Optimal industrial targeting with unknown learning-by-doing

Elias Dinopoulos*, Tracy R. Lewis, David E. M. Sappington

Department of Economics, University of Florida, Gainesville, FL 32611, USA

Received November 1992, revised version received June 1994

Abstract

We examine a government's optimal targeting policy when it has limited information about the learning curves of domestic producers. Popular arguments suggest that in order to promote learning-by-doing, the government might want to protect domestic producers from foreign competition by temporarily closing the domestic market to foreign producers. We identify a set of conditions under which such trade intervention is not optimal. Instead, domestic welfare is better fostered either by no government intervention, or by providing subsidies to the most capable domestic producers who are willing to set a particularly low domestic price for their product.

Key words: Industrial policy; Learning-by-doing; Protection; Asymmetric information

JEL classification: F12; F13

1. Introduction

Industrial targeting refers to the process of identifying firms (or industries) that are believed to have significant growth potential, and then devoting considerable resources to the development of these firms. The development of targeted industries commonly takes the form of providing tax incentives for capital investment, offering subsidies for research and development, and granting firms in the industry temporary protection from import

* Corresponding author.

competition.¹ The literature on targeting (and ‘strategic trade policy’, more generally)² suggests that government intervention can enhance domestic welfare when markets are imperfectly competitive,³ when static scale economies are present, or when production technologies exhibit learning-by-doing, so that future production costs decline as current production increases.⁴ These conclusions have generally been derived under the assumption of perfect information, where the government is fully aware of all relevant aspects of the environment. In reality, domestic producers often have superior, private information about their present and future production capabilities. Therefore, the optimal form of industrial targeting in the presence of asymmetric knowledge about learning economies is important to analyze, and is the subject of this research.⁵

Domestic firms may be tempted to exaggerate the extent of their learning economies in order to secure production subsidies, import protection, or other favorable treatment from their government. Thus, the government’s targeting problem may be complicated by the presence of asymmetric information. The government may have difficulty choosing the best firms or industries to target, and the most appropriate mix of policy instruments to employ.

¹ See Krugman and Obstfeld (1991, ch. 11) for a useful discussion of issues relating to industrial policy. Carlner (1986) provides an excellent description of Japanese, U.S., and French industrial policies. Also see the Congressional Budget Office (1985). Hufbauer et al. (1986) explain how the U.S. government aided the Harley–Davidson Corporation by imposing tariffs and import restrictions on heavyweight motorcycles between 1983 and 1988.

² See Helpman and Krugman (1989) for an interesting survey of the literature on strategic trade policy.

³ See, in particular, Brander and Spencer (1983, 1985).

⁴ See, for example, Krugman (1984, 1986), Dixit and Kyle (1985), Dixit and Grossman (1986), Cheng (1988), Dasgupta and Stiglitz (1988), and Mezzetti and Dinopoulos (1991), among others.

⁵ There is a growing literature that analyzes the optimal design of trade policy in the absence of perfect information. (Feenstra et al., 1990, provide a recent survey.) The literature provides mixed results concerning optimal trade policy. To illustrate, Mayer (1984) analyzes a setting where goods must be consumed before consumers learn the quality of products. In this setting, optimal trade policy can involve subsidies for infant exporters. Grossman and Horn (1988) analyze a model involving both adverse selection and moral hazard in which consumers are not perfectly informed about the quality of goods produced domestically. The authors find that protection of the infant domestic industry reduces welfare, because it exacerbates the problem of adverse selection and encourages excessive entry by low-quality producers. Bagwell and Staiger (1989) explore the role export subsidies can play when domestic consumers are not perfectly informed about the quality of goods produced abroad. They find that this information asymmetry results in too little entry by domestic producers, but that export subsidies encourage production by high-quality domestic producers. Dixit (1987, 1989) examines the design of trade policy in markets where moral hazard and adverse selection problems prevail. He finds a limited role for trade protection. Flam and Staiger (1991) find that tariffs may be socially preferred to production subsidies when information asymmetries cause production distortions.

To focus on the special concerns raised by asymmetric information, the ensuing analysis abstracts from considerations of imperfect competition among domestic firms and between domestic firms and foreign producers. We examine the welfare-maximizing policy for the domestic government when a monopolistic domestic producer faces a competitive fringe of foreign suppliers.⁶ The foreign suppliers are mature firms that have exhausted their learning economies. The foreign fringe's supply curve is infinitely elastic at the fringe's known, constant marginal cost of production, c . The domestic producer, in contrast, has not exhausted its learning economies. In the first of the two periods we consider, the domestic firm's marginal cost of production exceeds c . However, the domestic firm's marginal cost can fall below c in the second period if its learning curve is sufficiently steep. Welfare maximization entails production by the domestic firm only if its learning curve is sufficiently steep.

Due to the competitive structure of our model, the domestic government can sometimes achieve the welfare-maximizing production pattern despite its limited knowledge of the domestic firm's capabilities. This ideal production pattern will arise without any intervention in the marketplace whenever domestic demand and the domestic firm's technology are such that for the highest degree of learning economies, the domestic firm would produce without entirely displacing the foreign fringe in the absence of government intervention. More generally, the domestic government can increase domestic welfare by intervening in the domestic market. However, the optimal form of intervention is not to close the domestic market to foreign competition. The optimal targeting policy provides a subsidy to the domestic producer that is larger the farther below c the domestic firm sets its second-period price. Perhaps surprisingly, this optimal policy provides a subsidy to the domestic producer precisely when it would drive the foreign fringe from the domestic market on its own, in the absence of government intervention.

These findings are presented and explained in more detail in Section 4. First, though, the model we analyze is described in Section 2. Two benchmark settings are analyzed in Section 3: the no-intervention setting,

⁶ Alternative industry structures and their implications are considered briefly in the concluding section. The market structure on which we focus is common in the literature. Investigations of the equivalence between tariffs and quotas have commonly assumed a perfectly elastic foreign product supply (see, for example, Bhagwati, 1969; Pelcovits, 1976; Sweeney et al., 1977; and Helpman and Krugman, 1989, ch. 3). The developing literature on trade policy under conditions of asymmetric information also commonly assumes a competitive supply of imports. (See, for example, Mayer, 1984; Grossman and Horn, 1988; Dixit, 1989; and Flam and Staiger, 1991.) This latter literature offers different conclusions regarding the optimal mix of policy instrument for the domestic government (as explained in the preceding footnote), so we view our analysis as a contribution to this ongoing inquiry.

where the domestic government abstains from all forms of targeting; and the full-information setting, where the government shares the domestic producer's knowledge of its learning curve. Concluding observations are offered in Section 5. The proofs of all formal results are in the Appendix.

2. Elements of the model

There are two periods in the model, and two sources of production for the domestic market: the domestic firm and a competitive fringe of foreign producers. The foreign fringe is a group of mature producers with a known, constant marginal cost of production, c , in both periods. The domestic firm has less production experience, and therefore has higher first-period production costs, $C^1(Q) > cQ$, $\forall Q > 0$. However, the experience gained by the domestic producer in the first period will reduce its second-period production costs, $C^2(\cdot)$. The magnitude of the cost reduction depends on the amount of the homogeneous good produced and sold by the domestic firm in the first period, Q_1 , and on the degree of its learning economies, θ . Higher first-period output leads to lower second-period costs at a decreasing rate, so $C_{Q_1}^2(Q_2|Q_1, \theta) < 0$ and $C_{Q_1 Q_1}^2(\cdot) > 0$ for all strictly positive second-period output levels, Q_2 . Higher realizations of the learning parameter, θ , result in lower total and marginal costs of second-period production for the domestic firm, i.e. $C_\theta^2(Q_2|Q_1, \theta) < 0$ and $C_{Q_2 \theta}^2(\cdot) < 0$, $\forall Q_1, Q_2 > 0$. Furthermore, the higher is θ , the more rapidly second-period costs decline as first-period output by the domestic firm increases, i.e. $C_{Q_1 \theta}^2(\cdot) < 0$, $\forall Q_2 > 0$. The domestic firm's cost function exhibits decreasing returns to scale in both periods over the relevant range, i.e. $C^{1''}(Q_1) > 0$ and $C_{Q_2 Q_2}^2(\cdot) > 0$.^{7,8}

Total domestic demand for the product at price p is denoted $Q(p)$. $P(\cdot)$ denotes the corresponding inverse demand function.⁹ For simplicity, demand is assumed to be identical in the two periods. Both the demand and the inverse demand functions are continuously differentiable, with strictly

⁷ The cost function of the domestic firm is also assumed to be thrice continuously differentiable. Furthermore, $C_{\theta Q_1}^2(Q_2|Q_1, \theta) \geq 0$, $C_{\theta Q_1 Q_2}^2(\cdot) \geq 0$ and $C_{\theta Q_2 Q_2}^2(\cdot) \geq 0$, $\forall Q_1, Q_2, \theta$.

⁸ One can view $C^i(\cdot)$ as the domestic firm's variable cost function in period i , with the firm's total costs given by $K + C^i(\cdot)$. With positive fixed costs of production, K , increasing marginal costs are consistent with the presumed monopoly structure in the domestic industry. Our main qualitative conclusions would not change if these fixed costs were introduced, but we abstract from them for expositional convenience.

⁹ For simplicity, we assume the domestic firm never produces for the world market. This will be the case, for example, if the domestic firm's costs of transporting the good to the world market are sufficiently large relative to the firm's maximum potential cost reduction due to learning economies.

negative first derivatives. Furthermore, $P(0) > c$, which ensures nontrivial demand for the product. All transactions occur at a single market-clearing price in each period. Thus, unless fringe supply is restricted by the domestic government, the domestic firm can only sell its output when the domestic price is at or below c . If the domestic firm sells Q_i units of output at price c in period i , the corresponding level of sales by the fringe is $Q^f(Q_i) = \max\{0, Q(c) - Q_i\}$.¹⁰ We assume that domestic demand is inelastic for prices below c , so the domestic firm never finds it profitable to drive the domestic price below c .¹¹

The domestic demand function and all cost functions are common knowledge. The realization of the learning parameter is the sole source of asymmetric information in the model. Only the domestic firm knows the value of θ from the outset. The domestic government views θ as a random variable with density $f(\theta)$ that has strictly positive support on the closed interval $[\underline{\theta}, \bar{\theta}]$. $F(\theta)$ will denote the corresponding distribution function for θ .

Attention is focused on the case where the domestic government wishes to maximize the expected present discounted value of domestic welfare, which consists of the surplus of domestic consumers and the profit of the domestic producer.¹² The gross value domestic consumers derive from consuming Q units of the product is denoted $U(Q)$. $U(\cdot)$ is an increasing, strictly concave function of its argument. Domestic welfare in each period is simply the difference between $U(\cdot)$ and the sum of: (i) the production costs incurred by the domestic producer; and (ii) payments to foreign producers.¹³

3. Benchmark solutions

In this section two benchmark cases are analyzed. Subsection 3.1 discusses the outcome that would arise if the domestic government adopted a laissez-faire ‘no intervention’ policy, allowing the domestic producer to make its

¹⁰ Thus, ‘ties’ are broken in favor of the domestic firm, so domestic consumers purchase the output of the domestic producer before that of the fringe when both outputs are sold at the same price. Otherwise, consumers buy from the producer charging the lowest price.

¹¹ Our central conclusions are not altered by this simplifying assumption. With elastic demand, the domestic firm might reduce price below c , but would not reduce price to the level of its marginal cost of production. The existence of a discrepancy between price and marginal cost is the key reason for government intervention in the model analyzed here.

¹² The case where there are welfare losses associated with raising taxes to subsidize domestic producers will also be considered.

¹³ While our formal analysis proceeds in the setting where there is only one firm and one industry, other interpretations are possible. The domestic economy might encompass a continuum of industries, each with a representative firm characterized by θ . The government’s task in this setting would be to determine which of the otherwise-identical industries should be targeted for government assistance, and how that assistance should be supplied.

own profit-maximizing production decisions. Subsection 3.2 examines the policy the domestic government would pursue if it shared the domestic firm's perfect knowledge of its learning parameter, θ .

3.1. The no-intervention benchmark

Absent government intervention, the domestic firm would simply choose how much output to produce in both periods, taking as given the fringe's unbounded supply of output at price c . Since domestic demand is inelastic for prices below c , the domestic firm with learning parameter θ would choose output levels to

$$\max_{Q_1, Q_2} \pi(Q_1, Q_2|\theta) \equiv cQ_1 - C^1(Q_1) + \beta\{cQ_2 - C^2(Q_2|Q_1, \theta)\}, \quad (3.1)$$

where Q_i is the domestic firm's output in period $i = 1, 2$, and β is the relevant discount factor for all parties.

The necessary conditions for a solution to (3.1) include

$$c - C^{1'}(Q_1^N) - \beta C_{Q_1}^2(Q_2^N|Q_1^N, \theta) \leq 0 \quad (3.2)$$

and

$$c - C_{Q_2}^2(Q_2^N|Q_1^N, \theta) \leq 0, \quad (3.3)$$

where the superscript 'N' denotes the solution in this 'no-intervention' setting. The third term in (3.2) reflects the reduction in the domestic firm's second-period production costs from increasing first-period output. These learning economies are assumed to be sufficiently pronounced for the larger realizations of θ (i.e. for those above a critical level, denoted θ_1^N) that the domestic firm, acting on its own in this setting where government intervention does not occur, would generate more than its opportunity profit level (which is normalized to zero) by producing strictly positive output levels in periods 1 and 2. (We assume the domestic firm is able to finance any loss it incurs in the first period.) With smaller learning economies ($\theta \leq \theta_1^N$), the domestic firm could not make positive profits by producing in this no-intervention setting. It is assumed that $\theta_1^N \in (\underline{\theta}, \bar{\theta})$.¹⁴

Two distinct second-period production patterns can arise in this no-intervention setting. The profit-maximizing domestic producer with learning parameter θ_1^N will supply the entire second-period market demand at price c [i.e. it will supply $Q(c)$] when the firm's second-period marginal cost curve

¹⁴ The superscript 'N' refers to the no-intervention setting. The subscript '1' denotes the first (smallest) realization of θ for which the domestic firm will supply a strictly positive level of output.

Fig. 1. Market dominance.

lies below that of the fringe for all output levels less than $Q(c)$. This situation is illustrated in Fig. 1, and will be referred to as the case of *market dominance* for the domestic firm.

In contrast, when the second-period marginal cost of the domestic firm with learning parameter θ_1^N rises above c for output levels below $Q(c)$, the profit-maximizing domestic producer will not supply the entire market demand at price c . It will supply the $\hat{Q}_2$ units illustrated in Fig. 2, leaving the fringe to supply $Q(c) - \hat{Q}_2$ units of output. This case will be called the case of *market sharing*.

The distinction between the cases of market dominance and market sharing is crucial. As will be shown in Section 4, a role for government intervention always emerges when demand and cost functions in the

Fig. 2. Market sharing.

domestic industry are such that the market-dominance case prevails. When industry conditions give rise to the market-sharing case, a corresponding role for the government may not emerge.

In both the market-dominance and the market-sharing settings, certain consequences of the domestic firm's profit-maximizing behavior are readily derived. These consequences are recorded in Lemma 1. The lemma refers to $Q_i^N(\theta)$, which is the profit-maximizing output level for the domestic firm in period i when its learning parameter is θ and it operates in the no-intervention setting. $\pi^N(\theta)$ denotes the corresponding present discounted value of profits for the domestic firm.

Lemma 1. At the solution to (3.1):

- (i) $Q_1^{N'}(\theta) > 0, \quad \forall \theta > \theta_1^N;$
- (ii) $Q_2^{N'}(\theta) \geq 0, \quad \forall \theta > \theta_1^N;$

and

$$(iii) \quad \pi^N(\theta) = \begin{cases} 0 & \text{for } \theta \leq \theta_1^N, \\ -\beta \int_{\theta_1^N}^{\theta} C_{\theta}^2(Q_2^N(\xi) | Q_1^N(\xi), \xi) d\xi & \text{for } \theta > \theta_1^N. \end{cases}$$

Property (i) of Lemma 1 states that the firm will produce more output in the first period the greater the degree of its learning economies. The higher is θ , the greater the reduction in second-period costs for any increment in first-period output. This expanded value of first-period output explains its increased magnitude. With lower second-period production costs, the domestic firm that is not already serving the entire second-period market (in the market-sharing case) will expand its output, as noted in property (ii) of Lemma 1. Property (iii) of the lemma describes the rate at which the domestic firm's profits increase with the degree of its learning economies in the no-intervention setting. Second-period profits increase with θ because of the lower production costs that accompany a higher learning parameter. [Recall $C_{\theta}^2(\cdot) < 0$.]

In summary, in this benchmark setting of no government intervention, the domestic firm will not produce if its learning parameter is below θ_1^N . For higher values of the learning parameter, the domestic firm will sell strictly positive amounts of output at price c in both periods, and earn profits that increase with θ . In the case of market dominance, if the domestic firm produces at all, it will supply the entire second-period market demand. Both the domestic firm and the fringe may serve the domestic market in the second period in the case of market sharing.

3.2. The full-information benchmark

Now consider the policy the domestic government would pursue if it could operate in the *full-information* setting, where the government shares the domestic firm's knowledge of its learning parameter, θ . The government would select non-negative output levels for both the domestic firm and the foreign fringe to maximize

$$W(Q_1, Q_2, Q_1^f, Q_2^f | \theta) \equiv U(Q_1 + Q_1^f) - C^1(Q_1) - cQ_1^f + \beta[U(Q_2 + Q_2^f) - C^2(Q_2 | Q_1, \theta) - cQ_2^f]. \quad (3.4)$$

The domestic welfare function in (3.4) reflects the fact that each unit of consumption of the output produced by the foreign fringe costs domestic consumers c . $W(\cdot)$ is assumed to be jointly concave in aggregate output in the first period and aggregate output in the second period.

Let $Q_i^*(\theta)$ denote the values of Q_i ($i = 1, 2$) that maximize (3.4). The important features of these optimal production levels by the domestic firm in the full-information setting are recorded in Lemmas 2 and 3. Lemma 2 refers to

$$\theta_2^N \equiv \sup\{\theta \in [\underline{\theta}, \bar{\theta}] | C_{Q_2}^2(Q_2^N(\theta) | Q_1^N(\theta), \theta) \geq c\}.$$

θ_2^N is the largest value of the learning parameter for which the foreign fringe will supply output to the domestic market in the second period in the no-intervention setting (see Fig. 3). For values of θ that exceed θ_2^N , the second-period marginal cost of the domestic producer in the no-intervention setting is less than c for all output levels below $Q(c)$. The lower marginal cost ensures the domestic producer will serve all second-period demand.

Fig. 3. Second-period production in a no-intervention setting.

Lemma 2. In the market-sharing case:

$$(i) \quad Q_i^*(\theta) = Q_i^N(\theta) \quad \forall \theta \in [\underline{\theta}, \theta_2^N] \quad \text{for } i = 1, 2;$$

and

$$(ii) \quad Q_i^*(\theta) > Q_i^N(\theta) \quad \forall \theta \in (\theta_2^N, \bar{\theta}] \quad \text{for } i = 1, 2.$$

In the market-sharing case there are two distinct regions where production levels in the no-intervention setting coincide with those in the full-information setting. For the smallest realizations of θ , the domestic firm will choose not to operate in the no-intervention setting, and this is precisely the production pattern that maximizes domestic welfare (i.e. $Q_i^*(\theta) = Q_i^N(\theta) = 0$, $\forall \theta \in (\underline{\theta}, \theta_1^N]$). Furthermore, there will be an additional range of θ 's where the domestic firm operating in the no-intervention setting will supply strictly positive output levels that are precisely the levels the government would dictate in the full-information setting (i.e. $Q_i^*(\theta) = Q_i^N(\theta) > 0$, $\forall \theta \in (\theta_1^N, \theta_2^N]$). The coincidence of interests arises here because foreign competition forces the profit-maximizing domestic firm to sell at a price equal to its marginal cost of production in the second period, which is the optimal production pattern from the social perspective. Notice that if $\theta_2^N = \bar{\theta}$, so that even for the highest degree of learning economies the domestic firm does not entirely displace the foreign fringe in the second period, the production patterns in the full-information setting will be precisely those that arise in the no-intervention setting. Hence, when $\theta_2^N = \bar{\theta}$ in the market-sharing case, the ideal outcome from the social perspective will arise when the government does not intervene in the domestic market.

If $\theta_2^N < \bar{\theta}$ in the market-sharing case, though, a role for government intervention may arise. Here, for the larger degrees of learning economies, $\theta \in (\theta_2^N, \bar{\theta}]$, the second-period price in the domestic market will exceed the domestic firm's marginal cost. Consequently, the profit-maximizing firm will produce less than the socially preferred output level.

The same is true whenever the domestic firm produces in the market-dominance case. Recall that in this case, whenever the domestic firm produces it serves the entire second-period domestic demand, because its marginal cost lies everywhere below c in the relevant range. With price in excess of marginal cost, less than the socially preferred output level is produced in the no-intervention setting. Because even the marginal domestic producer (i.e. the one with learning parameter θ_1^N) supplies less than the socially preferred output level, it follows that there is a range, $\theta \in (\theta_0^N, \theta_1^N)$, in which the domestic firm will not produce in the no-intervention setting, although the domestic government would dictate that the firm produce in the full-information setting (see Fig. 3). If $\theta_0^N > \underline{\theta}$, there will be a range of learning parameters where no output is both the profit-maximizing decision

of the domestic firm in the no-intervention setting and the welfare-maximizing decision by the domestic government in the full-information setting. These observations are summarized in Lemma 3.

Lemma 3. In the market-dominance case:

$$(i) \quad Q_i^*(\theta) = Q_i^N(\theta), \quad \forall \theta \in [\underline{\theta}, \theta_0^N] \quad \text{for } i = 1, 2,$$

and

$$(ii) \quad Q_i^*(\theta) > Q_i^N(\theta), \quad \forall \theta \in (\theta_0^N, \bar{\theta}] \quad \text{for } i = 1, 2.$$

Lemmas 2 and 3 explain how the domestic government would alter the market outcome if it knew the learning capabilities of the domestic producer. Intuitively, the domestic government would instruct the domestic firm to expand its output whenever it would otherwise produce an output level for which domestic marginal cost is below c . Otherwise no government intervention will arise.

4. Optimal government policy under asymmetric information

The domestic government's task can become more complicated when it does not know the realization of θ . In this setting the government will design a policy to maximize the expected discounted value of domestic welfare. A policy consists of a schedule of output levels by the domestic firm in periods 1 and 2, $\{Q_1(\cdot), Q_2(\cdot)\}$, corresponding production levels by the foreign fringe, $\{Q_1^f(\cdot), Q_2^f(\cdot)\}$, and an associated transfer payment from consumers to the domestic producer, $T(\cdot)$. The domestic firm can choose its most preferred $\{Q_1(\cdot), Q_2(\cdot), Q_1^f(\cdot), Q_2^f(\cdot), T(\cdot)\}$ option from the schedule offered by the government. In addition to $T(\cdot)$, the domestic firm receives the revenues from its sales.

The revelation principle (e.g. Myerson, 1979) ensures there is no loss of generality in indexing the options made available to the domestic firm on its report of θ , and examining government policies that induce truthful reporting of θ by the domestic firm. Formally, the domestic government's problem, [GP], is

$$\begin{aligned} \max_{Q_1(\cdot), Q_2(\cdot), Q_1^f(\cdot), Q_2^f(\cdot), T(\cdot)} \int_{\underline{\theta}}^{\bar{\theta}} \{ & U(Q_1(\theta) + Q_1^f(\theta)) - C^1(Q_1(\theta)) - cQ_1^f(\theta) \\ & + \beta[U(Q_2(\theta) + Q_2^f(\theta)) - C^2(Q_2(\theta) | Q_1(\theta), \theta) - cQ_2^f(\theta)] \\ & - \alpha T(\theta) \} dF(\theta) \end{aligned}$$

subject to, $\forall \theta, \theta' \in [\underline{\theta}, \bar{\theta}]$:

$$\pi(\theta) \equiv \pi(\theta|\theta) \geq 0 \quad (4.1)$$

and

$$\pi(\theta) \geq \pi(\theta'|\theta), \quad (4.2)$$

where

$$\begin{aligned} \pi(\theta'|\theta) = & P(Q_1(\theta') + Q_1^f(\theta'))Q_1(\theta') - C^1(Q_1(\theta')) + T(\theta') \\ & + \beta[P(Q_2(\theta') + Q_2^f(\theta'))Q_2(\theta') - C^2(Q_2(\theta')|Q_1(\theta'), \theta)], \end{aligned} \quad (4.3)$$

and

$$Q_i^f(\theta) = 0, \quad \text{if } Q(P(Q_i(\theta))) \leq Q_i(\theta),$$

while

$$Q_i^f(\theta) = Q_i(\theta) - Q(P(Q_i(\theta) + Q_i^f(\theta))), \quad \text{if } Q(P(Q_i(\theta))) > Q_i(\theta). \quad (4.4)$$

The individual rationality constraints (4.1) in [GP] ensure the domestic firm earns at least its opportunity profit. The incentive compatibility constraints (4.2) ensure the domestic firm will report its learning parameter truthfully. The objective function in [GP] reflects the government's concern with expected discounted welfare in the domestic market. It also allows for social costs associated with distortionary taxes that may have to be imposed to generate the revenues required to subsidize domestic production. Higher values of the parameter $\alpha \geq 0$ in [GP] reflect greater social losses from these distortionary taxes.¹⁵ The case of $\alpha = 0$ reflects the benchmark setting where taxes (e.g. lump-sum taxes) are not distortionary, so the government's objective is to maximize total expected surplus. The focus here will be on the case of $\alpha = 0$, but other cases will also be considered. The objective function in [GP] also incorporates the minimum possible payment of c per unit to the foreign fringe for any output it supplies. From (4.4), the fringe will only supply output to the domestic market if total market demand, $Q(\cdot)$, exceeds domestic supply, $Q_i(\cdot)$, at the associated market-clearing price.

Because potential second-period production costs are lower the higher is θ , the domestic firm's profits are nondecreasing in θ at the solution to [GP].

¹⁵ See Laffont and Tirole (1986). Alternatively, $\alpha > 0$ could reflect greater government concern with the welfare of consumers than with the welfare of the domestic producer, perhaps for political reasons. Under this interpretation, prices diverge from marginal costs to limit the rents of the domestic producer, but not to generate higher profit margins in order to limit the taxes that must be imposed to finance the firm's operations.

The rate at which the firm's profits increase with θ is recorded in Lemma 4. The lemma refers to θ_1^G , which is the smallest realization of $\theta \in [\underline{\theta}, \bar{\theta}]$ for which strictly positive output is induced from the domestic firm.¹⁶

Lemma 4. At the solution to [GP]:¹⁷

$$\pi(\theta) = \begin{cases} 0 & \forall \theta \in [\underline{\theta}, \theta_1^G], \text{ and} \\ -\beta \int_{\theta_1^G}^{\theta} C_{\theta}^2(Q_2(\theta) | Q_1(\theta), \theta) d\theta, & \forall \theta \in [\theta_1^G, \bar{\theta}]. \end{cases}$$

Following standard techniques, the expression for profit identified in Lemma 4 can be substituted into the objective function in [GP], using (4.3) to express $T(\theta)$ as a function of $\pi(\theta)$. Integration by parts and pointwise optimization then provides:¹⁸

Proposition 1. At the solution to [GP]:

$$\begin{aligned} \text{(i)} \quad & P(Q_1(\theta) + Q_1^f(\theta)) = C_1'(Q_1(\theta)) + \beta C_{Q_1}^2(Q_2(\theta) | Q_1(\theta), \theta) \\ & - \frac{\alpha}{1+\alpha} \left[Q_1(\theta) P'(Q_1(\theta) + Q_1^f(\theta)) + \beta C_{\theta Q_1}^2(\cdot) \frac{1-F(\theta)}{f(\theta)} \right], \\ & \forall \theta \in [\theta_1^G, \bar{\theta}]; \end{aligned} \quad (4.5)$$

$$\begin{aligned} \text{(ii)} \quad & P(Q_2(\theta) + Q_2^f(\theta)) = C_2^2(Q_2(\theta) | Q_1(\theta), \theta) \\ & - \frac{\alpha}{1+\alpha} \left[Q_2(\theta) P'(Q_2(\theta) + Q_2^f(\theta)) + C_{\theta Q_2}^2(\cdot) \frac{1-F(\theta)}{f(\theta)} \right], \\ & \forall \theta \in [\theta_1^G, \bar{\theta}]; \end{aligned} \quad (4.6)$$

and

$$\begin{aligned} \text{(iii)} \quad & P(Q_i(\theta) + Q_i^f(\theta)) - c + \alpha P'(Q_i(\theta) + Q_i^f(\theta)) \leq 0; \\ & Q_i^f(\theta) [P(Q_i(\theta) + Q_i^f(\theta)) - c + \alpha P'(Q_i(\theta) + Q_i^f(\theta))] = 0, \\ & \forall \theta \in [\underline{\theta}, \bar{\theta}] \text{ for } i = 1, 2. \end{aligned} \quad (4.7)$$

¹⁶ The superscript 'G' denotes the solution to [GP]. The subscript '1' denotes the first (smallest) realization of θ for which strictly positive output is induced from the domestic firm.

¹⁷ When $\alpha = 0$, taxes are not distortionary and so distributional concerns are effectively absent. Consequently, the profit schedule identified here is not the unique solution to [GP]. However, it is a solution to [GP], and it is the unique solution when $\alpha > 0$.

¹⁸ This approach (due to Baron and Myerson, 1982) imposes only the local incentive compatibility constraints in (4.2). Given the maintained assumptions, however, all of the incentive compatibility constraints will be satisfied at the identified solution to [GP]. (See the proof of Proposition 1.)

In the case of primary interest where taxes are not distortionary (i.e. where $\alpha = 0$), the government will induce the same output levels that it would dictate in the full-information setting. Notice from (4.6) and (4.7) that price and minimal marginal production cost will be equated in period 2. In period 1, output of the domestic firm is expanded to the point where consumer willingness to pay is equal to the sum of the firm's marginal cost of production and the marginal second-period cost reduction from additional output [see (4.5)]. In the case of market sharing, these output levels are precisely the levels the domestic firm would choose in the no-intervention setting for $\theta \in [\theta_1^N, \theta_2^N]$. [Compare (4.5) with (3.2), and compare (4.6) with (3.3).] Output will be smaller in the no-intervention setting for $\theta \in (\theta_2^N, \bar{\theta}]$ because the profit-maximizing domestic firm does not expand output sufficiently to cause the market price to fall below c . The expanded domestic output in the solution to [GP] for $\theta \in (\theta_2^N, \bar{\theta}]$ results in higher profits for the domestic firm. [Compare Lemma 4 with property (iii) in Lemma 1, and recall that $C_\theta^2 < 0$.] These conclusions are recorded formally as:

Corollary 1. Suppose $\alpha = 0$. Then in the case of market sharing, the solution to [GP] has:

- (i) $Q_i(\theta) = Q_i^*(\theta) = Q_i^N(\theta) = 0, \quad \forall \theta \in [\underline{\theta}, \theta_1^N];$
- (ii) $Q_i(\theta) = Q_i^*(\theta) = Q_i^N(\theta) > 0, \quad \forall \theta \in (\theta_1^N, \theta_2^N];$
- (iii) $Q_i(\theta) = Q_i^*(\theta) > Q_i^N(\theta) > 0, \quad \forall \theta \in (\theta_2^N, \bar{\theta}];$

and

- (iv) $\pi(\theta) = \pi^N(\theta), \quad \forall \theta \in [\underline{\theta}, \theta_2^N], \quad \text{while } \pi(\theta) > \pi^N(\theta)$
 $\forall \theta \in (\theta_2^N, \bar{\theta}].$ ¹⁹

Two central features of the optimal intervention policy in the case of market sharing are evident from Corollary 1. First, the market participation decision of the domestic firm is not altered. If a domestic firm would not produce on its own in the absence of government intervention, then it will also not produce under the optimal intervention policy. In essence, domestic firms that could not compete on their own are not subsidized or otherwise encouraged to compete by the domestic government. Second, output expansion is induced from and associated production subsidies are paid to the domestic firm only if it can successfully drive the foreign suppliers from the domestic market and, in fact, would do so operating on its own in the

¹⁹ The same conclusions reported here (and in Corollary 2) arise if the firm's opportunity profit level is taken to be $\pi^N(\theta)$ rather than 0, reflecting an ability of the domestic firm to 'insist' on no government intervention.

absence of government intervention. In this sense, optimal government intervention takes the form of subsidizing only the most capable and successful of domestic producers.

Transfer payments to the domestic producer are explicitly linked to its production level. Larger payments are made the further below c the domestic firm drives second-period price by expanding output.²⁰ The transfer payments are calculated so that the accompanying output expansion is profitable to the domestic firm only if its degree of learning economies is sufficiently large. In this manner, the government ensures output expansion is only induced when it is in the social interest.²¹

In the case where $\theta_2^N = \bar{\theta}$, so that the domestic firm shares the market with the foreign fringe even for the most pronounced degree of learning economies, the welfare-maximizing government policy involves no intervention. The presence of the competitive fringe causes the profit-maximizing domestic producer to undertake the welfare-maximizing production plan.

Additional government intervention will be optimal in the market-dominance case. Recall from Lemma 2 that in this case the domestic firm does not produce in the no-intervention setting for $\theta \in (\theta_0^N, \theta_1^N)$ even though strictly positive production by the domestic firm with a learning parameter in this range is called for in the full-information setting. Furthermore, the domestic firm that does produce in the no-intervention setting produces too little output for all $\theta \in [\theta_1^N, \bar{\theta}]$. Therefore, in the market-dominance case, welfare-maximizing government policy may subsidize production by a domestic producer that would not produce in the absence of government intervention. It also induces the domestic producer to produce enough output to drive the market price below c in the second period. The higher transfer payments promised for expanded output lead to higher profits for the domestic firm. These observations are summarized in Corollary 2.

²⁰ In essence, production subsidies are being recommended during the ‘mature’ phase of competition, as in Fudenberg and Tirole’s (1983) duopoly model with learning-by-doing. Dasgupta and Stiglitz (1988) make a related point in a setting where there is no asymmetric information about the domestic firm’s learning potential. The authors explain the value of enforceable contracts under which the firm promises to deliver second-period output to consumers at reduced prices in return for higher first-period payments.

²¹ It will be important for the domestic government to avoid the possibility that a domestic firm might initially promise to drive second-period price below c , collect the associated subsidy for doing so, and subsequently renege on its promise. The government can avoid this possibility by paying the subsidy, $T(\cdot)$, only after second-period output is observed. Alternatively, the portion of $T(\cdot)$ that provides exactly zero first-period profits to the firm can be paid at the end of the first period (to ease possible financing constraints) without creating incentives for the domestic firm to produce when it is socially inefficient for it to do so.

Corollary 2. Suppose $\alpha = 0$. Then in the case of market dominance, the solution to [GP] has:

$$(i) \quad Q_i(\theta) = Q_i^*(\theta) = Q_i^N(\theta) = 0, \quad \forall \theta \in [\underline{\theta}, \theta_0^N];$$

$$(ii) \quad Q_i(\theta) = Q_i^*(\theta) > Q_i^N(\theta) = 0, \quad \forall \theta \in (\theta_0^N, \theta_1^N];$$

$$(iii) \quad Q_i(\theta) = Q_i^*(\theta) > Q_i^N(\theta) > 0, \quad \forall \theta \in (\theta_1^N, \bar{\theta}];$$

and

$$(iv) \quad \pi(\theta) = \pi^N(\theta), \forall \theta \in [\underline{\theta}, \theta_0^N], \quad \text{while } \pi(\theta) > \pi^N(\theta), \quad \forall \theta \in (\theta_0^N, \bar{\theta}].$$

Notice that the government's unrestricted ability to link transfer payments to production levels is important here. This ability enables the government to fashion sharp differences in the profitability of output–subsidy patterns according to the domestic firm's private information. If the government were restricted to more blunt policy instruments such as linear subsidies (i.e. a fixed subsidy per unit of output), it could not implement these sharp differences so readily. Consequently, the welfare improvements available from government intervention in the domestic market would be more limited.

The focus to this point has been on the case where $\alpha = 0$. When α is strictly positive, the taxes imposed to raise the funds used to subsidize the domestic producer are distortionary, and so are costly to society. Two major changes arise when taxes are costly. These changes are evident from (4.5)–(4.7). The first change reflects a move away from marginal cost prices toward Ramsey prices. Prices are raised above marginal cost (via output reductions) to generate additional profit contributions for the domestic firm directly from its sales. Increased profit margins on sales reduce the need to employ distortionary taxes to raise the funds required to induce the domestic producer to operate. The second change also involves output reductions for the domestic firm in both periods. These output reductions serve to limit the rents of the domestic producer. Recall that the domestic firm's rents rise with θ because a higher degree of learning economies reduces second-period production costs, *ceteris paribus*. Furthermore, since $C_{Q, \theta}^2(\cdot) < 0$, the second-period cost advantage associated with a higher degree of learning economies is more pronounced the greater the first-period output. Consequently, by reducing first-period output, the cost

advantage and thus the rents of the domestic producer are reduced, thereby reducing requisite subsidies and associated costly taxes. A smaller first-period output, in turn, increases second-period costs, which leads to reduced second-period output.

5. Conclusions

This research has employed standard techniques from the literature on contracting under asymmetric information to examine the optimal design of industrial targeting policy when domestic firms have private knowledge of their learning economies. A simple market structure was examined in order to isolate the effects due to asymmetric information. We found that in the presence of a competitive foreign fringe, market intervention by the domestic government enhances welfare only when the learning economies of the domestic firm are particularly strong, and so the firm is particularly capable of competing on its own without government assistance. When government intervention is welfare-enhancing, it takes the form of a subsidy that is greater the lower is the second-period price set by the domestic producer.

Clearly, the optimal targeting policy derived here differs from targeting policy described in the popular press. This latter policy involves temporary import exclusions, whereby the domestic government forbids imports in the first period but opens the domestic market to unfettered foreign competition in the second period. There are two important drawbacks to this policy relative to the optimal policy derived above. First, the absence of foreign competition in the first period can encourage first-period production by the domestic firm even though its degree of learning economies is so slight that it will not be able to compete successfully against the foreign fringe in the second period. Total domestic welfare would be higher in this case if consumers were allowed to purchase the product at unit price c from the foreign fringe in both periods. Thus, closing the domestic market to foreign competition can encourage production by 'inefficient' domestic producers.

The second drawback to this policy of temporary import exclusion is that it encourages a higher first-period price for the product. Absent the discipline of the foreign fringe, the domestic producer will set prices to maximize its discounted profits. Even 'efficient' domestic producers with large learning economies may set first-period prices above c , resulting in inefficiently small output levels in both the first and the second period. Thus, temporarily shielding domestic producers from foreign competition can be an unwise policy in the presence of asymmetric information about

learning economies. No intervention can constitute a superior policy, and will do so under the conditions we have identified.^{22,23}

In closing, it is important to emphasize that the central conclusions derived here follow from the assumptions of the model. In particular, the elastic supply of the foreign producers plays a key role. The competitive foreign fringe can force the domestic producer to equate second-period price and marginal cost, thereby eliminating one potential reason for intervention by the domestic government. Furthermore, because the competitive fringe's supply decision does not vary with changes in the supply function of the domestic producer, some strategic reasons for intervention by the domestic government are ruled out. An alternative setting might have the domestic producer and foreign supplier competing as Cournot duopolists, for example. In such a setting, domestic welfare might increase if government assistance to the domestic producer served to reduce the output supplied by the foreign producer. (See Brander and Spencer, 1983.) Similar considerations might emerge if the model included a foreign government that could influence the supply decisions of foreign producers.

Acknowledgements

We are grateful to the National Science Foundation for financial support. We also wish to thank anonymous referees and seminar participants at the University of Osaka, the 1993 Southeastern International Economics Meetings, and the 1994 American Economic Association Meetings for very useful suggestions.

²² Dasgupta and Stiglitz (1988) present conditions under which the policy of temporary import exclusion can be socially preferred to the policy of no intervention by the domestic government. Their comparison of 'second-best' policies presumes the domestic government cannot contract with domestic producers for lower second-period prices in return for first-period subsidies, as it can in our model. In practice, policies akin to such contracts seem to have been implemented in Japan, for example. As Yamamura (1986) reports, the Japanese Ministry of International Trade and Industry initially helped finance investment and growth by a number of large producers of televisions and semiconductors, and later encouraged expanded output levels and competition among the producers. Although we do not explicitly allow for competition among domestic producers in our model, such managed competition, in practice, can be the vehicle by which low second-period prices and expanded output are secured by the domestic government, following first-period production subsidies.

²³ Hufbauer et al. (1986) report that the temporary protection afforded Harley-Davidson between 1983 and 1988 resulted in a 15 percent increase in the domestic price of heavyweight motorcycles, and a net decrease in sales to U.S. consumers of 25,000 units. While the protection may have saved as many as 700 jobs in the United States in 1984, the associated cost to U.S. consumers was approximately \$150,000 per job. These findings might lead one to question whether the adopted trade policy was advisable, and whether alternative policies (e.g. production subsidies) might have been preferable.

Appendix

Proof of Lemma 1. For $\theta > \theta_1^N$, (3.2) and (3.3) hold as equalities. Therefore,

$$Q_1^{N'}(\theta) = -\beta C_{Q_1\theta}^2(\cdot) / [C_1^{1''}(\cdot) + \beta C_{Q_1\theta_1}^2(\cdot)] > 0,$$

and

$$Q_2^{N'}(\theta) = -C_{Q_2\theta}^2(\cdot) / C_{Q_2\theta_2}^2(\cdot) > 0.$$

From (3.1),

$$\begin{aligned} \pi^{N'}(\theta) = & [c - C_1^{1'}(\theta_1^N) - \beta C_{Q_1}^2(Q_2^N | \theta)] Q_1^{N'}(\theta) \\ & + \beta [c - C_{Q_2}^2(Q_2^N | Q_1^N, \theta)] Q_2^{N'}(\theta) - \beta C_{\theta}^2(Q_2^N | Q_1^N, \theta). \end{aligned} \quad (A1)$$

From (3.2) and (3.3), each of the two terms in square brackets in (A1) is zero. Therefore, since $\pi^N(\theta_1^N) = 0$, property (iii) of the Lemma follows from integrating (A1). $\square$

Proof of Lemma 2. The conclusions of the lemma are a direct consequence of the concavity of $W(\cdot)$ and the fact that $C_{Q_2}^2(Q_2^N(\theta) | Q_1^N(\theta), \theta) \geq c$, $\forall \theta \in [\underline{\theta}, \bar{\theta}]$ and $C_{Q_2}^2(\cdot) < c$, $\forall \theta \in (\theta_2^N, \bar{\theta}]$. The excess of price over the second-period marginal cost of the domestic firm is the source of the divergence between welfare- and profit maximizing production levels. $\square$

Proof of Lemma 3. Since $C_{Q_2}^2(Q_2^N(\theta_1^N) | Q_1^N(\theta_1^N), \theta_1^N) < c$, continuity ensures there exists a nontrivial range of θ 's ($\theta \in (\theta_0^N, \theta_1^N)$) for which $Q_i^N(\theta) = 0$ and $Q_i^*(\theta) > 0$. The deviation between the market price and the marginal cost of the domestic firm ensures $Q_i^*(\theta) > Q_i^N(\theta)$, $\forall \theta \in [\theta_1^N, \bar{\theta}]$. $\square$

Proof of Lemma 4. From (4.3) and the revelation principle,

$$\pi'(\theta) = \frac{\partial \pi(\theta' | \theta)}{\partial \theta} \Big|_{\theta'=\theta} = -\beta C_{\theta}^2(Q_2(\theta) | Q_1(\theta), \theta) > 0, \quad \forall \theta \in [\theta_1^G, \bar{\theta}]. \quad (A2)$$

The inequality in (A2) holds because $C_{\theta}^2(\cdot) < 0$. The lemma then follows from integration of (A2). $\square$

Proof of Proposition 1. Using Lemma 1 and integration by parts,

$$\int_{\underline{\theta}}^{\bar{\theta}} \pi(\theta) dF(\theta) = -\beta \int_{\theta_1^G}^{\bar{\theta}} C_{\theta}^2(Q_2(\theta) | Q_1(\theta), \theta) \frac{1 - F(\theta)}{f(\theta)} dF(\theta). \quad (A3)$$

After substituting (A3) into the objective function in [GP], pointwise optimization with respect to $Q_1(\theta)$, $Q_2(\theta)$, and $Q_i^f(\theta)$ provide (4.5), (4.6), and (4.7), respectively.

Expressions (4.1) and (4.2) are satisfied at the identified solution if $\pi(\theta'|\theta)$ is a concave function of θ' for all θ . Using (A2) and (4.3), this concavity is ensured if at the solution identified by (4.5)–(4.7):

$$C_{\theta Q_1}^2(\cdot)Q_1'(\theta) + C_{\theta Q_2}^2(\cdot)Q_2'(\theta) \leq 0, \quad \forall \theta \in [\underline{\theta}, \bar{\theta}] \quad (\text{A4})$$

The inequality in (A4) will hold if $Q_1'(\theta) \geq 0$ and $Q_2'(\theta) \geq 0$ at the solution identified by (4.5)–(4.7). It is straightforward to verify that these inequalities hold under the maintained assumptions. $\square$

Corollaries 1 and 2 follow immediately from Proposition 1, so their proofs are omitted.

References

- Bagwell, K. and R. Staiger, 1989, The role of export subsidies when product quality is unknown, *Journal of International Economics* 27, 69–89.
- Baron, D. and R. Myerson, 1982, Regulating a monopolist with unknown costs, *Econometrica* 50, 911–930.
- Bhagwati, J., 1969, On the equivalence of tariffs and quotas, in: J. Bhagwati, ed., *Trade, tariffs, and growth* (MIT Press, Cambridge, MA) 248–265.
- Brander, J. and B. Spencer, 1983, International R&D rivalry and industrial strategy, *Review of Economic Studies* 50, 707–722.
- Brander, J. and B. Spencer, 1985, Export subsidies and international market share rivalry, *Journal of International Economics* 16, 83–100.
- Carliner, G., 1986, Industrial policies for emerging industries, in: P. Krugman, ed., *Strategic trade policy and the new international economics* (MIT Press, Cambridge, MA) 147–168.
- Cheng, L., 1988, Assisting domestic industries under international oligopoly: The relevance of the nature of competition to optimal policies, *American Economic Review* 78, 746–758.
- Congressional Budget Office, 1985, Federal financial support for high-technology industries, U.S. Congress.
- Dasgupta, P. and J. Stiglitz, 1988, Learning-by-doing, market structure, and industrial and trade policies, *Oxford Economic Papers* 40, 246–268.
- Dixit, A., 1987, Trade and insurance with moral hazard, *Journal of International Economics* 23, 201–220.
- Dixit, A., 1989, Trade and insurance with adverse selection, *Review of Economic Studies* 56, 235–248.
- Dixit, A. and A. Kyle, 1985, The use of protection and subsidies for entry promotion and deterrence, *American Economic Review* 75, 139–152.
- Dixit, A. and G. Grossman, 1986, Targeted export promotion with several oligopolistic industries, *Journal of International Economics* 21, 233–250.
- Feenstra, R., T. Lewis and J. McMillan, 1990, Designing policies to open trade, *Economics and Politics* 2, 223–240.

- Flam, H. and R. Staiger, 1991, Adverse selection in credit markets and infant industry protection, in: E. Helpman and A. Razin, eds., *International trade and trade policy* (MIT Press, Cambridge, MA) 96–117.
- Fudenberg, D. and J. Tirole, 1983, Learning by doing and market performance, *Bell Journal of Economics* 14, 522–530.
- Grossman, G. and H. Horn, 1988, Infant-industry protection reconsidered: The case of informational barriers to entry, *The Quarterly Journal of Economics* 103, 767–787.
- Helpman, E. and P. Krugman, 1989, *Trade policy and market structure* (MIT Press, Cambridge, MA).
- Hufbauer, G., D. Berliner and K. Elliott, 1986, *Trade protection in the United States: 31 case studies* (Institute for International Economics, Washington, DC).
- Krugman, P., 1984, Import protection as export promotion: International competition in the presence of oligopoly and economies of scale, in: H. Kierzkowski, ed., *Monopolistic competition and international trade* (Clarendon Press, Oxford) 180–193.
- Krugman, P., ed., 1986, *Strategic trade policy and the new international economics* (MIT Press, Cambridge, MA).
- Krugman, P. and M. Obstfeld, 1991, *International economics: Theory and policy* (Harper–Collins, New York).
- Laffont, J. and J. Tirole, 1986, Using cost observation to regulate firms, *Journal of Political Economy* 94, 614–641.
- Mayer, W., 1984, The infant-export industry argument, *Canadian Journal of Economics* 17, 249–269.
- Mezzetti, C. and E. Dinopoulos, 1991, Domestic unionization and import competition, *Journal of International Economics* 31, 79–100.
- Myerson, R., 1979, Incentive compatibility and the bargaining problem, *Econometrica* 47, 61–74.
- Pelcovits, M., 1976, Quotas versus tariffs, *Journal of International Economics* 4, 363–370.
- Sweeney, R., E. Tower and T. Willett, 1977, The ranking of alternative tariff and quota policies in the presence of domestic monopoly, *Journal of International Economics* 7, 349–362.
- Yamamura, K., 1986, Caveat emptor: The industrial policy of Japan, in: P. Krugman ed., *Strategic trade policy and the new international economics* (MIT Press, Cambridge, MA) 169–209.