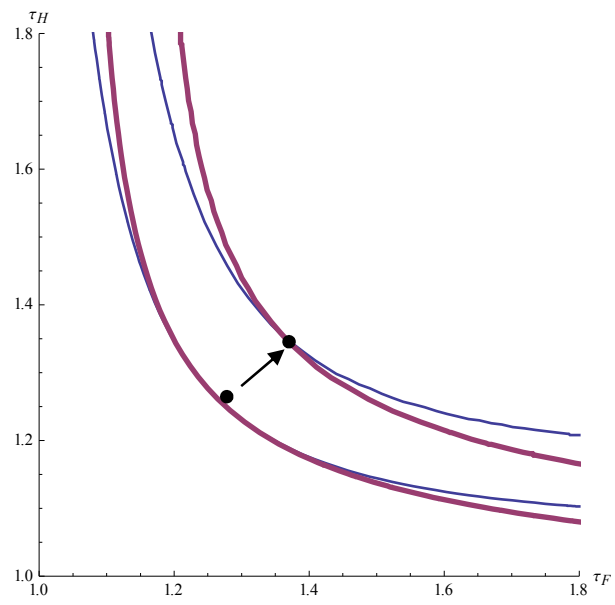


Figure 2.9

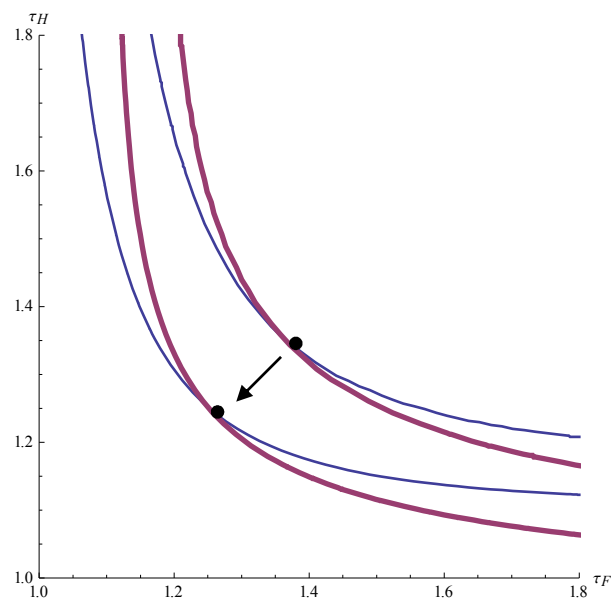


Figure 2.10

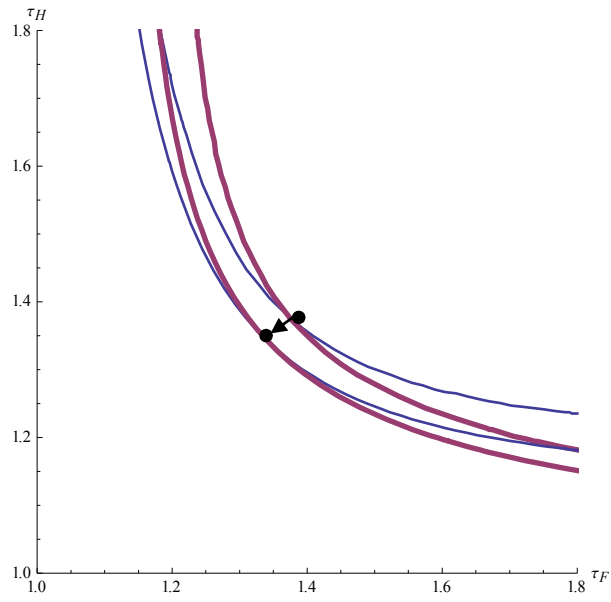


Figure 2.11

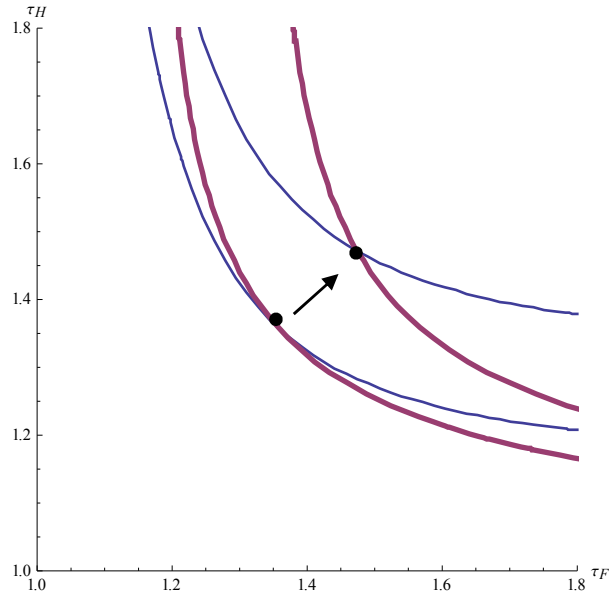


Figure 2.12

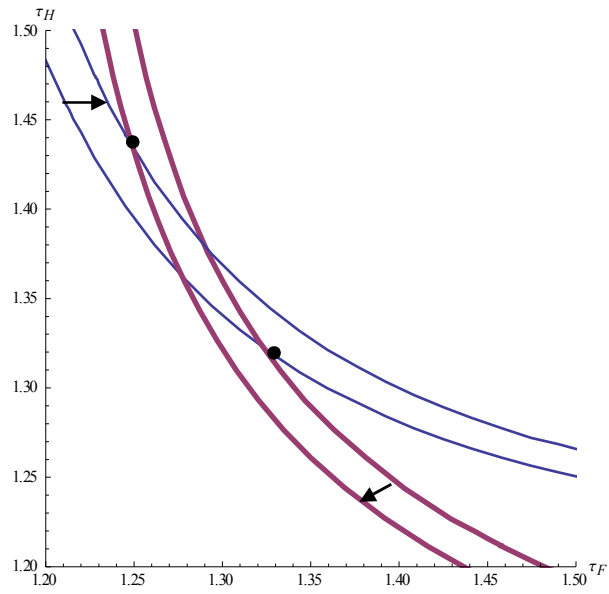


Figure 2.13

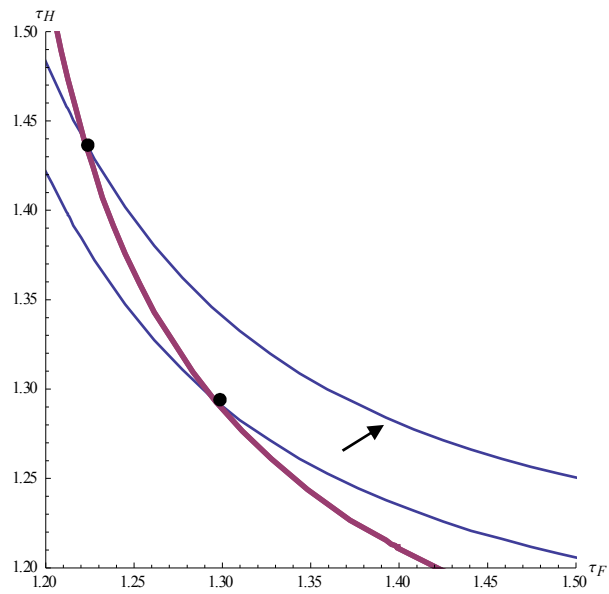


Figure 2.14

CHAPTER 3

EMPIRICAL ANALYSIS

The central premise that motivates most of the political economy and public choice literature is that the government does *not* automatically act in the best interests of all its citizens—that it does not necessarily use its policy-making authority to maximize collective welfare. Rather, this literature postulates that government decisions about the economy respond to political pressures and contributions. This approach may seem disconcerting to most non-cynical citizens and many traditional economists. Yet it is an important vehicle for explaining why so many economic and commercial policies remain suboptimal from a welfare perspective.

The original “Protection for Sale” [PFS] model presented by Grossman and Helpman (1994) [GH] demonstrates the internal logic by which trade policy is influenced by industrial lobbies. Two features of their model are especially prominent in the associated empirical literature: the relative weight the government

places on political contributions from import-competing industries, α , and the distinction between politically organized and unorganized industries. Empirical investigations by Goldberg and Maggi, 1999 [GM] and Gawande and Bandyopadhyay, 2000 [GB] yielded promising results consistent with GH's predictions. The estimated relationship between imports and protection was negative among politically organized industries, while for politically unorganized industries the estimated relationship was positive or altogether absent.

The subsequent evidence is more mixed, however, with much criticism directed at the operationalization of political organization.¹ Many papers have addressed the simplicity of the political structure of the original PFS model (e.g., Mitra et al., 2006; Imai et al., 2008), but there is relatively little focus in the literature on the simplicity of the underlying economy. That is, the existing research has sought to improve upon the PFS framework by further developing and refining the political and lobbying apparatus. By contrast, this dissertation seeks to improve upon the PFS framework by making the underlying economy more realistic. In

¹ See chapter 1 for details.

chapter 2 we formulated a theoretical model that embedded the PFS framework in an economy characterized by fixed costs, free entry and heterogeneous firms. That model predicts a nonmonotonic relationship between the level of imports and the level of trade protection that is driven by variation in ‘natural’ barriers to trade, rather than by differences in political organization. Indeed, political contributions, the basis for most attempts at distinguishing organized from unorganized industries, is shown also to be an endogenous outcome of the model.

In this chapter we lay out an empirical strategy for estimating the structural parameters of the theoretical model using GB’s original data, modified and augmented as explained below. The results reinforce the logic of the PFS approach and refine our understanding of its empirical content. In particular, when incorporating a more sophisticated model of economic activity, and when adopting an empirical methodology that captures the structural connections, we find that the size and significance of α is even greater than previously estimated. In addition, we demonstrate that the organized-unorganized distinction among industries is

unnecessary for estimation purposes, and that its inclusion tarnishes earlier estimates with selection bias.

Preliminaries

The estimation and hypothesis tests in this chapter are all conducted using the original data of GB. We employ these data because they permit comparisons with the results offered by GB, GM and many others who have estimated the PFS tariff equation. These published results have proven very influential in the literature, and an alternative explanation should confront them on their own terms. The data cover a single cross-section of U.S. industries. As a result, we must adopt a set of simplifying assumptions designed to render the model empirically tractable. Normally, we might expect many of the model's parameters to be industry-specific, but there are not enough degrees of freedom to estimate such a specification. Instead, we assume that all model parameters are common across industries, foreign and domestic. Hence the parameter estimates we generate represent averages.²

² Ideally a panel approach could be used to separately identify industry-specific parameters. This would require that the key variables be available in longitudinal form. While tariff levels are surely available in this form, the author is not aware of any NTB coverage ratios that have been computed and collected over time. This is a fruitful avenue for future research.

A second difficulty concerns the absence of available measures of the number of importing firms for a given industry. This measure is important in accounting for the extensive margin of trade, or the relative number of foreign to domestic varieties. However, if we assume that each foreign country produces a single, differentiated variety of a good, akin to the Armington assumption, then we can augment GB's data with a simple count of the number of distinct source countries of imports for each industry. This is admittedly a crude measure as consumers are likely to differentiate between goods from a single country. Nevertheless, for two industries with otherwise similar levels of imports and similar levels of protection, the logic of the Melitz (2003) model would lead us to expect that the industry with fewer distinct source countries is characterized by higher "natural barriers" to exporting to the U.S. market.

The theoretical model, as presented in chapter 2, is nonlinear and unfortunately cannot be written as a set of reduced-form equations. Rather, we capture the core of the model in a set of 4 structural equations that determine the level of trade protection, the import elasticity, the import-penetration ratio and the

ratio of foreign to domestic varieties. The notation and variables used here are as defined in chapter 2. There are three parameters of interest. $\alpha \geq 0$ is the relative weight the government places on political contributions in its objective function, with $\alpha = 1$ signifying an equal weighting on consumer utility and political contributions while $\alpha = 0$ represents a government uninterested in political contributions. $\sigma > 1$ is the preference parameter capturing the elasticity of substitution. $\kappa > 0$ is the shape parameter on the Pareto distribution of productivities.

The first equation to be considered is the government's first-order condition for choosing the optimal level of trade protection. Let $G(\bullet)$ represent the government's objective function that balances aggregate consumer utility against political contributions offered by industry lobbies. The government's choice variable is the level of trade protection, represented by τ . Let $g(\bullet)$ represent the first derivative of the objective function with respect to the choice variable. Then the government's FOC is $g(\bullet) = 0$. This FOC is nonlinear in the parameters and cannot be solved explicitly for the choice variable τ . Consequently, we treat the function

$g(\bullet)$ as an elementary zero function (see Davidson and MacKinnon 2004). The key point is that the expectation of an elementary zero function must go to zero when evaluated at the true value of the parameters, but not otherwise. Thus, for any particular observation, the estimating equation takes the form $g(\bullet) + \varepsilon_1 = 0$, or

$$\begin{aligned}
& (\kappa - 1)\left(\frac{Z_j}{e_j}\right) + (\kappa)(Z_j)(\tau_j) - \frac{\sigma(\kappa - 1)}{(\sigma - 1)} \frac{1}{e_j} + \frac{\alpha(\sigma - 1)}{\sigma} (Z_j - 1)\left(\frac{E_j}{X_j}(Z_j - 1) - 1\right) \\
& + \alpha(\kappa - 1) \frac{(Z_j - 1)\left(\frac{E_j}{X_j}(Z_j - 1) - 1\right)}{e_j} + \frac{\kappa}{(\sigma - 1)} \left(V_j \frac{E_j}{X_j}(Z_j - 1) - 1\right) \quad (3.1) \\
& + \frac{\sigma\kappa(\kappa - 1)}{(\sigma - 1)^2} \frac{V_j\left(\frac{E_j}{X_j}(Z_j - 1) - 1\right)}{e_j} - 1 + \varepsilon_{j,1} = 0.
\end{aligned}$$

where $\varepsilon_{j,1} \sim N(0,1)$ represents industry-specific error.³

The second equation is the derivation of the import elasticity. Most researchers in this literature acknowledge that, technically, this elasticity should be treated as endogenous to the model; then they go on to use it as an exogenous regressor. Here we can write the import elasticity as a function of the import-penetration ratio and the model parameters. Let e represent the import elasticity for

³ In all of the estimating equations variables carrying a j subscript represent vectors of size $1 \times j$ where j indexes industries $1, \dots, J = 241$. Unsubscripted parameters are assumed to be equal across industries.

a given industry, Q_f the quantity of imports aggregated across all foreign varieties, and $\frac{p_f}{p_h}$ the relative price of imports. Then following Dixit and Norman (1980) e is defined as

$$e = \frac{dQ_f}{d(\frac{p_f}{p_h})} \frac{\frac{p_f}{p_h}}{Q_f},$$

and takes the form

$$e_j = \frac{(\kappa - 1)\sigma}{(\sigma - 1)} + \left(\frac{\kappa\sigma(\kappa - 1) - (\kappa - 1)(\sigma - 1)}{\kappa(\sigma - 1)} \right) Z_j + \varepsilon_{j,2}. \quad (3.2)$$

In GB's original paper, they use 'corrected' values of the import elasticity originally estimated by Sheills et al. (1986). Their corrections are based on an error-in-variables approach described in the appendix of their paper. We are using these same corrected estimates. The error term $\varepsilon_{j,2} \sim N(0, \sigma_2^2)$ captures typical measurement and industry-specific error.

The third and fourth equations are the derivations of the import-penetration ratio and the ratio of foreign to domestic varieties from the structural model:

$$\frac{Z_j}{1 - Z_j} = \left(\frac{1 - V_j}{V_j} \right) (\psi_j \tau_j) \left(\frac{F_j}{f_j} \right) (\exp[\varepsilon_{j,3}]) \quad (3.3)$$

$$\frac{V_j}{1 - V_j} = \frac{N_{f,j}}{N_{h,j}} (\psi_j \tau_j)^{\frac{\kappa\sigma}{1-\sigma}} \left(\frac{F_j}{f_j}\right)^{\frac{\kappa}{1-\sigma}} (\exp[\varepsilon_{j,4}]) \quad (3.4)$$

The error terms $\varepsilon_{j,3} \sim N(0, \sigma_3^2)$ and $\varepsilon_{j,4} \sim N(0, \sigma_4^2)$ represent industry-specific errors in each case.

Unfortunately, the fixed-cost ratio is unobserved, so we must combine equations (3.3) and (3.4) into a single composite equation, substituting away the fixed-cost ratio. The resulting equation is written in logarithmic form and includes both error terms $\varepsilon_{j,3}$ and $\varepsilon_{j,4}$.

$$\begin{aligned} \log\left[\frac{Z_j}{1 - Z_j}\right] &= b_0 + (1 - \sigma)\log[\psi_j \tau_j] + \left(\frac{\kappa - \sigma + 1}{\kappa}\right)\log\left[\frac{1 - V_j}{V_j}\right] \\ &\quad + \left(\frac{1 - \sigma}{\kappa}\right)\log[Y_j] + \left(\frac{\sigma - 1}{\kappa}\right)\varepsilon_{j,4} + \varepsilon_{j,3}. \end{aligned} \quad (3.5)$$

This composite equation introduces potential problems for estimation of the structural parameters. Specifically, although V is endogenous in the model, it appears on the right-hand side of (3.5) as a regressor. Thus we can no longer maintain the assumption that the regressors are independent of the composite error term. Below, we outline and implement an indirect inference methodology to work around this problem and avoid the potential estimation bias. Results from an

application of GMM to the same set of empirical equations are presented in appendix D.

Implementing Indirect Inference

Despite the simplifications and functional form assumptions, there is no easy way to estimate directly the structural parameters in this model. This is due in large part to the (1) nonlinear structural relationships and (2) simultaneity among the endogenous variables. Many of the familiar microeconomic frameworks are designed to address one or the other of these difficulties, but not both. For example, two-stage least squares and quantile regressions are viable options for dealing with simultaneity, but they are not designed to estimate equations that are nonlinear in the parameters. By contrast, nonlinear least squares can handle the nonlinearity, but is not suited for handling simultaneity and instrumentation. As an alternative strategy, we turn to the method of indirect inference as presented in Smith (1993), Gouriéroux, Monfort and Renault (1993) and Li (2010). This method proceeds in three steps. First, we chose an auxiliary model that is related to the model of interest, but has the virtue of being easier to estimate. The coefficients of this

auxiliary model (sometimes called pseudo-true parameters) are estimated using standard techniques. The second step is to link the pseudo-true parameters from the auxiliary model to the structural parameters of the model of interest through the use of binding functions. In this application, we shall generate and estimate the binding functions by simulating the model of interest. Finally, the indirect estimates of the structural parameters are obtained by minimizing an appropriate criterion function. Each of these steps is described in detail below.

The great advantage of the method of indirect inference is the ability to identify structural parameters even in the midst of simultaneous endogenous relationships. For models that suffer from underidentification, because of nonlinearities in the parameters or weak instruments, the method of indirect inference is a viable alternative, provided the model can be simulated and connected to an appropriately chosen auxiliary model.

Step 1: The Auxiliary Model

We choose for our auxiliary model a simple linear equation in which the level of trade protection (measured separately by NTB coverage ratios and by average

tariff rates) is regressed on a vector of explanatory variables that are commonly employed as determinants of trade policy: import-penetration ratio, import elasticity, transportation costs, total value of domestic output, total number of production workers on payroll, relative capital-to-labor ratio and industry-level political contributions (Trefler, 1993; GM, 1999; GB, 2000). This includes several variables on the right-hand side that are widely acknowledged as endogenous to the process (import-penetration, import elasticity, contributions) and hence would normally be the cause of much concern over simultaneity bias. But we do not intend to interpret these coefficients—they will not be used for testing hypotheses, uncovering structural parameters or capturing marginal effects. These beta coefficients are simply targets for our optimization routine. They provide a window on the data, capturing and describing particular aspects of the sample. Our goal will be to replicate the OLS coefficients, bias and all, as closely as possible by simulating the model for different values of the structural parameters. In this sense the beta coefficients are sufficient statistics for the sample, summarizing all of the relevant information contained within the data. If two data sets generated the same values for the beta coefficients,

then our procedure will always yield the same inferences about the structural parameters. Let $\hat{\beta}$ represent the vector of beta coefficients generated by OLS estimation of the auxiliary model.

Step 2: The Binding Functions

The vector of structural parameters θ we are seeking to estimate consists of the elasticity of substitution σ , the shape parameter on the distribution of productivities κ , the relative weight the government places on contributions α , the constant term in the trade equation b_0 , and the three free error variances $\lambda_2, \lambda_3, \lambda_4$. Let $\mathbf{b}(\theta)$ represent the binding functions, linking the vector of structural parameters θ to the vector of regression coefficients $\hat{\beta}$ described above. These binding functions translate a given vector of structural parameter values θ into a vector of coefficient estimates $\beta_s^*(\theta)$ corresponding to the auxiliary model. They take the form

$$\mathbf{b}(\theta) = \frac{1}{S} \sum_{s=1}^S \beta_s^*(\theta) \quad (3.6)$$

where S is the number of simulations and $\beta_s^*(\theta)$ is the vector of coefficients generated by estimating the same auxiliary model in step 1, but using the simulated

data implied by a given vector θ . This is accomplished by simulating the key structural variables S times, estimating the auxiliary model on the simulated data each time and averaging over the resulting coefficients.

Our simulation process involves four steps. First, for a given θ and for draws from standard normal error distributions, we solve the nonlinear system given by equations (3.1), (3.2) and (3.5). This is done once for each observation ($N = 241$), resulting in simulated values for τ (the level of protection), e (the import elasticity) and Z (the import-penetration ratio). Second, we estimate the auxiliary model as in step 1 but using the simulated values for τ , e and Z and capture the resulting coefficient estimates. Third, we repeat the procedure S times for the same parameter vector θ , but drawing new errors each time. Finally, we average the simulated coefficient estimates to form $\mathbf{b}(\theta)$.

Step 3: Minimizing the Criterion Function

Let $Q(\theta)$ represent the criterion function used for choosing estimates for θ . Then we can write

$$Q(\theta) = (\hat{\beta} - \mathbf{b}(\theta))' \hat{\Sigma}^{-1} (\hat{\beta} - \mathbf{b}(\theta)) \quad (3.7)$$

where $\hat{\Sigma}$ is a consistent estimate of the covariance matrix of $\hat{\beta}$. The parameter estimates $\hat{\theta}$ are then obtained by minimizing $Q(\theta)$ with respect to θ . This can be thought of as minimizing the sum of squared residuals, where the residuals in question are the differences between the coefficient vector estimated in step 1 and the implied coefficient vector for any given vector of structural parameters, i.e., $\hat{\beta} - \mathbf{b}(\theta)$. As discussed in Davidson and MacKinnon (2004), this criterion function is distributed χ^2 , so hypothesis tests on $\hat{\theta}$ can be conducted by comparing restricted and unrestricted values of $Q(\theta)$.

The minimization of this criterion function can be computationally expensive. All search algorithms that employ derivatives of the criterion function must compute these derivatives numerically, and doing so involves completing the simulation process for each computed derivative. As an alternative, we choose to implement the Nelder-Mead algorithm (Nelder and Mead 1965; see also Lagarias, et al. 1998), a direct search method that does not require the computation of derivatives. The researcher chooses starting values for the parameters and values for delta, the size of the initial parameter step. These values are then used to build a multidimensional

simplex, and the objective function (the criterion function) is evaluated at the vertices of the simplex. The algorithm is designed to move away from the poorest (largest) value of the criterion, adapting and continually revising the simplexes in response to these values. A minimum is reached when the working simplex is sufficiently small, that is, when the criterion values are close enough to satisfy a tolerance limit.

The method of indirect inference is more common within time-series econometrics but is growing in popularity among microeconomists. Its application to political-economy models and trade data is still novel. In an attempt to bridge this gap, and to convince the reader of the applicability of this method to our problem, we have conducted a Monte Carlo-style experiment in appendix E in which a nonlinear system of equations is simulated for a similar sample size and selected parameters are estimated using the method of indirect inference.

Inference

As recently noted by Li (2010), indirect inference offers an important advantage over likelihood-based methods for testing hypotheses in structural

models—the indirect inference estimator is \sqrt{n} asymptotically normal, allowing for standard tests of significance. Moreover, according to Gouriéroux et al. (1993), the familiar Wald test, score test and a test based on the comparison of the constrained and unconstrained values of the criterion function are asymptotically equivalent.

Here, we test individual elements of the vector $\boldsymbol{\theta}$ by comparing the restricted and unrestricted values of $Q(\boldsymbol{\theta})$. The minimized value of the criterion function follows a $\chi^2(l - k)$ distribution, where l is the number of parameters estimated in the unrestricted model and k is the number of parameters estimated in the restricted model. Thus, testing one parameter restriction involves estimating the model with the parameter free (unrestricted), estimating the model again under the restriction implied by the null hypothesis (restricted), calculating the difference between the two minimized criterion functions (test statistic) and comparing it to an appropriate critical value taken from the $\chi^2(1)$ distribution. For a 95% confidence level, the critical value is 3.841. All hypothesis tests discussed below follow this procedure.

Operationalization of Variables

We adopt the original variables and data of GB consisting of a single cross-section of U.S. manufacturing industries classified according to the 4-digit SIC system (1972 revision). The variables used are the coverage ratio of non-tariff barriers, the total value of imports, the total value of exports, the import elasticity, the capital-labor ratio, the proportion of the industry labor force classified as unskilled, the proportion of the industry labor force classified as a scientist or researcher, and the political contributions of political-action committees aggregated to the industry level. These data are then augmented by variables capturing industry characteristics, including average tariff rates, transportation costs, industry aggregate five-factor productivity, proportion of industry capital stock devoted to plants and structures and the number of production workers on payroll. In addition, we add a measure of the extensive margin of trade constructed as the ratio of the number of distinct source countries for imports to the number of domestic firms in operation at the industry level. All data are for 1983 unless otherwise stated. All variables, labels, definitions and sources are available in table 3.1.

Results

The coefficient estimates generated by OLS estimation of the auxiliary model are presented in table 3.2. Note that we use seven regressors, so that the dimension of $\hat{\beta}$ is exactly equal to the dimension of θ , resulting in a just-identified model.

Although we do not interpret or draw inferences about these coefficients, it is interesting that some of the coefficients have the expected signs (transportation cost, total domestic production, total number of production workers) while other have counterintuitive signs (import elasticity, relative capital-to-labor ratio, and political contributions). Notably, the import-penetration ratio carries a positive coefficient. In addition, it is important to note that standard errors are quite low. This lends confidence to our indirect inference procedure and ensures that the matching algorithm is not targeting imprecise measures of the sample data characteristics.

The first column of table 3.3 reports baseline estimates for the structural parameters generated according to the indirect inference procedure outlined above.

The point estimates fall into ranges consistent with theoretical expectations.

Specifically, they satisfy the assumptions $\kappa > 0$, $\sigma > 1$, $\alpha \geq 0$ and the regularity

condition $\kappa - \sigma + 1 > 0$. The estimates are also not altogether different than those produced using the GMM procedure in appendix D. Moreover, although the products of very different approaches and methods, our estimate σ is remarkably close to that estimated by Bernard et al. (2003) ($\sigma = 3.8$) using U.S. firm-level data, while our estimate for κ is somewhat smaller than the average of the estimates obtained by Balistreri et al. (2009) ($\kappa = 4.5$). The estimate for the constant in equation 3 is represented by b_0 , and the lambdas are the estimates of the ratios of the standard deviations of the errors, such that $\lambda_2 = \sigma_2 / \sigma_1$, $\lambda_3 = \sigma_3 / \sigma_1$, $\lambda_4 = \sigma_4 / \sigma_1$, where σ_1 has been normalized to 1.

The value of α is of most interest to the political-economy literature. Recall that this parameter is interpreted as the weight the government places on political contributions relative to consumer interests. Our estimate, $\hat{\alpha} = 2.986$, suggests that the government favors contributions over consumers at almost a 3-to-1 rate. That is to say, the pattern of trade and protection observed in the data is consistent with a government that is willing to trade approximately \$3 of consumer welfare for \$1 of political contributions. This parameter estimate is considerably higher than those

produced by the two most prominent studies, 0.021 by Goldberg and Maggi (1999) and 0.905 by Gawande and Bandyopadhyay (2000). It is also larger than the estimates produced using GMM in appendix D, which range from approximately 2 to 2.5.

As a first check on the robustness of these estimates, we estimate the same model using the same indirect approach for a measure of average industry tariffs in the second column of table 3.3. The estimates are remarkably similar, even though the two measures of trade policy are only weakly correlated (Pearson's coefficient 0.21). We interpret these results as evidence that, although there are important differences in these two measures of protection, they are not so different as to require different structural explanations. Consequently, all remaining results considered here are estimated using GB's measure of non-tariff barriers.

As a further check on the robustness of the estimation results and the indirect inference algorithm we altered several of the key elements of the procedure. These results are presented in table 3.4. Overall, the estimates are fairly insensitive to

changes in the convergence tolerance limit, the size of the initial simplex delta, the number of simulations and the starting values.

One limitation of our approach is the estimation of single values for the parameters for all industries. We might expect that consumers' elasticity of substitution among varieties varies across types of good; similarly, we might expect that the productivity distribution should take on different shapes for different industries. There are insufficient degrees of freedom to estimate separate parameters for each industry, yet we can split the sample and construct groups of industries that share important features, and then obtain separate parameter estimates for each group.

Table 3.5 presents results of the first sample split following the industry categorization found in GB. All industries labeled "food" or "natural resources" are combined to form group 1, while all industries that are labeled either "manufacturers" or "capital goods" are combined to form group 2. The parameter estimates for the two groups of industries are quite close, and we cannot reject the null hypothesis that the parameters are identical; the one exception is σ . These

point estimates suggest that the elasticity of substitution is greater for industries in group 2. This is an intuitive result insofar as manufactured and capital goods are characterized by greater variety than are foodstuffs and natural resources. The null hypothesis that these two groups have the same elasticity of substitution is rejected at the 10% level of confidence but cannot be rejected at the 5% level of confidence.

Table 3.6 presents results for a sample split following an industry categorization offered by Rauch (1999). He divides traded goods into three groups: differentiated products, reference-priced (an intermediate category) and homogeneous goods. Presumably, we would expect the group of differentiated goods to be characterized by a larger elasticity of substitution than the other two categories. To maintain workable sample sizes, we combine the differentiated and reference-priced goods into a single group. The estimation results are again very similar for the two groups, and we cannot reject the null hypotheses that α and κ are the same for the two groups. As we might expect, the estimate of the elasticity of substitution for the group of differentiated goods industries is larger than the

estimate for the group of homogenous goods industries. This result is statistically significant at the 10% level of confidence.

Finally, we use the same sample-splitting strategy to investigate GB's categorization of the sample into those industries that are politically organized and those that are not. According to GH's original model, politically organized industries offer political contributions in exchange for policy protection. By contrast, politically unorganized industries are characterized by trade policies that are set according to consumer interests alone. Typically, this distinction is modeled as separate slope coefficients in the tariff equation for each subgroup. Here, we split the sample according to GB's dummy variable and then estimate the structural model on the two subgroups. The results appear in table 3.7. They suggest that there is no appreciable difference between the two subgroups.

It is instructive to compare the results of these sample splits using indirect inference to the results obtained using nonlinear GMM (see appendix D). Regarding the first and second sample splits, the two methods are in broad agreement that there appears to be some differences in the elasticity of substitution among the

subsamples. However, when splitting the sample according to the organizational dummy, the results of the two methods diverge. As noted above, the indirect inference approach failed to distinguish the two groups according to any of the key structural parameters. By contrast, the nonlinear GMM approach provides evidence that both σ and κ are statistically different for the two groups. That is, the GMM results suggest that organized industries are characterized by a higher elasticity of substitution and a more highly skewed productivity distribution of firms. What the previous literature has identified as differences in political organization is here shown to reflect differences in fundamental demand and technological parameters.

There are two possible explanations for the difference in the indirect inference and GMM results; they nicely illustrate the tradeoffs involved with the two methodologies. On the one hand, as mentioned previously, the GMM estimates are potentially plagued by simultaneity bias, and the magnitude of this bias may fluctuate across different subsamples. On the other hand, in the absence of standard errors, it is difficult to assess the precision of the indirect inference estimates. It is possible that a simulation-based approach is unable to provide precise estimates for

this size sample. In this case, the two subsamples may indeed differ along the structural parameters, but the indirect inference approach is unable to detect this difference—especially when, as is the case with the GMM estimates, these differences are quite small. In *either* case, our results suggest that GB’s separate slope coefficients are a statistical artifact. These two groups of industries may differ according to “deeper” structural parameters (κ and σ), or they may differ according to other unobserved characteristics, but we show no evidence that so-called politically organized industries exercise any more (or less) influence over trade policy than unorganized industries—the values for α when estimated separately for the two groups are statistically indistinguishable.

This is the first important result of this chapter. Much of the current literature on the political economy of trade policy continues to refer to political organization as an important *explanatory* variable in the PFS framework (e.g., GM 1999; GB 2000; Eicher and Osang 2002; Mitra and Ulubasoglu 2006; Ederington and Minier 2008). And surely the process of lobby formation and political contributions *is* an important part of the story. But it is a simultaneous outcome, both

influencing and influenced by the level of trade and the level of protection.

Moreover, all three of these endogenous outcomes are functions of more fundamental demand and industry characteristics. Accordingly, inferences based on the typical specification are plagued by bias. In chapter 2 we advanced the hypothesis that differences in natural barriers to trade are an important source of exogenous variation across industries. While the estimates for the structural parameters presented in tables 3.3 - 3.7 are consistent with that hypothesis, the absence of observable measures of the fixed costs of trade leaves us unable to reject plausible alternatives. In this chapter we offer more direct evidence that differences in the elasticity of substitution and in the shape of the industry-level productivity distribution are driving the observed difference in political organization.

Table 3.8 presents the results from a series of hypothesis tests using the baseline model. The first set of tests address core theoretical assumptions of the model. Specifically, hypothesis (i) tests the null hypothesis that the government places no weight on producer interests. This is soundly rejected at the 1% level of confidence. Our interpretation of this result is that a political-economy model of

policymaking with competing economic interests is a better fit to the data than a more traditional trade model where policy is decided along strict utilitarian grounds. Hypothesis (ii) tests the null hypothesis that the constant term in equation 3 is zero. It is rejected at the 5% level of confidence. Hypothesis (iii) tests the null hypothesis that the productivities are distributed uniformly; it is rejected at the 1% level of confidence. We interpret this result as supporting our modeling assumption concerning heterogeneous firms. Hypothesis (iv) tests the regularity condition that $\kappa > \sigma - 1$. This is a technical condition required for the convergence of the integrals in the theoretical model. Unfortunately, although the point estimates respect this condition, we are unable to reject the statistical possibility that this condition is violated in practice.

The second set of hypotheses tested in table 3.8 refers to competing estimates of α . Recall from table 3.3 that our estimate for α is 2.986, implying that the government favors political contributions from producer interests at approximately a 3-to-1 rate. Hypothesis (v) tests the fit of the estimate presented by Goldberg and Maggi (1999) (GM). Their results suggest that the government places a very small

relative weight on contributions ($\alpha = 0.021$) when compared to consumer interests. Indeed, their estimate implies that the government would only be willing to trade approximately \$0.02 of consumer welfare for every extra dollar in contributions from import-competing producers. Our results reject this value for α at the 1% confidence level. Hypothesis (vi) tests the fit of the estimate presented by Gawande and Bandyopadhyay (2000) (GB). Their results suggest a fairly even weighting between consumer interests and contributions ($\alpha = 0.905$), implying that the government would only be willing to trade approximately \$0.90 of consumer welfare for every extra dollar in contributions. Our results also reject this estimate at the 1% level of confidence.

Although estimated on essentially the same sample data, the econometric specifications in GM and GB differ considerably from that presented here. GM and GB use the standard PFS protection equation, including the political organization indicator variable, the import-penetration ratio and the import elasticity. GM move the elasticity to the left-hand side, thereby rescaling the measure of non-tariff barriers, while GB treat the import elasticity as an exogenous regressor. Both GM

and GB specify separate reduced-form equations for the import-penetration ratio and political organization/contributions. In neither case are these equations informed by theory, nor are they structurally connected to the protection equation. By contrast, we estimate a protection equation that resembles the original PFS formulation but is derived from a more complicated and realistic model of the economy. We make no distinction between politically organized and unorganized industries; rather, we test whether such distinctions are supported by the data. Like GM and GB, we employ separate estimating equations for the import elasticity and the import-penetration ratio, but in our case they are derived from the model of the economy and so share a deep structural connection with the protection equation. As a result, our estimate for α is both substantively and statistically different from previous results in the literature. Substantively, our estimate suggests trade policy that is significantly skewed in the interests of industry and at the expense of consumers. Statistically, in the context of the structural model, our estimate fits the data better than either of the previously published results, is generated using a more comprehensive model of trade and trade policy, and is not adulterated by the simultaneity bias that results

from the common practice of including the political organization variable in the protection equation.

The final two hypotheses that appear in table 3.8 test the estimates generated by the GMM procedure in appendix D. These estimates range between 2 and 2.5, so hypothesis (vii) tests the value $\alpha = 2$ and hypothesis (viii) tests the value $\alpha = 2.5$.

Both of these results are much closer to the indirect inference results appearing in table 3.3 than to any of the previously published results. Nevertheless, as explained in appendix D, the GMM estimating approach differs from indirect inference in important ways—most notably, the GMM estimation relies on an assumption of the exogeneity of the ratio of foreign to domestic varieties which is not consistent with theoretical expectations. The results of the hypothesis tests indicate that while $\alpha = 2$ is rejected at the 1% level, the p-value for $\alpha = 2.5$ just misses the 5% level of confidence. This suggests that there is some overlap between the range of GMM estimates presented in appendix D and the indirect inference estimate considered here.

Table 3.1: Variable Definitions and Sources

Variable	Definition	Source
ntb	Non-tariff barriers aggregated to industry level and written as ad-valorem rate.	GB (2000)
tar	Tariff barrier calculated as ratio of total duties collected to total customs value of imports, written as ad-valorem rate.	Magee (2001): Census of Manufacturers and NBER
R_{fh}	Total value of imports in millions of dollars.	Feenstra (1998): NBER
X	Total value of exports in millions of dollars.	Feenstra (1998): NBER
Y	Total value of domestic shipments in millions of dollars	Feenstra (1998): NBER
R_{hh}	Total domestic production consumed at home.	Calculation: $R_{hh} = Prod - X$
E	Total domestic consumption.	Calculation: $E = R_{hh} + R_{fh}$
Z	Import-penetration ratio.	Calculation: $Z = \frac{R_{fh}}{E}$
s	Transport cost; constructed as the ratio of the total c.i.f. value of imports to the total customs value of imports.	Magee (2001): Census of Manufacturers and NBER
N_{hh}	Number of domestic firms (varieties).	U.S. Census Bureau: Economic Census (1992)
N_{fh}	Number of foreign firms (varieties). A count of the number of distinct source countries for imports.	Feenstra (1998): NBER
V	Ratio of domestic to total firms (varieties).	Calculation: $V = \frac{N_{hh}}{N_{hh} + N_{fh}}$
e	Import elasticity	Sheills, et al. (1986); GB (2000)
$relkl$	Relative capital-labor ratio; constructed as the ratio of the industry capital-labor ratio to the maximum capital-labor ratio available in the sample.	GB (2000)
$reltfp$	Relative total factor productivity; constructed as the ratio of the industry aggregate five-factor productivity to the maximum aggregate five-factor productivity available in the sample.	NBER Productivity (1996)
$punsk$	Proportion of industry labor force classified as unskilled.	GB (2000)
$psci$	Proportion of industry labor force classified as scientist or researcher.	GB (2000)
$pplant$	Proportion of industry capital stock devoted to plants and structures.	NBER Productivity (1996)
pac	Political contributions of political-action committees. Originally firm-level, aggregated up to industry level.	GB (2000)
$workers$	Number of production workers on payroll.	NBER Productivity (1996)

Table 3.2: Auxiliary Model**OLS Regression: Dependent Variable: ntb ($N = 241$)**

Regressor	$\hat{\beta}$	Std. Error
Z	0.1846	0.0574
e	0.0379	0.0224
s	-0.2414	0.0758
log(Y)	0.0265	0.0068
workers	0.4022	0.0712
relkl	0.1248	0.0670
log(pac)	-0.0428	0.0158

Table 3.3: Comparing Estimates using Tariffs and Non-tariff Barriers.
Simulated Variables: τ , e , Z

<i>Policy Measure</i>	Non-tariff barriers (<i>ntb</i>)	Average tariffs (<i>tar</i>)
N	241	241
<i>Estimates</i>		
α	2.986	3.001
κ	3.009	2.998
σ	3.935	3.995
b_0	5.001	5.062
λ_2	0.021	0.010
λ_3	0.005	0.011
λ_4	0.003	0.010
$Q(\theta)$	84.084	103.583
<i>Hypothesis Tests</i>		
Restriction	Test Statistic	p-value
$H_0: \alpha_{ntb} = \alpha_{tar}$	1.775	0.183
$H_0: \kappa_{ntb} = \kappa_{tar}$	1.124	0.289
$H_0: \sigma_{ntb} = \sigma_{tar}$	0.125	0.725

Table 3.4: Tests for Robustness**Simulated Variables:** τ , e , Z

<i>Setting</i>	α	κ	σ	b_0	λ_2	λ_3	λ_4	$Q(\theta)$
Convergence								
Tolerance								
10e-6	2.971	3.022	3.995	5.058	0.021	0.022	0.011	84.349
10e-9	2.972	3.024	3.994	5.063	0.008	0.021	0.021	84.247
10e-12	2.999	3.001	4.001	5.001	0.009	0.010	0.009	84.742
Initial Simplex								
Delta								
0.1	2.986	3.009	3.935	5.001	0.021	0.005	0.003	84.084
0.01	2.972	3.024	3.994	5.063	0.008	0.021	0.021	84.247
0.001	2.953	3.014	3.972	5.015	0.023	0.024	0.022	84.132
Simulations								
25	2.972	3.024	3.994	5.063	0.008	0.021	0.021	84.247
50	2.952	3.014	3.969	5.014	0.024	0.022	0.024	84.176
75	2.952	3.009	3.962	5.018	0.025	0.024	0.021	84.182
Starting								
Values								
$\alpha = 1$								
$\kappa = 2$	2.598	2.995	3.974	5.001	0.004	0.014	0.016	87.449
$\sigma = 2$								
$\alpha = 2.5$								
$\kappa = 3.5$	2.972	3.024	3.994	5.063	0.008	0.021	0.021	84.247
$\sigma = 3.5$								
$\alpha = 4.5$								
$\kappa = 5.5$	3.075	3.298	3.479	4.971	0.086	0.014	0.027	91.731
$\sigma = 5.5$								

Table 3.5: Specification Tests (1)**Simulated Variables:** τ , e , Z

<i>Sample Split:</i>	Food and Natural Resources	Manufactured and Capital Goods
<i>Gawande Types</i>	N = 121	N = 120
<i>Estimates</i>		
α	3.099	2.949
κ	2.964	3.006
σ	3.504	3.898
b_0	4.967	4.969
λ_2	0.021	0.052
λ_3	0.026	0.018
λ_4	0.007	0.017
$Q(\theta)$	60.782	58.374
<i>Hypothesis Tests</i>		
Restriction	Test Statistic	p-value
$H_0: \alpha_1 = \alpha_2$	0.163	0.686
$H_0: \kappa_1 = \kappa_2$	0.252	0.616
$H_0: \sigma_1 = \sigma_2$	3.401	0.065

Table 3.6: Specification Tests (2)

Simulated Variables: τ , e , Z

<i>Sample Split:</i>	Differentiated Goods	Homogeneous Goods
<i>Rauch Types</i>	N = 49	N = 181
<i>Estimates</i>		
α	3.002	2.931
κ	3.012	2.976
σ	4.004	3.735
b_0	5.006	5.101
λ_2	0.016	0.023
λ_3	0.015	0.042
λ_4	0.009	0.024
$Q(\theta)$	60.548	78.528
<i>Hypothesis Tests</i>		
Restriction	Test Statistic	p-value
$H_0: \alpha_1 = \alpha_2$	0.399	0.528
$H_0: \kappa_1 = \kappa_2$	0.401	0.526
$H_0: \sigma_1 = \sigma_2$	3.788	0.052

Table 3.7: Specification Tests (3)**Simulated Variables:** τ , e , Z *Sample Split:*

<i>Gawande</i>	Politically Organized	Not Politically Organized
<i>Organizational</i>	N = 164	N = 77
<i>Dummy</i>		

Estimates

α	2.998	2.822
κ	3.001	3.022
σ	4.004	3.957
b_0	5.049	5.033
λ_2	0.011	0.032
λ_3	0.009	0.031
λ_4	0.009	0.032
$Q(\theta)$	58.183	74.987

Hypothesis Tests

Restriction	Test Statistic	p-value
$H_0: \alpha_1 = \alpha_2$	1.056	0.304
$H_0: \kappa_1 = \kappa_2$	0.856	0.355
$H_0: \sigma_1 = \sigma_2$	2.545	0.111

Table 3.8: Hypothesis Tests

	Restriction	Test Statistic	p-value
(i)	$H_0: \alpha = 0$	236.707	0.000
(ii)	$H_0: b_0 = 0$	3.951	0.047
(iii)	$H_0: \kappa = 1$	78.286	0.000
(iv)	$H_0: \kappa = \sigma - 1$	0.149	0.483
(v)	$H_0: \alpha = 0.021$ (GM)	170.39	0.000
(vi)	$H_0: \alpha = 0.905$ (GB)	287.559	0.000
(vii)	$H_0: \alpha = 2$ (GMM Appendix D)	47.147	0.000
(viii)	$H_0: \alpha = 2.5$ (GMM Appendix D)	3.543	0.059

CHAPTER 4

CONCLUSIONS AND AVENUES FOR FUTURE RESEARCH

The principal objective of this dissertation research is to improve our understanding of the relationship between the volume of imports and the degree of trade protection. The existing international trade literature considers this question from a very traditional perspective—trade policies affect trade flows and thereby influence economic outcomes for individuals and firms. Yet this approach is limited in that it ignores the feedback effect of economic outcomes on policymaking. That is, rational agents are motivated to influence the very policies that affect their economic fortunes. Accordingly, this dissertation adopts a political economy perspective for analyzing the relationship between trade and trade policies. In this view, trade policies are modeled as the outcome of a political process that is influenced by the economic outcomes the policies are designed to shape.

Chapter 1 describes the historical development of the literature on the political economy of trade and trade policy. It outlines Grossman and Helpman's

(1994) seminal paper, “Protection for Sale,” and illustrates the substantial influence this work has had on the subsequent literature. Yet this model is not without its critics, and the weaknesses that have emerged have fueled much new theoretical and empirical research. In particular, the model relies too much on political organization to explain variation across sectors in the relationship between the level of protection and the import-penetration ratio. From a theoretical standpoint, this raises questions concerning the endogeneity of political organization and political contributions. From an empirical perspective, this presents econometric challenges to inference that have not been adequately addressed in the existing literature.

As a response to the questions raised in chapter 1, this dissertation offers two important contributions. First, chapter 2 presents a new political-economy model of trade and trade policy that provides important theoretical insights into the simultaneous relationship between trade, trade policy and political activity. The limitations of the original PFS model have led many researchers to further develop and refine the political mechanisms. By contrast, this dissertation adopts a more realistic and complex model of the underlying economy. It combines the existing

political apparatus of the PFS framework with a model of the economy featuring monopolistic competition, heterogeneous firms, free entry, fixed and variable costs to trade. This approach to modeling trade provides a richer economic environment than appears in the existing literature, and it affords us the opportunity to explore important counterfactual scenarios that influence decision-making.

Using this model we generate two new theoretical results. First, when some barriers to trade are the result of policy decisions (i.e., tariffs) and other barriers to trade emerge more naturally (i.e., fixed market entry costs), import-competing industries have a greater incentive to seek policy protection when natural barriers are relatively low, all else equal. That is, trade policy can substitute for natural barriers, but at a cost. This cost takes the form of political contributions the industry must provide to the government as compensation for reducing consumer welfare. This effect then drives the second theoretical result—a nonmonotonic relationship between the level of policy protection and the import-penetration ratio that is *not* dependent on exogenous variation in political organization or contributions. Rather, we show that variation in the natural barrier to trade

produces industries that are differentially vulnerable to import competition and hence place distinctive values on policy protection. Consequently, the level of the tariff, the volume of imports, the size of political contributions and the size and structure of each industry are all endogenously determined by the structural parameters and the natural barrier to trade. This result is important because, like Grossman and Helpman, our model predicts different slopes in imports-tariff space for different groups of industries, but unlike Grossman and Helpman, we do not rely on differences in political organization as the source of exogenous variation.

One promising area for future research is to join the model of trade and the economy developed here with a model of lobby formation and endogenous political organization in the spirit of Mitra (1999) and Bombardini (2008). Whereas these authors have extended the political apparatus of the PFS framework, thereby emphasizing industry-level variation in the *costs* of political organization, we have extended and refined the underlying model of the economy, emphasizing variation in the potential *benefits*. A natural next step is to consider these two theoretical

developments concurrently and examine the relationship between trade and protection along both dimensions.

As a simple example, suppose that, in addition to a fixed cost of trade, each industry also faced a fixed cost of political organization where a high cost indicated substantial organizational hurdles. In this case we might expect a strong positive association between these two types of costs. High fixed costs of trade imply small benefits of tariffs, while high fixed costs of organization imply high costs of lobbying, resulting in industries that are politically passive, even in the face of new foreign competition. At the other extreme, low fixed costs of trade imply large benefits of tariffs, while low fixed costs of organization imply low costs of lobbying, resulting in industries that are politically active, ready to jump at the slightest hint of increased imports. In such a formulation the intermediate cases would prove the most revealing—to what degree do high costs of organization outweigh high motivation, or vice versa? In addition, this theoretical structure could provide a window for examining how these two dimensions influence and interact with industrial

organization, thereby tightening the connection between endogenous market structure, trade flows and trade policy.

The second contribution of this dissertation consists of a structural estimation of the model parameters using U.S. data appearing in chapter 3. The endogenous determination of so many key variables, while a strength of the theoretical model, poses substantial difficulties for estimation and inference. Thus, we employ an estimation strategy—indirect inference—that is novel to the empirical trade and political economy literature but is well suited to handling a nonlinear system of simultaneous equations.

The parameter estimates are consistent with theoretical expectations and are shown to be robust to changes in the estimation algorithm. Using sample splits informed by the literature, we show that the model specification and estimation results are not idiosyncratic. More importantly, we show that the common practice of estimating separate coefficients for politically organized and unorganized industries is not warranted. Our estimates suggest *both* groups of industries exercise political influence over trade policy decisions. Nevertheless, there is some evidence

that the industry groupings defined by this variable do differ according to more fundamental demand (σ) and technological parameters (κ). Thus inferences about the effect of political organization common in the literature are potentially plagued by simultaneity bias.

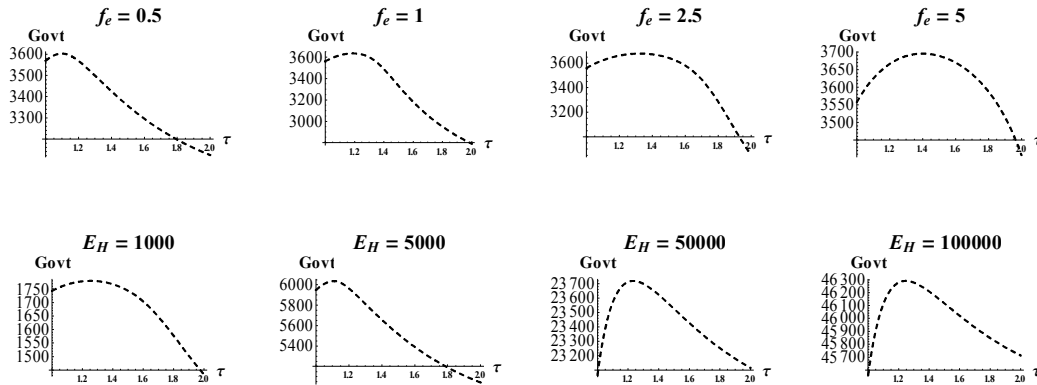
Estimating the relative weight the government places on political contributions is another common goal in the empirical literature. When employing an empirical methodology that captures the structural connections among the endogenous variables and avoids common forms of bias, we estimate that the government favors the contributions of import-competing producers over consumer welfare at approximately a 3-to-1 rate. That is, the pattern of trade and protection observed in the sample are consistent with a government that is willing to trade \$3 of consumer welfare for every \$1 in additional contributions. This estimate for α is both substantively and statistically different from previous studies. The evidence presented here both reinforces the utility of the political-economy approach to understanding the link between trade and trade policy and refines our understanding of the relative priorities of government decision-makers.

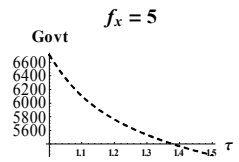
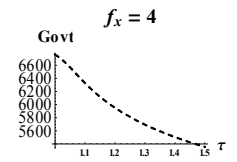
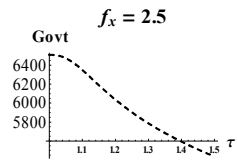
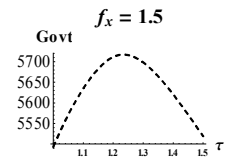
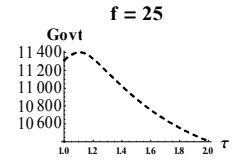
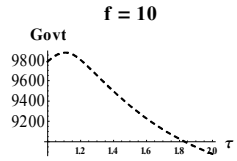
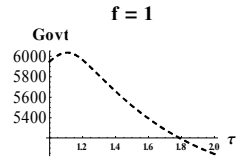
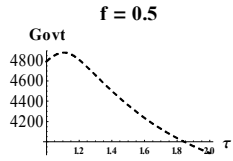
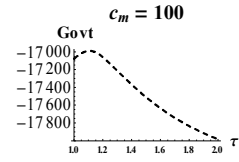
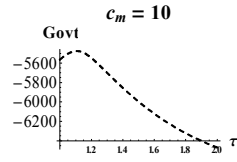
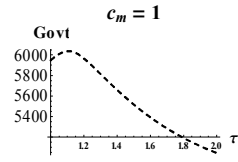
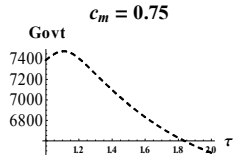
The empirical results presented in chapter 3 suggest promising avenues for future research. The indirect inference approach is remarkably flexible and could very easily be applied to discrete-choice problems such as predicting new trade flows at the country and/or industry level, predicting the decision to organize and lobby the government, and predicting the choice among a menu of different types of trade policies. These applications potentially share many of the same econometric difficulties that appear here, especially nonlinearity and simultaneity, and so may prove amenable to the indirect inference methodology. In addition, our results could potentially be improved by a larger and more representative data set. A panel data structure would provide a boost to our degrees of freedom thereby enabling estimation of industry-specific parameters. Similarly, a broader definition of trade policy protection would permit an extension of the model to less traditional forms of protection. Indeed, the developed world has generally succeeded in lowering tariffs through the WTO, shifting much of the current political economy focus onto the use of such nontariff barriers as antidumping and countervailing duties.

APPENDIX A:

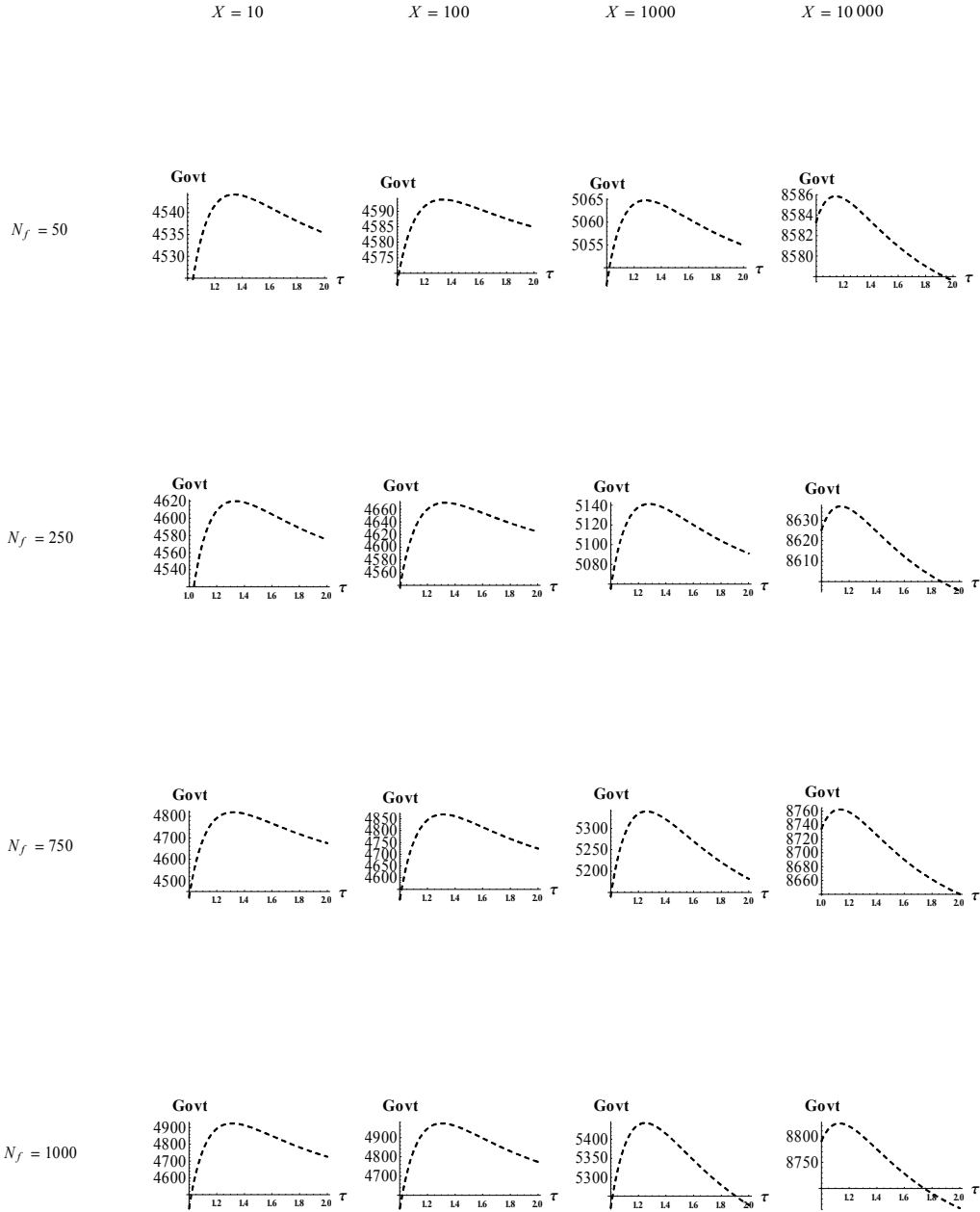
NUMERICAL DEMONSTRATION OF THE CONCAVITY OF THE GOVERNMENT'S OBJECTIVE FUNCTION

The following graphs examine numerically the shape and behavior of the government's objective function as we vary the level of the tariff. We show that it is concave for any interior solution, and that it is monotonically decreasing when the optimal policy is free trade. This feature is robust to changes in the start-up cost, f_e , the size of the domestic economy, E_H , the scale parameter in the Pareto distribution, c_m , and the fixed cost of serving the domestic market, f , and the fixed cost of trade, f_x .

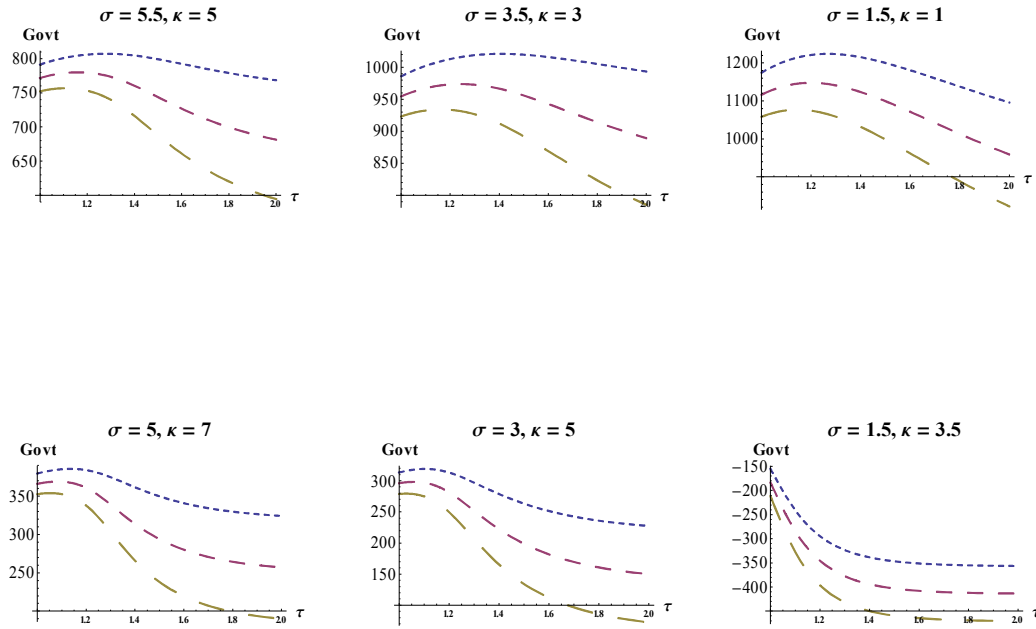


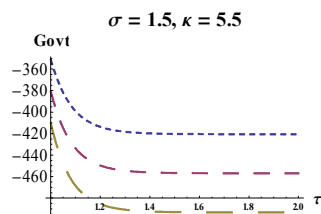
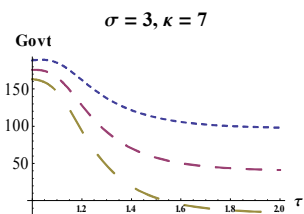
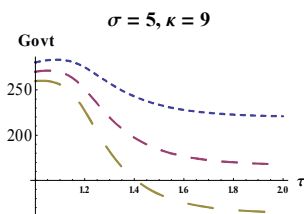
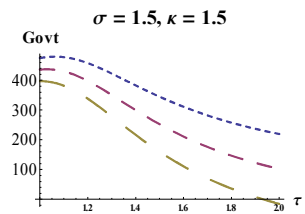
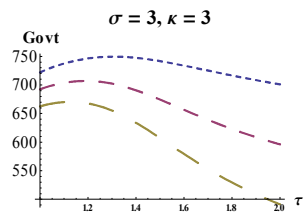
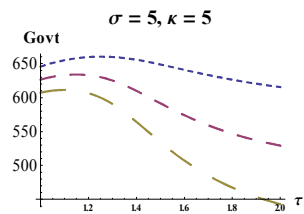


Here we show that the concavity feature is robust to simultaneous changes in demand for home country exports, X , and the number of foreign firms attempting to sell in the home market, N_F .



Here we show that concavity feature is robust to simultaneous changes in the elasticity of substitution, σ , the shape parameter from the Pareto distribution, κ , and the weight the government places on political contributions, α . In each graph the topmost curve with the smallest dashes is drawn for $\alpha = 2$, while the middle curve is drawn for $\alpha = 1$ and the lowest curve with the largest dashes is drawn for $\alpha = 0$.





APPENDIX B:
PROOFS OF CLAIMS 1 AND 2

Recall the notation: $\varepsilon_x^y = \frac{dy}{dx} \frac{x}{y}$

Proof of Claim 1

Using the expression for the import-penetration ratio in (2.14),

$$\varepsilon_{\Theta}^Z = 1 + \kappa \varepsilon_{\Theta}^{c_F}.$$

Using the derivation of the cost cutoffs in (2.12),

$$\varepsilon_{\Theta}^{c_F} = \varepsilon_{\Theta}^{\Delta_H} - \frac{\sigma}{\sigma-1} \quad \text{and} \quad \varepsilon_{\Theta}^{c_H} = \varepsilon_{\Theta}^{\Delta_H}.$$

Using the market-clearing condition for the domestic market, $E_H = R_H + R_F$,

$$R_H(\varepsilon_{\Theta}^{N_H} + \kappa \varepsilon_{\Theta}^{c_H}) = -R_F(\kappa \varepsilon_{\Theta}^{c_F} + 1).$$

Using the market-clearing condition for exports in (2.13),

$$\varepsilon_{\Theta}^{N_H} = -\kappa \varepsilon_{\Theta}^{c_X}.$$

Using the free entry condition in (2.16),

$$\varepsilon_{\Theta}^{c_H} R_H = -\varepsilon_{\Theta}^{c_X} X.$$

Combining the equations above,

$$\varepsilon_{\Theta}^{c_H} = \frac{R_F \left(\frac{\kappa\sigma - \sigma + 1}{\sigma - 1} \right)}{\kappa \left(E_H + \frac{(R_H)^2}{X} \right)},$$

and so

$$\varepsilon_{\Theta}^{c_F} = \frac{R_F \left(\frac{\kappa\sigma - \sigma + 1}{\sigma - 1} \right)}{\kappa \left(E_H + \frac{(R_H)^2}{X} \right)} - \frac{\sigma}{\sigma - 1}.$$

To prove the claim we must show $\varepsilon_{\Theta}^Z < 0$:

$$\varepsilon_{\Theta}^Z <=> 0$$

$$\Rightarrow 1 + \kappa \left(\frac{Z \left(\frac{\kappa\sigma - \sigma + 1}{\sigma - 1} \right)}{\kappa \left(\frac{R_H}{X} (1 - Z) + 1 \right)} - \frac{\sigma}{\sigma - 1} \right) <=> 0$$

$$\Rightarrow 1 <=> \left(\frac{Z \left(\frac{\sigma - 1 - \kappa\sigma}{\sigma - 1} \right)}{\left(\frac{R_H}{X} (1 - Z) + 1 \right)} + \frac{\kappa\sigma}{\sigma - 1} \right)$$

$$\Rightarrow \frac{\sigma - 1 - \kappa\sigma}{\sigma - 1} <=> \frac{Z \left(\frac{\sigma - 1 - \kappa\sigma}{\sigma - 1} \right)}{\left(\frac{R_H}{X} (1 - Z) + 1 \right)}$$

$$\Rightarrow \left(\frac{R_H}{X} (1 - Z) + 1 \right) >=< Z$$

$$\Rightarrow 1 > Z \quad (\text{by definition of the import-penetration ratio})$$

$$\Rightarrow \varepsilon_{\Theta}^Z < 0.$$

Proof of Claim 2

Using the expression for the import-penetration ratio given in (2.14),

$$\varepsilon_F^Z = 1 + \kappa \varepsilon_F^{c_F}.$$

Using the derivation of the cost cutoffs given in (2.12),

$$\varepsilon_F^{c_F} = \varepsilon_F^{\Delta_H} - \frac{1}{\sigma-1} \quad \text{and} \quad \varepsilon_F^{c_H} = \varepsilon_F^{\Delta_H}.$$

Using the market-clearing condition for the domestic market, $E_H = R_H + R_F$,

$$R_H(\varepsilon_F^{N_H} + \kappa \varepsilon_F^{c_H}) = -R_F(\kappa \varepsilon_F^{c_F} + 1).$$

Using the market-clearing condition for exports in (2.13),

$$\varepsilon_F^{N_H} + 1 = -\kappa \varepsilon_F^{c_X}.$$

Using the free entry condition in (2.16),

$$\kappa \varepsilon_F^{c_H} R_H + X = -\kappa \varepsilon_F^{c_X} X.$$

Combining the equations above,

$$\varepsilon_F^{c_H} = \frac{R_F \left(\frac{\kappa - \sigma + 1}{\sigma - 1} \right)}{\kappa \left(E_H + \frac{(R_H)^2}{X} \right)},$$

and so

$$\varepsilon_{\Theta}^{c_F} = \frac{R_F \left(\frac{\kappa - \sigma + 1}{\sigma - 1} \right)}{\kappa \left(E_H + \frac{(R_H)^2}{X} \right)} - \frac{1}{\sigma - 1}.$$

To prove the claim we must show $\varepsilon_F^Z < 0$:

$$\varepsilon_F^Z < \Rightarrow 0$$

$$\Rightarrow 1 + \kappa \left(\frac{Z \left(\frac{\kappa - \sigma + 1}{\sigma - 1} \right)}{\kappa \left(\frac{R_H}{X} (1 - Z) + 1 \right)} - \frac{1}{\sigma - 1} \right) < \Rightarrow 0$$

$$\Rightarrow 1 < \Rightarrow \left(\frac{Z \left(\frac{\sigma - 1 - \kappa}{\sigma - 1} \right)}{\left(\frac{R_H}{X} (1 - Z) + 1 \right)} + \frac{\kappa}{\sigma - 1} \right)$$

$$\Rightarrow \frac{\sigma - 1 - \kappa}{\sigma - 1} < \Rightarrow \frac{Z \left(\frac{\sigma - 1 - \kappa}{\sigma - 1} \right)}{\left(\frac{R_H}{X} (1 - Z) + 1 \right)}$$

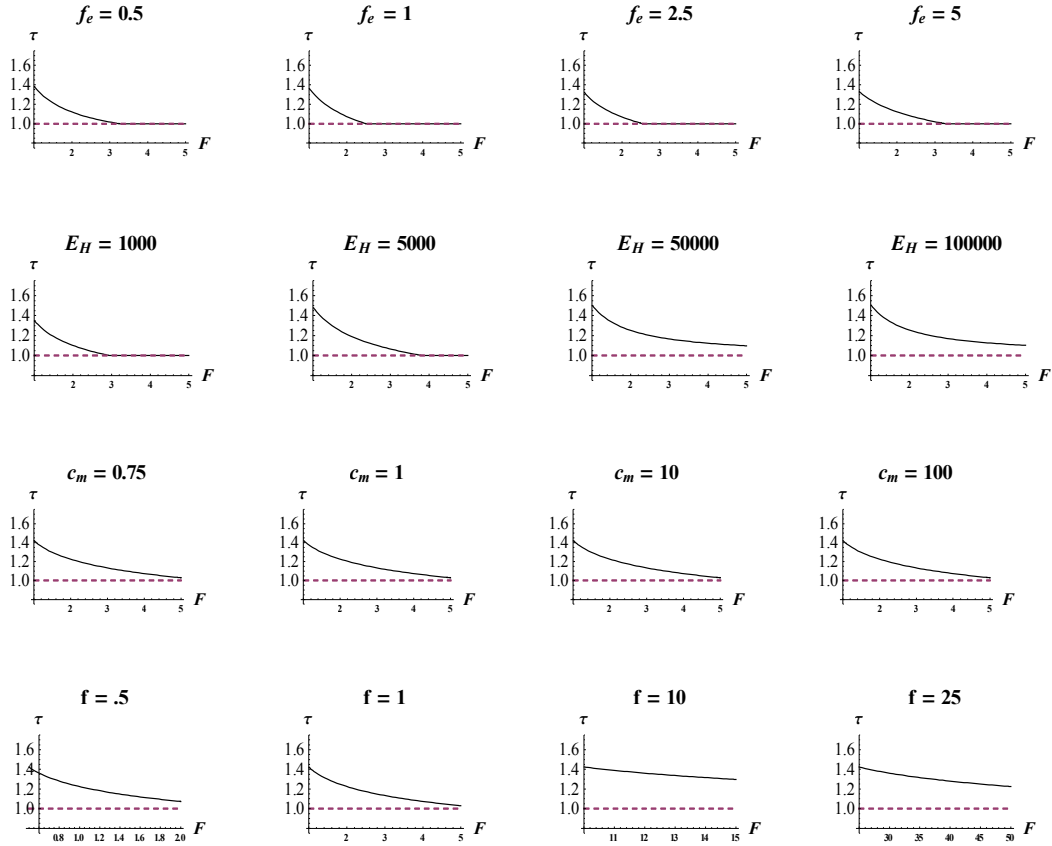
$$\Rightarrow \left(\frac{R_H}{X} (1 - Z) + 1 \right) > \Rightarrow Z$$

$$\Rightarrow 1 > Z \quad (\text{by definition of the import-penetration ratio})$$

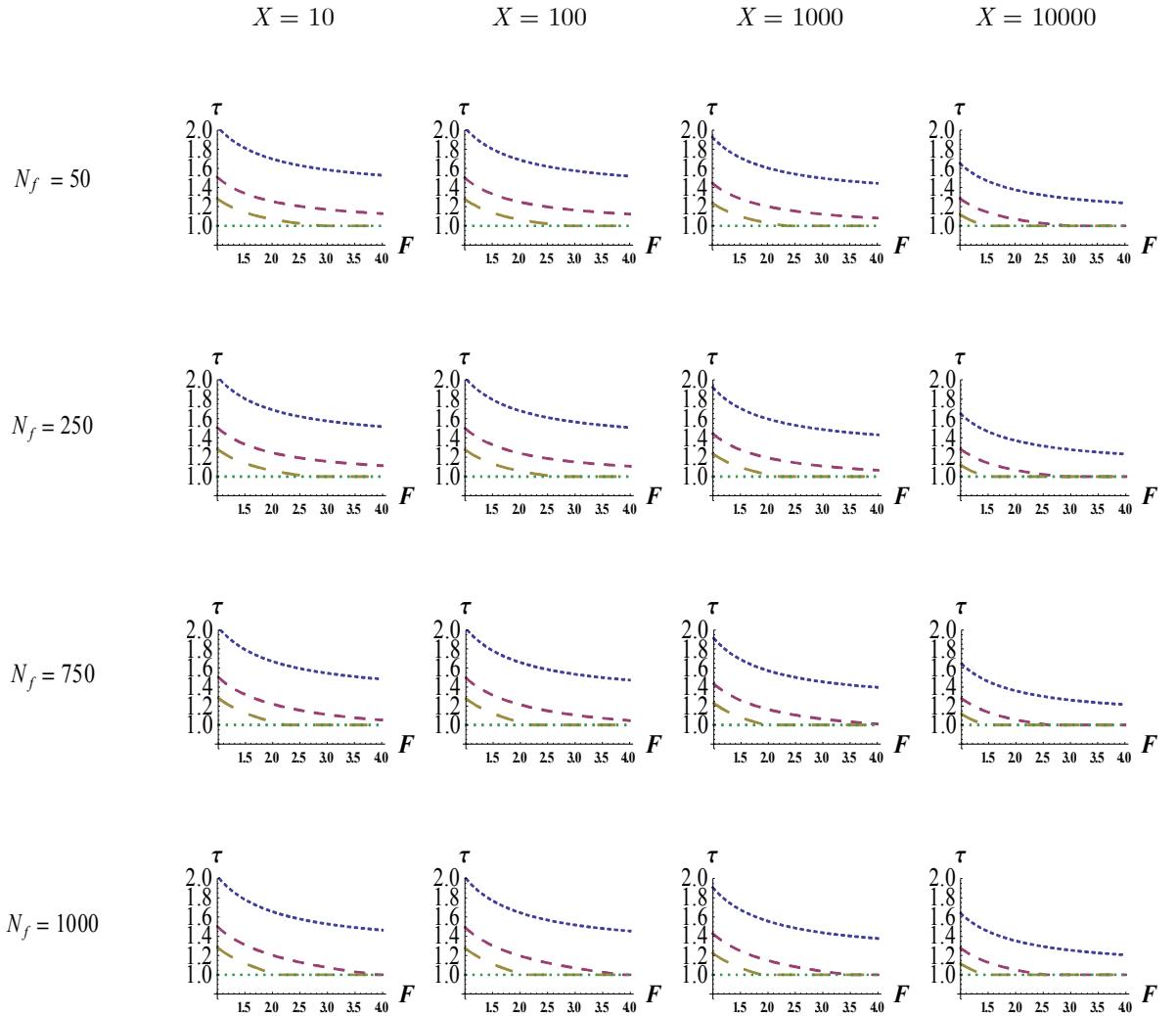
$$\Rightarrow \varepsilon_F^Z < 0.$$

APPENDIX C: **NUMERICAL DEMONSTRATIONS OF CLAIMS 3 AND 4**

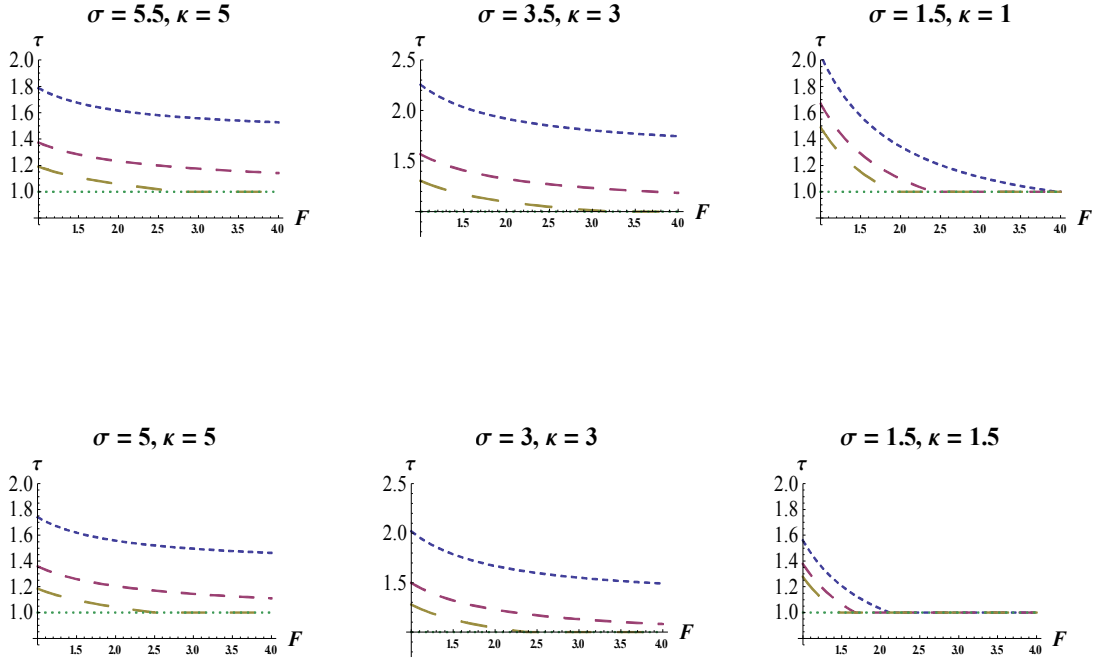
The following graphs examine numerically the negative relationship between the fixed cost of trade and the endogenous tariff. Below we show that the equilibrium relationship is robust to changes in the start-up cost, f_e , the size of the domestic economy, E_H , the scale parameter in the Pareto distribution, c_m , and the fixed cost of serving the domestic market, f .

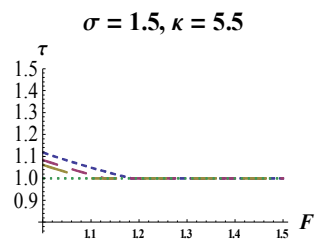
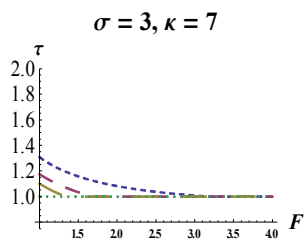
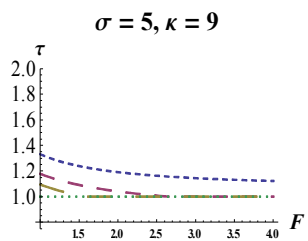
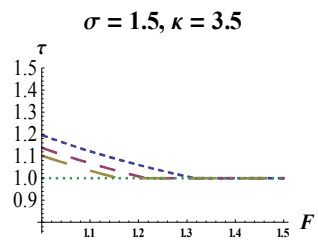
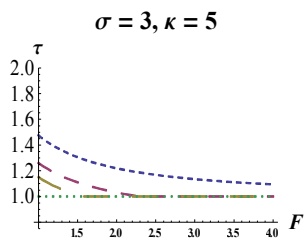
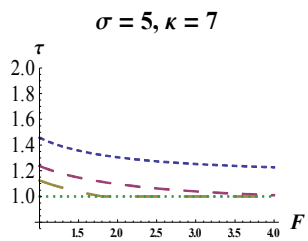


Here we show that the equilibrium relationship is robust to simultaneous changes in demand for home country exports, X , the number of foreign firms attempting to sell in the home market, N_F , and the weight the government places on political contributions, α . In each graph the topmost curve with the smallest dashes is drawn for $\alpha = 2.5$, while the middle curve is drawn for $\alpha = 1$ and the lowest curve with the largest dashes is drawn for $\alpha = 0$.

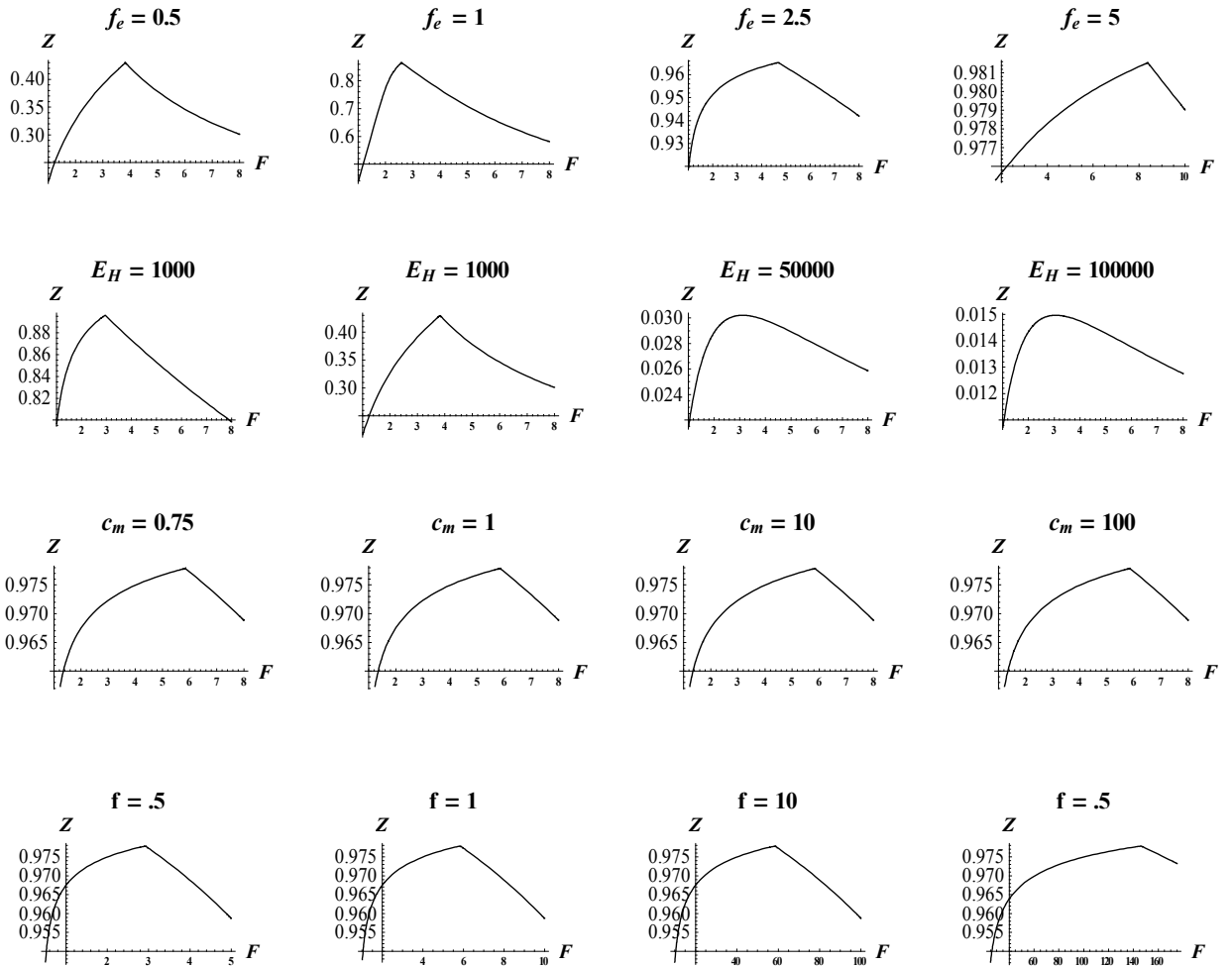


Here we show that the equilibrium relationship is robust to simultaneous changes in the elasticity of substitution, σ , the shape parameter from the Pareto distribution, κ , and the weight the government places on political contributions, α . In each graph the topmost curve with the smallest dashes is drawn for $\alpha = 2.5$, while the middle curve is drawn for $\alpha = 1$ and the lowest curve with the largest dashes is drawn for $\alpha = 0$.

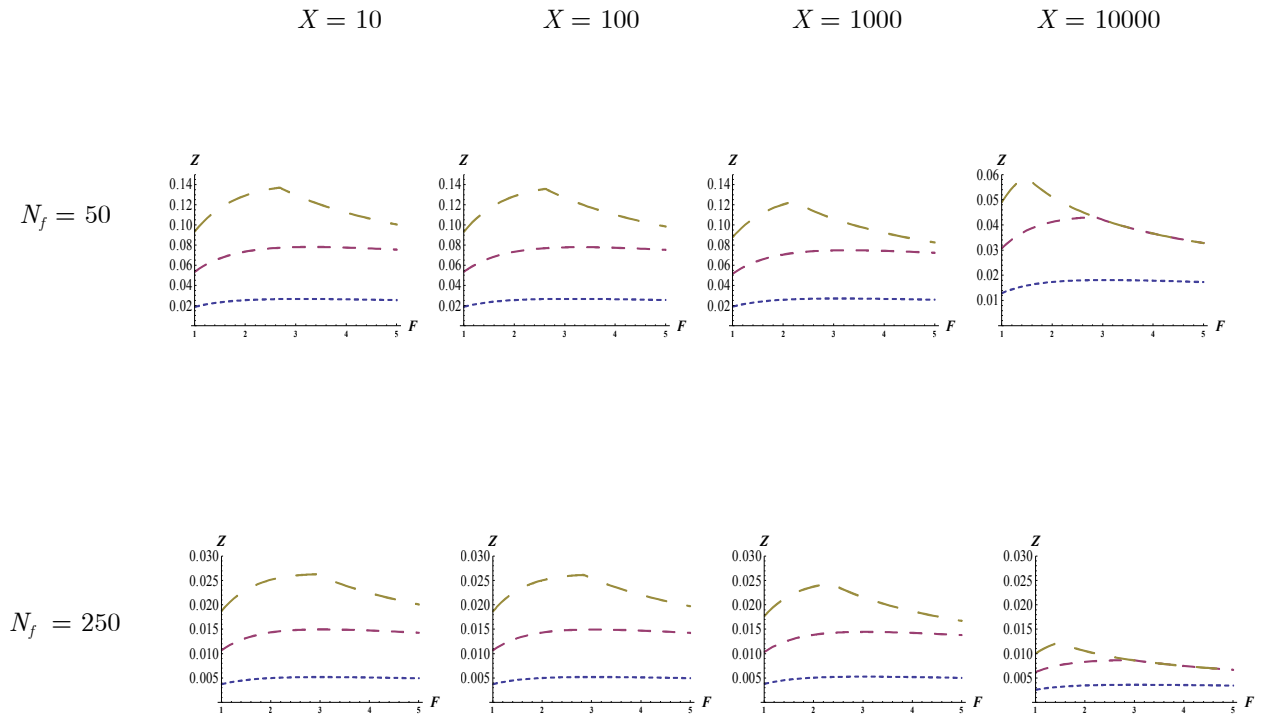




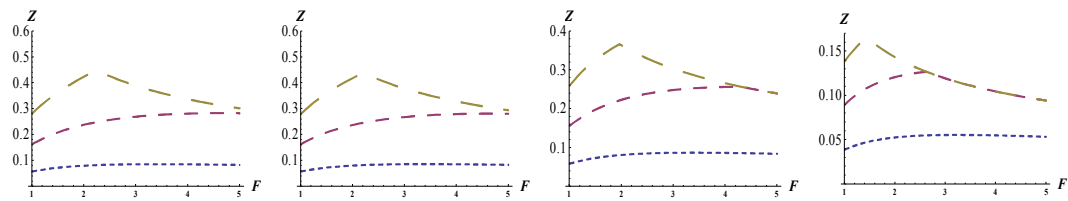
The following graphs examine numerically the nonmonotonic relationship between the fixed cost of trade and the import-penetration ratio. Below we show that the equilibrium relationship is robust to changes in the start-up cost, f_e , the size of the domestic economy, E_H , the scale parameter in the Pareto distribution, c_m , and the fixed cost of serving the domestic market, f .



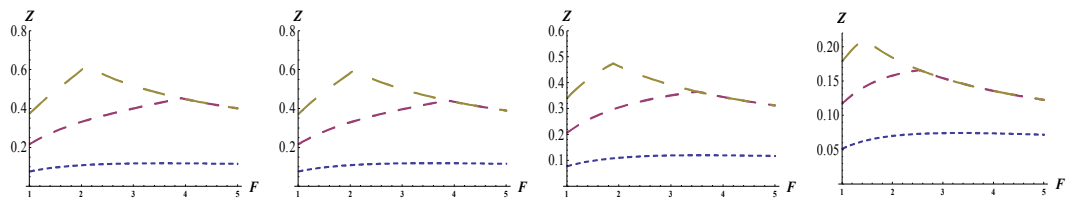
Here we show that the equilibrium relationship is robust to simultaneous changes in demand for home country exports, X , the number of foreign firms attempting to sell in the home market, N_F , and the weight the government places on political contributions, α . In each graph the lowest curve with the smallest dashes is drawn for $\alpha = 2.5$, while the middle curve is drawn for $\alpha = 1$ and the highest curve with the largest dashes is drawn for $\alpha = 0$.



$N_f = 750$

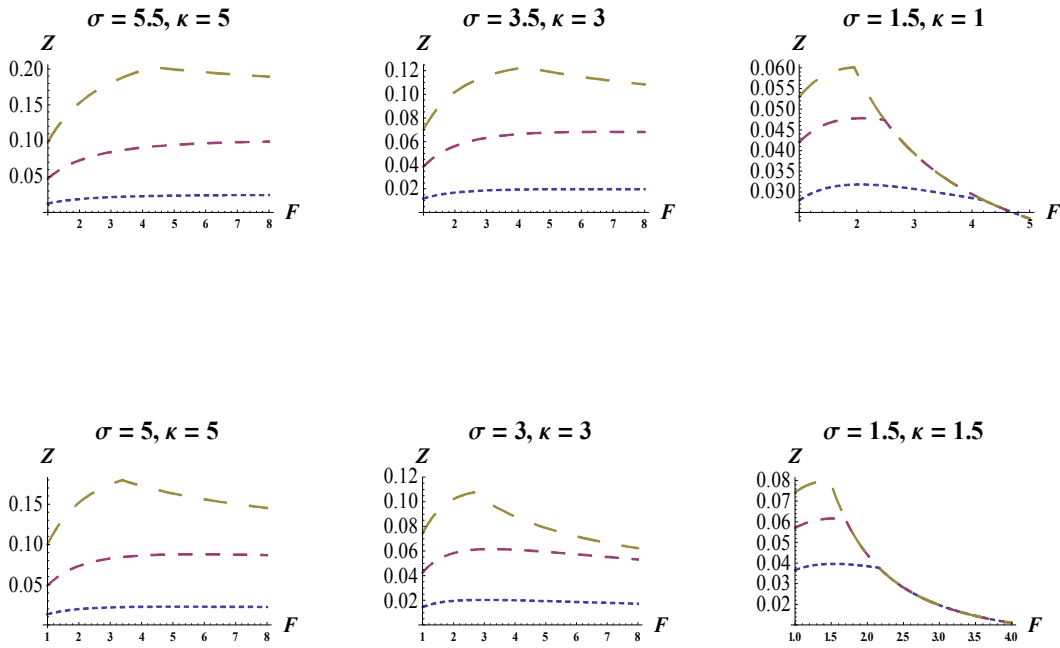


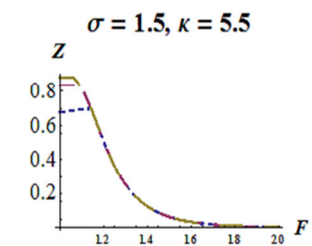
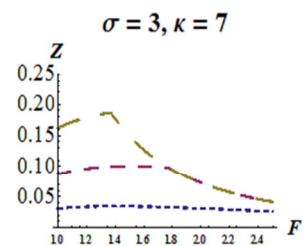
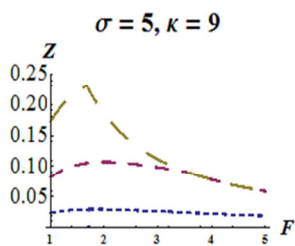
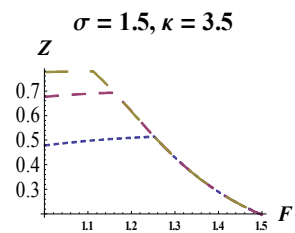
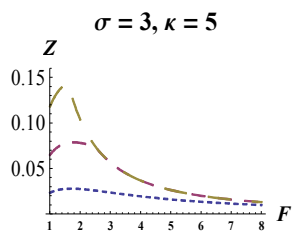
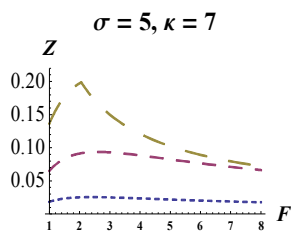
$N_f = 1000$



Here we show that the equilibrium relationship is robust to simultaneous changes in the elasticity of substitution, σ , the shape parameter from the Pareto distribution, κ , and the weight the government places on political contributions, α .

In each graph the bottom curve with the smallest dashes is drawn for $\alpha = 2.5$, while the middle curve is drawn for $\alpha = 1$ and the highest curve with the largest dashes is drawn for $\alpha = 0$.





APPENDIX D: GMM ESTIMATION

The purpose of this appendix is to present an alternative empirical strategy and estimation results. The equations of interest are the same as in the body of chapter 3: the government's FOC, the derivation of the import elasticity and the derivation of the composite trade equation. Note that for the GMM procedure we can augment the trade equation with a set of industry-level variables suggested by Treﬂer(1993) and GB(2000). Specifically, $relkl$ is the relative industry-level capital-labor ratio, $reltfp$ is the relative industry-level total factor productivity from the previous year, $punsk$ is the proportion of the industry labor force that is considered unskilled, $psci$ is the proportion of the industry labor force that are considered scientists/researchers and $pplant$ is the proportion of the industry capital stock devoted to plants and structures. Insofar as the U.S. is a capital-abundant country, we would expect higher import-penetration ratios to be associated with lower values on $relkl$, $reltfp$, and $psci$ and with higher values on $punsk$. Similarly, insofar as

higher fixed costs dampen trade, then we would expect higher import-penetration ratios to be associated with lower values on *pplant*.

In the theoretical model presented in chapter 2, trade is motivated by product differentiation. The inclusion of the above variables serves as a set of controls for other sources and motivation for trade. In particular, we control for variation in imports due to endowment differences by including *relkl* in the import equation, and we control for variation in imports due to productivity differences by including *reltfp* in the import equation. This is not possible in the indirect inference approach due to a lack of degrees of freedom. This flexibility in the GMM framework should allow a closer fit to the import data.

The parameters of interest are the same— κ , σ , α —and have the same interpretations as before, and each new variable added to the trade equation carries its own coefficient. The three-equation system consists of structural equations that are nonlinear in the parameters. The estimation technique is nonlinear GMM using instrumental variables.

As discussed in the body of chapter 3, the system actually includes 4 variables that should properly be considered endogenous. The absence of a reliable measure of fixed costs, however, prevents the estimation of four separate equations. When implementing indirect inference, we combined the derivation of the trade equation and the derivation of the varieties equation into a single composite equation determining trade with two sources of error. This is not a feasible strategy in the context of GMM, so we are forced to estimate a three-equation system and treat one of the endogenous variables as exogenous—the ratio of foreign to home varieties. Thus, the three equation system consists of three endogenous variables (ntb , Z , e), up to 10 exogenous variables depending on specification (V , E , Y , s , X , $relkl$, $reltfp$, $punsk$, $psci$, $pplant$) and up to 9 independent parameters. As a defense against bias, only those variables that are considered truly exogenous are included in the subset of instruments. Nevertheless, this is an imperfect solution; hence this exercise has been added as an appendix, for use as a point of reference and for comparison with the method of indirect inference adopted in the body of chapter 3.

Implementing GMM

The estimation procedure uses the available moment conditions to estimate a specific set of free coefficients, while the remaining coefficients are constrained to be functions of the free coefficients. The structural parameters are generated as nonlinear functions of the free coefficient estimates, and the standard errors are calculated using the delta method. Theory suggests that we use the transport cost as an instrument for all three equations and the level of exports as an instrument for equation one. The remaining exogenous variables are employed as instruments in different combinations considered below. The total number of industries in the sample differs slightly from GB due to data limitations. Throughout the analysis, we examine all specifications twice, first using GB's measure of non-tariff barriers then using a measure of average industry tariffs. All estimates are generated using two-step GMM with a robust weight matrix constructed to accommodate heteroskedasticity.

The first set of specifications uses *ntb* as the measure of trade-policy protection. Estimation results are presented in table D.1. Each column represents a

different choice of instruments, resulting in a different number of parameters and moment conditions. Estimates for the structural parameters of interest appear in the middle of the table with standard errors in parentheses. Results from a series of hypothesis tests for each specification appear at the bottom of the table.

Note first that the estimates for κ and σ meet theoretical expectations across the majority of specifications—both have point estimates and confidence intervals that are strictly greater than one. σ ranges from 1.888 to 4.021 while κ ranges from 1.868 to 2.238. The point estimates for κ and σ usually satisfy the restriction $\kappa > \sigma - 1$, though the estimates are not usually precise enough to reject the hypothesis that this restriction is violated. The point estimates for α are similarly reasonable, though the variation across specifications is larger, and the estimates themselves are uniformly less precise. Nevertheless, they suggest that the government values political contributions over consumer utility at a roughly 2-to-1 rate.

It is useful to compare these estimates to those produced using the indirect inference procedure. The indirect inference estimate for σ was 3.997, located on the

upper end of the range of estimates produced using GMM. The indirect inference estimate for κ was 3.021; it is larger than any of the κ estimates here. The indirect inference estimate for α was 2.965, and it is generally larger than the GMM estimates. There are two potential reasons for these differences. First, we added auxiliary variables to the trade equation in the GMM procedure, with the goal of improving the fit of the model to the observed import-penetration ratio. The use of instrumental variables afforded the extra degrees of freedom, whereas in the indirect inference procedure the model was already just identified. It is possible that the difference in the estimates is due to the inclusion of these auxiliary variables. A second possibility is that the GMM procedure is plagued by estimation bias due to the treatment of V as an exogenous regressor. In this case, the indirect inference results reflect estimates for the parameters that are purged of this kind of bias. For example, the GMM procedure may be artificially deflating the size of its estimates as a result of the aforementioned simultaneity bias.

Another possibility is that the two approaches are not actually producing different estimates, but that one or the other (or both) is simply producing rather

imprecise estimates. We test this idea directly in the body of chapter 3 regarding the value of α and found that some of the GMM estimates were rejected by the indirect inference procedure while others were not. Indeed, estimates of α seem to be the least precise in both approaches.

All of the specifications presented here are overidentified, so we can use Hansen's J statistic to test the specification. This test is constructed such that all of the restrictions implied by the model are satisfied under the null hypothesis. A rejection of the null hypothesis casts doubt on the appropriateness of the model specification, the validity of the instruments, or both. As can be seen in the table, all ten specifications fail to reject the null at the 95% level of confidence, and eight of the ten fail to reject the null at the 90% level of confidence. We interpret this result as evidence in support of the basic specification and choice of instruments. Moreover, the consistency of the estimates across the ten models suggests that they are robust to different combinations of instrumental variables.

As an additional robustness check, we estimate each specification first using GB's measure of non-tariff barriers (*ntb*) and then using a measure of average tariffs

(*tar*). These two variables are only weakly correlated in the sample [Pearson’s coefficient 0.21], yet the estimation results are remarkably similar. Table D.2 presents the results of one such comparison. Both cases produce comparable point estimates and standard errors for all the key parameters and ancillary coefficients. In addition, the results of three important hypothesis tests are also consistent. We interpret this result to suggest that, although there are important differences in these two measures of protection, they are not so different so as to need distinctive structural explanations. The remainder of this appendix will use GB’s measure (*ntb*) unless otherwise noted.

As mentioned in chapter 3, one limitation of the baseline specification is the estimation of single values for κ and σ for all industries. Here we again split the samples and estimate separate sigmas and kappas for each group. The results appear in table D.3.

First, we consider the industry labels used by GB. All industries that are labeled either “food” or “natural resources” are combined to form group 1, while all industries that are labeled either “manufactured” or “capital goods” are combined to

form group 2. The new parameter estimates appear in the middle of the table, and the results of hypothesis tests appear near the bottom. Note first that the estimated values for $\kappa(1)$ and $\kappa(2)$ are quite similar, and we cannot reject the null hypothesis that they are indeed the same. This suggests that this particular grouping of industries does not reveal any significant difference in the distribution of productivities. It appears that the values for $\sigma(1)$ and $\sigma(2)$ are also quite close, but in this case we can reject the null that they are the same value. In other words, this grouping does appear to reveal a difference in consumer preferences—the elasticity of substitution for agricultural goods and raw materials exceeds that for manufactured and capital goods. This is a counterintuitive result, but it should not be taken too seriously as this specification fails the overidentification test.

We next consider a classification of industries due to Rauch (1999). He divides manufactured goods into three groups: differentiated products, reference-priced (an intermediate category) and homogenous goods. Presumably, we would expect the group of differentiated goods to be characterized by a larger elasticity of substitution than the other two categories. To maintain workable sample sizes, we

combine the differentiated and reference-priced goods into a single group and compare estimates for σ and κ to those for the homogeneous goods. In this case, the estimates for σ and κ differ in important ways. As expected, the point estimate for σ is larger for the differentiated-goods group than for the homogenous-goods group. Interestingly, the point estimate for κ is also larger for the differentiated-goods group than for the homogenous-goods group. The interpretation is that those industries in group 1 are characterized by a greater skew in the productivity (and hence size) distribution than those in group 2. The σ and κ estimates are precise enough that we can reject the null hypothesis that they are the same in the two groups. Moreover, and in contrast to the estimates in column [1], this specification survives the overidentification test.

We use the same strategy to investigate GB's categorization of the sample into those industries that are politically organized and those that are not. According to the original PFS model, politically organized industries offer political contributions in exchange for policy protection. By contrast, politically unorganized industries are characterized by trade policies that are set according to consumer

interests alone. In GB's empirical work, this distinction is modeled as separate slope coefficients for each subgroup. Here, we estimate the same baseline specification as before, but split the sample according to GB's organization dummy, allowing for separate σ and κ estimates as before.

The results appear in column [3] of table D.3. Once again, the point estimates provide evidence of two distinct groups within the sample. The organized industries are characterized by a higher elasticity of substitution and a more skewed productivity distribution than are the unorganized industries. Moreover, these differences are not likely due to chance, as Wald tests reject the null hypotheses of equal κ and equal σ for the two groups; this specification also survives an overidentification test. We interpret these results as offering evidence that the industry groupings GB constructed based on political activity actually differ according to even more fundamental characteristics. That is, using the organizational groupings of GB introduces selection bias into the estimating procedure. The fact that these industry groupings are a function of other industry-level determinants that also affect the level of protection implies that we cannot

maintain the assumption that this regressor is independent of the error term in the protection equation. Note that this specification is not a replication of GB’s model or results—we continue to maintain the assumption that all industries are organized and capable of offering political contributions. Consequently, and in contrast to GB, the estimate for α continues to depend on both groups of industries. Rather, we have simply allowed these two groups of industries to be characterized by different preference and technological parameters. What GB interprets as the effect of differences in political organization on trade policy, we interpret as the effect of differences in “deeper” industry attributes.

As a final robustness check, we turn our attention to the α estimates presented in table D.1. As noted earlier, this parameter is consistently estimated with the least precision. Indeed, it is often the case that we cannot reject the null hypothesis that α takes the value zero. This can be problematic as α captures the weight the government places on political contributions. If the data truly supports such a conclusion, then the entire political-economy apparatus of the model is called into question. We address this issue by estimating a restricted version of the

preferred specification (column 9 of table D.1) with the α parameter fixed at zero.

The results are informative: while the estimate for κ is reasonable—2.49 with a standard error of 0.043—the estimate for σ is very suspect and very imprecise—24.99 with a standard error of 9.11. Moreover, Hansen’s J is 56.09 with a p-value of 0.00, leading us to reject the null hypothesis that this model is correctly specified. We conclude from this evidence that the unrestricted version—with point estimate for α of 1.859—is a better fit with the data than the restricted version with α set to zero. In other words, and unsurprisingly, political-economy factors matter for explaining variation in trade policy across U.S. industries.

Table D.1: GMM Estimates using Non-tariff Barriers

<i>Model</i>	[1]	[2]	[3]	[4]	[5]	[6]
<i>Instruments</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>
	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>
	<i>relkl</i>		<i>relkl</i>	<i>relkl</i>	<i>relkl</i>	
		<i>reltfp</i>	<i>reltfp</i>	<i>reltfp</i>	<i>reltfp</i>	
				<i>punsk</i>	<i>punsk</i>	<i>punsk</i>
					<i>psci</i>	<i>psci</i>
N	241	241	241	234	198	198
# parameters	5	5	6	7	8	6
# moments	8	8	11	14	17	11
<i>Estimates</i>						
α	2.054 (1.074)	2.520 (1.275)	1.851 (0.871)	2.240 (0.968)	0.883 (0.450)	3.801 (2.886)
κ	2.008 (0.169)	1.936 (0.166)	2.039 (0.152)	1.937 (0.151)	2.260 (0.138)	1.956 (0.244)
σ	2.563 (0.688)	2.294 (0.538)	2.705 (0.684)	2.446 (0.522)	3.918 (1.453)	1.888 (0.521)
<i>Hypothesis Tests</i>						
Hansen's <i>J</i>						
χ^2	3.552	1.633	4.358	12.560	13.819	7.574
p-value	0.314	0.651	0.499	0.083	0.128	0.181
$H_0: \sigma = 1$						
χ^2	5.160	5.770	6.200	6.690	4.600	2.570
p-value	0.023	0.016	0.012	0.009	0.032	0.108
$H_0: \kappa = \sigma - 1$						
χ^2	0.730	2.940	0.390	1.780	0.420	0.960
p-value	0.393	0.086	0.531	0.182	0.515	0.327

Standard errors in parentheses calculated using delta method.

Constant and other coefficients from equation 3 not shown.

Table D.1:(continued)

<i>Model</i>	[7]	[8]	[9]	[10]
<i>Instruments</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>
	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>
			<i>relkl</i>	<i>relkl</i>
			<i>reltfp</i>	<i>reltfp</i>
	<i>punsk</i>	<i>punsk</i>		<i>punsk</i>
	<i>psci</i>			<i>psci</i>
	<i>pplant</i>	<i>pplant</i>	<i>pplant</i>	<i>pplant</i>
N	198	234	241	198
# parameters	7	6	7	9
# moments	14	11	14	20
<i>Estimates</i>				
α	1.673 (1.366)	3.017 (1.389)	1.859 (0.843)	0.888 (0.436)
κ	2.047 (0.248)	1.868 (0.148)	2.035 (0.146)	2.238 (0.131)
σ	2.781 (1.259)	2.129 (0.421)	2.697 (0.656)	4.021 (1.338)
<i>Hypothesis Tests</i>				
Hansen's <i>J</i>				
χ^2	10.132	10.578	4.938	13.891
p-value	0.181	0.061	0.667	0.239
$H_0: \sigma = 1$				
χ^2	2.00	7.190	6.680	5.120
p-value	0.157	0.007	0.009	0.023
$H_0: \kappa = \sigma - 1$				
χ^2	0.07	7.280	0.440	0.430
p-value	0.792	0.007	0.508	0.514

Standard errors in parentheses calculated using delta method.
Constant and other coefficients from equation 3 not shown.

Table D.2: Comparing Estimates using Tariffs and Non-tariff Barriers.

<i>Policy Measure</i>	Non-tariff barriers (<i>ntb</i>)	Average tariffs (<i>tar</i>)
N	241	241
# parameters	7	7
# moments	14	14
<i>Estimates</i>		
α	1.859 (0.843)	1.921 (0.901)
κ	2.035 (0.146)	2.023 (0.151)
σ	2.697 (0.656)	2.649 (0.657)
Eq. 3 constant	3.799 (2.906)	3.566 (2.842)
Eq. 3 <i>relkl</i> coefficient	-0.151 (0.308)	-0.179 (0.288)
Eq. 3 <i>reltfp</i> coefficient	0.716 (0.946)	0.572 (0.885)
Eq. 3 <i>pplant</i> coefficient	-0.435 (0.857)	-0.342 (0.803)
<i>Hypothesis Tests</i>		
Hansen's <i>J</i>		
χ^2	4.938	5.283
p-value	0.667	0.625
$H_0: \sigma = 1$		
χ^2	6.680	6.30
p-value	0.009	0.012
$H_0: \kappa = \sigma - 1$		
χ^2	0.440	0.54
p-value	0.508	0.461

Standard errors in parentheses calculated using delta method.

Instruments used: *s*, *X*, *relkl*, *reltfp*, *pplant*.

Table D.3: Specification Tests using Non-tariff Barriers.

<i>Model</i>	[1]	[2]	[3]
<i>Sample Split</i>	<i>Gawande Types</i>	<i>Rauch Types</i>	<i>Gawande Orgs</i>
Group 1	Food and Natural Resources: N = 121	Differentiated Goods: N = 49	Politically Organized: N = 164
Group 2	Manufactured and Capital Goods: N = 120	Homogeneous Goods: N = 181	Not Politically Organized: N = 77
# parameters	9	9	9
# moments	28	28	28
<i>Estimates</i>			
α	1.058 (0.202)	1.106 (0.315)	0.547 (0.153)
$\kappa(1)$	2.127 (0.063)	2.114 (0.068)	2.382 (0.066)
$\kappa(2)$	2.180 (0.070)	1.764 (0.059)	2.273 (0.076)
$\sigma(1)$	3.755 (0.471)	3.354 (0.595)	6.159 (1.359)
$\sigma(2)$	3.455 (0.439)	2.905 (0.425)	5.704 (1.245)
<i>Hypothesis Tests</i>			
Hansen's J			
χ^2	39.33	35.95	22.22
p-value	0.004	0.247	0.273
$H_0: \sigma_1 = \sigma_2$			
χ^2	13.03	9.12	4.55
p-value	0.001	0.011	0.032
$H_0: \kappa_1 = \kappa_2$			
χ^2	1.17	295.0	4.14
p-value	0.280	0.000	0.042

Standard errors in parentheses calculated using delta method.

Constant and other coefficients from equation 3 not shown.

Instruments used: s , X , $relkl$, $reltfp$, $pplant$.

APPENDIX E: EXPERIMENTING WITH INDIRECT INFERENCE

The choice to employ the method of indirect inference is driven by the potential for multiple endogenous relationships and the inherent nonlinearity of the theoretical model being estimated. This method more commonly appears in time-series applications (Broze et al., 1995; Pastorello et al., 2000), but there are a growing number of microeconomic examples. This appendix is designed to demonstrate the usefulness of indirect inference for overcoming the above-mentioned problems that often plague standard econometric approaches and inhibit valid inferences.

Our first step is to construct a hypothetical model that shares the structure and features of the model in the text. Consider the following two-equation model,

$$y_1 = a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5y_2 + \varepsilon_1 \tag{E.1}$$

$$\log(y_2) = b_1 \log(x_1) + b_2 \log(y_1) + b_3\varepsilon_2, \tag{E.2}$$

where y_1 and y_2 are endogenous variables, x_1 - x_4 are exogenous variables drawn from independent uniform distributions and a_1 - a_5 , b_1 - b_3 are parameters. Note that both

equations include endogenous variables on the right-hand side, and that equation 2 is nonlinear in the parameters. The error terms are drawn from independent normal distributions with mean zero; b_3 captures the ratio of their standard deviations.

With the exogenous variables and error terms in hand, we can simulate values for the two endogenous variables for any set of parameters by solving the nonlinear system. Let the true values of the parameters be as follows:

$$\begin{array}{ccccc} a_1 = 2 & a_2 = 0.2 & a_3 = 1 & a_4 = 0.5 & a_5 = 0.75 \\ b_1 = 1 & b_2 = -1.5 & b_3 = 0.5 & & \end{array}$$

With an N of 250, these parameter values generate a y_1 with mean 11.025 and standard deviation 4.078 and a y_2 with mean 0.0829 and a standard deviation 0.056.

Equation (E.1) constitutes the auxiliary model, so we estimate its five coefficients using a standard OLS approach, understanding the potential for bias.

Let $\hat{\beta}$ represent the resulting coefficient vector. Estimation results are presented in table E.1.

Table E.1: Auxiliary Model
OLS Regression: Dependent Variable y_1 (N = 250)

Regressor	$\hat{\beta}$	Std. Error
x_1	2.039	0.037
x_2	0.221	0.033
x_3	0.999	0.032
x_4	0.510	0.032
y_2	-1.739	1.045

These coefficient estimates function as targets for choosing estimates of the parameters that produce simulation results that most closely match the behavior captured by $\hat{\beta}$. Notice that the OLS coefficient estimates for a_I - a_4 are fairly close to the true values, but the estimate on a_5 is more than twice the true value and carries the wrong sign. This is an illustration of the estimation bias that occurs when ignoring the endogeneity of a regressor.

Let $b(\theta)$ represent the binding functions (one for each element of $\hat{\beta}$) defined in the main text. They represent the corresponding coefficient estimates for the auxiliary model for a given set of parameter values, averaged over 75 simulations. Similarly, let $Q(\theta)$ represent the criterion function defined in the main text. It is a

measure of the distance of the values in the binding functions to the values in $\hat{\beta}$.

The optimization procedure therefore minimizes $Q(\theta)$ with respect to θ .

One important note: the dimension of $\theta(k)$ must be less than or equal to the dimension of $\hat{\beta}(l)$. Thus we fix a_2, a_3, a_4, b_1 at their true values and estimate the rest. This provides us with one degree of freedom with which we can perform an overidentification test using Hansen's J . The resulting parameter estimates and criterion value are presented in table E.2.

Table E.2: Indirect Inference Estimation Results
Simulated Variables: y_1, y_2

Parameter	Estimate
a_1	2.020
a_5	0.767
b_2	-1.649
b_3	0.635
$Q(\theta)$	0.460

The parameter estimates are all fairly close to their true values. Of particular interest is the coefficient estimate for a_5 . Recall that a standard application of OLS resulted in a biased estimate for this parameter. By contrast, the indirect inference

procedure has generated a coefficient estimate that is quite close to the true value, even though it used the biased OLS coefficient estimate as a target for matching.

As discussed in Davidson and MacKinnon (2004), the minimized value of the criterion function is distributed as $\chi^2(l - k)$. This allows us to test the overidentifying restrictions using Hansen's J . The null hypothesis of this test is that the overidentifying restrictions are appropriately chosen, so a rejection of the null casts suspicion on the parameter estimates. The test statistic is 0.460 with a p-value of 0.859. Hence we cannot reject the null hypothesis; although overidentified, the minimized value of the criterion function is sufficiently small to support the parameter estimates. This should come as no surprise—we know with certainty that the restricted coefficients are properly chosen, so we would expect no statistical difference when choosing a different subset of parameters to estimate. We interpret this result as favorable to the method.

We can also test individual elements of the vector θ by comparing the restricted and unrestricted values of $Q(\theta)$. This approach is often used to test whether restricting a parameter to zero has any statistically significant effect on the

minimized value of the criterion function. Here, we will test whether there is any statistically significant difference between the value of $Q(\boldsymbol{\theta})$ as reported above and the value of the minimized criterion function when a given parameter is set to its true value. The results are presented in table E.3.

Table E.3: Selected Hypothesis Tests

Restriction	Test Statistic	p-value
$a_1 = 2$	0.321	0.904
$a_5 = 0.75$	0.424	0.871
$b_2 = -1.5$	0.239	0.929
$b_3 = 0.5$	0.116	0.966

Normally, we would hope for large differences in the minimized criterion values, producing large test statistics and small p-values, leading us to reject the null hypotheses. In this case, however, we restrict each element of the parameter vector to its known true value, and construct the null hypotheses to reflect this choice. Thus, failing to reject the null in each test is interpreted as lending support to the method. Put differently, the results lead us to (correctly) fail to reject null hypotheses we know to be true.

To summarize, in this appendix we have constructed a two-equation model characterized by endogenous relationships and nonlinear parameters. The method of indirect inference, using an N of 250 and 75 simulations, produced parameter results that are reasonably close to their known true values. In addition, using these estimates and the value of the minimized criterion function, we drew the correct conclusions in a test of the overidentifying restrictions and when testing individual elements of the parameter vector. These results give us confidence when employing the method of indirect inference to the model in chapter 3, whose structure is similar and for which we have a data set of comparable size.

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