Informationally Efficient Trade Barriers*

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Abstract

Why are trade barriers often used to protect home producers, even at the cost of introducing deadweight losses from higher commodity prices? We add an informational friction to the standard textbook argument in favor of free trade, and show that trade restrictions may be a more efficient policy than a lump sum transfer to the displaced producers. Trade barriers, while generating deadweight losses, have the benefit that they do not generate a need for compensation. When the policy maker does not know the amount that should be transferred, the risk of over-compensating may make trade barrier more efficient.

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Why are trade barriers often used to protect home producers, even at the cost of introducing deadweight losses from higher commodity prices? According to a standard textbook argument in favor of free trade, in order to maintain the welfare of the home producers at the pre-trade level, a combination free trade and a lump sum transfer to displaced home producers is a more efficient policy than trade barriers. The reason is that trade barriers imply higher commodity prices, which cause deadweight losses for the consumers. This paper shows that this argument hinges on the assumption that the policy maker has complete information about the losses suffered by the displaced home producers. We relax this assumption and show that trade barriers can be the informationally efficient policy instead.

We add the informational friction to focus on the informational problem associated with implementing the textbook "winners compensate losers" argument. Seemingly inefficient trade barriers arise only as the optimal response to the information constraints. The policy has an interesting form: the losers choose between a fixed transfer (which can be interpreted as a workers assistance program) and the trade barrier.

Our explanation relies on the intuition that trade barriers, while inefficient, have the benefit that they do not generate a need for compensation. When the policy maker does not know the amount that should be transferred, there is a risk of over-compensating. Compensating with a transfer is expensive because it induces losers to over-report their losses in order to receive a higher transfer.

There have been several attempts to explain the apparent contradiction between the textbook free trade argument and the empirical fact that trade is, for the large part, not free. We believe this paper provides a novel explanation to the puzzle (see Section 1).

We introduce in Section 2 a very stark model. Consumers in a small open economy benefit from trade through lower world prices. Home producers may lose from being displaced; this loss is simply a parameter, meant to embody the various ways in which displacement may be costly. We do not model explicitly the nature of competition, since we are interested only in constructing a particular set of outcomes and comparing them to the complete information optimal policy, which, by textbook logic, corresponds to free trade. In an attempt to make the results as strong as possible we assume that the foreign good is always cheaper than the domestic good, and that the difference is larger than the loss suffered by the displaced home producers. Therefore, under complete information, the consumer would always choose to consume the foreign good and compensate the home producer with a transfer. By doing so, we are intending to make it as difficult as possible to get trade barriers to arise. We do not model the aggregation of consumer's preferences and assume that a representative consumer dictates the trade policy. We also do not model the reasons why the consumers want to protect the domestic producers, because it is not the focus of this paper; instead, we assume that a policy must be chosen subject to keeping the home producers at least as well off as they are in autarchy.

In Section 3 we present first the problem under the assumption that the consumer can buy one indivisible unit of the good either from the home producer or from a foreign producer. The consumer solves a mechanism design problem, with the constraint that the home producer should be kept as well off as he would be when he produces the good. In this problem, the home producers report the displacement loss they would suffer under free trade, and the consumer pre-commits to a policy as a function of the report. The optimal policy has two regions, one where a trade barrier is enacted, and another where a constant transfer is made. The home producer chooses whichever region she prefers. One can think of this as a policy where the government offers either a trade barrier or a "trade assistance program" for displaced producers, and the producers chooses one or the other. The basic intuition for the result is that whenever the policy maker chooses a transfer to a producer reporting a given displacement loss, it must also transfer the same amount to all producers reporting a lower displacement loss, or these would have an incentive to misreport. This implies that the consumer sometimes pays in excess of the actual displacement losses. Whenever such overpayment is larger than the deadweight loss deriving from the trade barrier, a cash transfer is not the information-constrained optimal policy. Hence, there will be a threshold compensation level: if the protected producer requests a compensation at or below that level, it will receive a compensation equal to the threshold. Higher requests will be compensated by introducing trade barriers.

We generalize the result in two ways. First, in the mechanism design problem the consumer has the ability to commit to a policy as a function of the home producer's report of displacement loss. The problem is that once the loss is revealed, the consumer prefers to use this information to target the amount of the transfer and avoid the deadweight loss associated with using the trade barrier. In Section 4 we undertake an equilibrium approach and characterize the equilibrium outcomes in the asymmetric information case when there is no commitment. While the model displays a large number of equilibria, the characterization of the outcome is the same as in the commitment case. In these equilibria essentially two signals are used, "a high signal", sent from firms with a "high" displacement loss, and a "low signal", sent by firms with lower displacement loss. The policy maker chooses trade protection when the protected producer sends a high signal and gives transfers whenever the producer reports a low signal. Such transfer must be equal to the highest displacement loss of those reporting the low signal (otherwise if the transfer is lower those with higher loss send the high signals that guarantees the trade protection). From the policy maker's point of view it may be better use the trade barrier and pay the deadweight loss rather than choose to send a transfer to every producer sending a low signal.

Secondly, in Section 5 we extend the model to allow for partial protection by allowing the amount the consumer chooses to consume from home producers to vary continuously. We show that partial protection may be the optimal policy. The solution involves consuming more of the home good (i.e. more protection) than would be chosen under complete information. In order to decentralize such an outcome in the case of many identical consumers, this implies that it would be essential to impose a barrier to trade.

1 Alternative explanations and related literature

The literature offers various answers to the question "why is international trade not free". We cannot discuss here all contributions, most of which are surveyed by Rodrick (1995). Our paper is related to explanations relying on different forms of incomplete information. This section explains how we offer a novel approach relative to this subset of the literature.

Feenstra and Lewis (1991), for example, suggest that transfers may be costly because of difficulties involved in identifying the identity of the winners and losers from trade.[1] In their model, the biggest loser from free trade gets no rent at the optimal policy, while the biggest winner gets the highest rent. When funds are not available from other sources to implement the complete information optimum, the optimal policy moves away from that optimum, imposing distortions in order to generate revenue to finance the transfer. In effect, asymmetric information is crucial because it eliminates a source of lump-sum transfers.

We view our explanation as complementary to this. We assume that the winners from the trade policy can both be identified and their gains quantified, so that it is easy under complete information to generate the transfers implied by the textbook free trade argument. The difficulty in our story is that compensation through cash transfer generates an information rent, and that rent distorts the optimal policy away from such transfers. We think both stories contribute to our understanding of why seemingly inefficient trade barriers exits. Our notion that payment through transfers generates scope for rents for those that receive transfers seems in accord with intuition; however, we do not deny that there might also be distortions in raising the funds that we do not incorporate.

One advantage of our structure is that our results hold independently from the rest

[1] More precisely, this explanation requires uncertainty about the identity of who wins the most and who loses the least.

of the taxation structure. Because Feenstra and Lewis study a distortion in the source of funds, they rely on the fact that another source of less distortive revenue is not available, or is not available in sufficient quantity. If one thought of embedding their model into a world where other sources of funds were available, but at a cost, the marginal distortion from trade barriers can only be as large as that of the least distortive tax instrument available. In our framework instead, there is no restriction on how distortive trade barriers might be relative to other forms of taxation.

Fernandez and Rodrik (1991)'s explanation is also based on uncertainty about who wins and loses from an efficiency enhancing reform. Their insight is that when the population is divided between a subset of certain winners, and a subset of people who may win or lose, if the expected gain in the latter subset is negative, they all vote against the reform. With perfect information about who is going to win or lose instead, the winners would vote in favor, and their vote might be enough to tilt the outcome in favor of the reform. Our paper however applies also to cases where identity of the winners and losers is certain to all.

Coate and Morris (1995), while not concerned directly with trade policy, show that whenever the efficiency of a project (in our case, trade protection) is uncertain to the electorate, politicians concerned of maintaining a "good" reputation may shy away from direct cash transfers. "Bad" politicians, favoring policies that transfer resources to the special interest, may choose to implement the project even when the cash transfer would be more efficient in order not to reveal their type. Hence, uncertainty about both the efficiency of the policy (policy uncertainty) *and* about the objectives of the politician (politician uncertainty) are needed. In such equilibria bad politicians adopt the inefficient policy as a disguised transfer mechanism, in order to maintain their reputation and be re-elected. Citizens re-elect them because they don't know if the policy is inefficient or not. Rodrik (1995) argues that these models might be useful for explaining seemingly inefficient trade policies. However, he also points out that the sort of trade policies we consider in this paper are hardly justifiable on the same grounds as in Coate and Morris, because for their argument to hold, trade barriers need to be efficient in some states of the world that are not observed by citizens. In our paper instead, we consider an environment where, under complete information, a cash transfer is always the preferred policy (using Coate and Morris' language, we do not have neither policy nor politician's uncertainty).

Several authors[2] have studied trade barriers in a political-economy framework, showing that barriers can arise in some circumstances. Our results differ from these in that the use

[2]See for example Brainard and Verdier (1997), Davidson, et al. (2004), Grossman and Helpman (1994), Mayer (1984), Mayer and Riezman (1987), Magee (2003), and Mitra (2001)

of trade barriers is only the response to a constrained-Pareto problem. We do not rely on any special political environment or distribution across voters to get barriers to arise.

Our characterization of the result under the commitment case parallels the result in Townsend (1979), which considers optimal insurance in an exchange economy with costly state verification and random endowments. In the optimal contract, monitoring is used when there is a low realization of the random variable, while no verification is used when the realization is high. In our framework bad news correspond to displaced industries suffering a high loss, and if this is the case, monitoring takes the form of a trade barrier. The cost of monitoring is the deadweight loss induced by the policy.[3]

The spirit of our paper is similar to a long line of papers, including work such as Baron and Myerson (1982), showing that asymmetric information can lead to an important tension between efficiency and division of surplus. Here, inefficient policies are adopted to avoid over-transferring resources to the home producer. If the producer were simply transferred the highest possible displacement loss, an efficient allocation could always be attained, but at high cost to the consumers.

2 The Model and the Outcome under Complete Information

There is a representative consumer who has an inelastic demand for one unit of a product. There are two producers of the good, home and foreign. Buying from the foreign producer generates a loss to the home producers of l per unit bought from the foreign producers, but creates a benefit $b > l$ for the consumer per unit consumed. Later, we will assume that l is not known to the consumer. Note that we are intentionally vague about the source of benefits and losses b and l; we want to emphasize that our results are not crucially dependant on a particular source of the gains from trade, so long as some portion of the losses from trade are not known to the winners.

Consumers, the potential winners from trade, choose the trade policy and are concerned about the potential welfare losses incurred by home producers displaced by free trade. We do not model directly this concern, but instead assume that they choose a policy that makes them as well off as possible, subject to the restriction that they keep the home producers' welfare at the level enjoyed under autarchy.[4] This restriction parallels the implicit assump-

[3]This form of solution has been shown to be optimal in the context of monitoring criminal activities, for example see Mookherjee and Png (1989) and Reinganum and Wilde (1985).

[4]One interpretation is that the consumer is trying to find a way to move from a current policy of complete barriers (autarky) to one where some trade might be used, but must find a way that is Pareto improving. We do not focus on initial conditions as our goal is simply to show that barriers can arise as a Pareto optimum.

tions used in the argument that with free trade winners can compensate losers, and still have enough left over to be better off.

Assume, as a benchmark, the consumers know the displacement loss l. In this case the textbook justification of free trade applies: the consumer would transfer l dollars to the home producer and buy the product from the foreign producer. Crucial to our theory is therefore that l is not observed by the consumer. One can imagine many examples where l might not be known to the consumer. For instance, the home producer might be unable to productively provide any other service, and will therefore be unemployed if the consumer uses the foreign producer. In this case, the home producer loses income if the consumer chooses the foreign producer, but gains leisure. The lost income might be easy to measure, but the gained leisure is not, which motivates the incomplete information assumption that we analyze. On the other hand, the home producer may have to start producing something different when the consumer chooses the foreign producer. While the new income might be easy to measure, all of the costs including potentially important psychological costs, moving costs (monetary and otherwise), and retraining costs, as well as the cost of switching to a less preferred job, might be hard to ascertain.

We model the set of policies the consumer can choose from as follows. First, the consumer can choose a protection level $m \in [0, 1]$, which is the minimum fraction of the good that must be purchased from the home producer. There is no direct interpretation of m, except that it tells us which producer the consumer buys from. However, we think that $m = 1$ is naturally interpreted as a trade barrier. In a decentralized world with many identical consumers, without a trade barrier, a single consumer concerned for the welfare of the home producer cannot significantly affect the aggregate well being of the home producers. Hence, she would have no incentive to buy the home produced good if the foreign produced good was available; she could free-ride off of other people's actions to determine the well being of the home producers. To implement $m = 1$, there would have to be a coordination device that could take the form of a government-imposed barrier to trade. Since we focus on the case of inelastic demand for a single unit, the model also does not distinguish between a tariff that forces domestic production and a complete import restriction.

Secondly, the consumer can make a lump sum transfer t to the producer. This transfer can be interpreted as a governmental assistance program for the home producers, financed from lump-sum taxation; a natural interpretation of t might be worker retraining compensation, or a fixed level of compensation for industries hit by foreign competition. Again, with many consumers, no individual consumer would have a private incentive to make a payment to the home producers, hence a government would have to take action.

3 The Mechanism Design Problem

For the remainder of the paper, we drop the assumption that the consumer knows the displacement loss l; the consumer knows only that l is drawn from some cumulative distribution $F(l)$ with support $[\underline{l}, \bar{l}] \equiv L$. We assume also that $F(l)$ is differentiable and therefore has an associated density function $f(l)$. We consider the extreme case where $\bar{l} < b$, in other words, we assume no policy uncertainty: under complete information, the consumer would always choose free trade and a transfer $t = l$. The assumption is meant to make trade barriers as *hard* to achieve as possible at an optimum.[5]

We ask what policy should the consumer use to guarantee that the home producer is always at least as well of as he is when there is no competition from the foreign producer. We calculate optimal policies by formulating the problem as a mechanism design problem.

The home producer reports a displacement loss $\widehat{l}$ from which the consumer chooses a transfer $t(\widehat{l})$ and trade protection $m(\widehat{l}) \in \{0, 1\}$, where $m = 1$ corresponds to buying from the home producer and $m = 0$ corresponds to buying from the foreign producer. In this section we focus on the simple case where the consumer has linear utility. Because of this linearity, the restriction to buying from one producer or the other is without loss of generality. In Section 5 we add curvature to the problem and consider $m \in [0, 1]$.

We use the revelation principle to focus on truth telling mechanisms. In order for the consumer to guarantee that the home producer is no worse off than if he produces $(m(l) = 1)$, it must be the case that, for any l, $t(l) \geq (1 - m(l))l$, in other words either trade protection $(m(l) = 1)$, in which case the transfer can be set to zero $(t(l) = 0)$, or no protection and a transfer covering the loss: $(m(l) = 0$ and $t(l) \geq l)$. We consider the case where the consumer chooses transfer and protection without randomization.[6]

The indirect utility of the consumer as a function of the policy is therefore:

$$u(t, m) = (1 - m)b - t$$

For the $1 - m$ units imported, the consumer benefits by b. The consumer also must pay t as a transfer to the home producer.

For a given report of $\widehat{l}$, the home producer suffers the displacement loss $\left(1 - m(\widehat{l})\right) l$ but benefits from the transfer $t(\widehat{l})$, so that the net benefit is

$$R_l\left(t(\widehat{l}), m(\widehat{l})\right) = t(\widehat{l}) - \left(1 - m(\widehat{l})\right) l \tag{1}$$

[5] In Appendix B we consider the case $b < \bar{l}$.

[6] For the preferences we consider, there is no loss of generality in this restriction to pure choices.

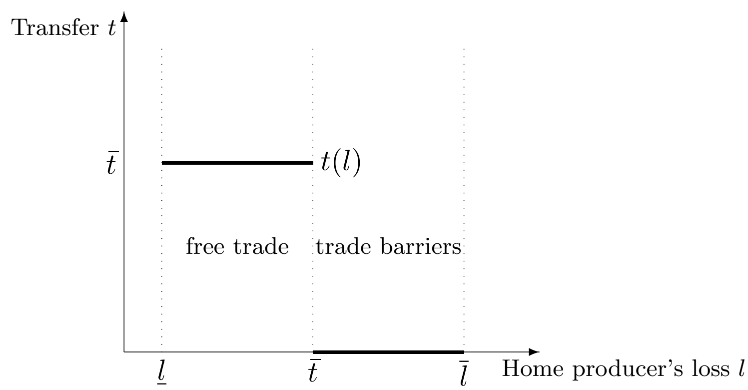

Figure 1: The optimal policy

The mechanism design problem is:

$$\max_{t(l),m(l)} \int u\left(t(l), m(l)\right) f(l) dl \tag{2}$$

$$\text{subject to: } l = \arg\max_{\widehat{l}} R_l(t(\widehat{l}), m(\widehat{l})) \tag{3}$$

$$t(l) \geq \left(1 - m(l)\right) l \text{ , for all } l \tag{4}$$

Constraint (3) is the truth-telling constraint. Constraint (4) guarantees that the home producers are always at least as well off as they would be in autarchy. The following proposition characterizes the optimal policy.

Proposition 1 *The optimal policy takes the form*

$$\begin{array}{ll} t(l) = \bar{t},\; m(l) = 0, & l \leq \bar{t} \\ t(l) = 0, m(l) = 1, & l > \bar{t} \end{array}, \quad \bar{t} \in L \tag{5}$$

The proof is in Appendix A. Figure 1 illustrates the optimal policy. Producers with losses less than $\bar{t}$ are compensated through a transfer of $\bar{t}$. Note that the transfer is constant in that range: if the consumer chooses to compensate any producer with a transfer, she must transfer the same amount to all producers being compensated with a transfer. If the transfer was not constant, the home producers receiving a lower transfer would misreport to get the largest possible transfer.[7] Hence, the amount to be transferred must be equal to the largest loss among the producers that are being compensated with a transfer.

[7] If the populace had a noisy signal of l, the rule could include a transfer increasing in l. This however would not affect our main conclusion that some producers may be compensated with trade restrictions.

Therefore, for high cost reports, it might be better to choose $m(l) = 1$, that is, to impose a trade barrier on foreign producers. Although this generates a deadweight loss, funding by transfer may be more costly because it implies larger overpayments to low cost producers.

Notice that, for producers with $l \in (\underline{l}, \bar{t})$, the compensation *more* than covers the loss, and they are strictly better off than under autarchy (no compensation and $m(l) = 1$). One can view this as an information rent.

To see the trade off more clearly, we use Proposition (1) and rewrite the problem as the choice of the threshold $\bar{t}$

$$\max_{\bar{t}} F(\bar{t})(b - \bar{t}) + (1 - F(\bar{t})) \cdot 0$$

When l is below $\bar{t}$ (which occurs with probability $F(\bar{t})$), consumers must pay $\bar{t}$ to compensate the home producers, but gain b. Above $\bar{t}$, consumers compensate the home producers with a trade barrier, gaining neither b nor paying t.

The first order condition for $\bar{t}$ is[8]

$$f(\bar{t})(b - \bar{t}) = F(\bar{t}) \tag{6}$$

The left hand side reflects the marginal benefit from increasing $\bar{t}$: the consumer obtains the benefit b from buying the foreign good, less the transfer. On the other hand, this increases the payment that must make to all producers reporting below $\bar{t}$; this payment is made with probability $F(\bar{t})$. The right hand side, then, is the marginal cost of increasing $\bar{t}$.

To see the way in which trade barriers are used, take F to be the uniform distribution on $[\underline{l}, \bar{l}]$. Then the solution is $\bar{t} = \max\{(b + \underline{l})/2, \bar{l}\}$. In other words, if the loss from consuming the home good is big enough ($b > 2\bar{l} - \underline{l}$), home producers are always compensated with a transfer of $\bar{l}$. When $b \in (\bar{l}, 2\bar{l} - \underline{l})$ using the home producer is always inefficient, in the sense that the loss of b from consuming the home good is always greater than the producer's loss from not producing, but the optimal mechanism prescribes that the consumer should purchase the home good for high enough reports of l. Hence, trade barriers can be an optimal policy under incomplete information about the costs to the losers from trade. As we noted earlier, under complete information, $m = 0$ and $t = l$; incomplete information is the only factor driving the result that trade barriers might be used.

Since the mechanism is incentive compatible, it is as if the consumer gave the home producers the choice of whether they would like transfer $\bar{t}$ or a trade barrier. Despite the extremely stark nature of the model, the outcome, then, generates simple policies that roughly mirror what is observed.

[8] We are for this calculation assuming that $f'(\bar{t})(l - \bar{t}) - 2f(\bar{t}) < 0$, so that the problem is concave.

4 Equilibrium Trade Barriers Without Commitment

The optimum studied in the previous section has the feature (shared with any typical mechanism design problem) that the consumer can commit to actions as a function of the report $\widehat{l}$. Conditional on receiving a truthful report, the consumer would always, *ex post*, prefer to use the transfer of $t(\widehat{l}) = \widehat{l}$, set $m(\widehat{l}) = 0$, and transfer exactly the amount that makes the home producer as well off as if he were producing. In this section we consider the case where the consumer cannot commit to the announced policies. We show that trade barriers ($m = 1$) may be used even in a pure "signalling" environment where there can be communication between the consumer and the home producer, but the consumer cannot commit to any specified policy.

In the environment we have in mind, after nature's choice of $l \in L$ the home producer can make an announcement $\sigma \in S$, where S has the same dimensionality as L. The strategy of the home producer specifies an announcement as a function of its type $\sigma(l)$. The consumer's strategy is specified by functions $m(\sigma)$, $t(\sigma)$ indicating respectively whether or not the trade restrictions are imposed and the amount of the cash transfers to be made after each announcement. We focus on Bayesian Nash Equilibria in pure strategies as a solution concept, but it is straightforward to extend our analysis to mixed strategies.

Naturally, the signaling game may display many equilibria. The following proposition establishes a property of the policy implied by all equilibrium outcomes: the policy takes a form similar to the one in the mechanism design problem, that is, transfers to low cost types and trade barrier to high cost types.

Proposition 2 *All pure strategy equilibria of the signalling game imply the following policy:*

$$\begin{array}{ll} (t\circ\sigma)(l) = \bar{t},\ (m\circ\sigma)(l) = 0 & \textit{if } l \le \bar{t} \\ (t\circ\sigma)(l) = 0,\ (m\circ\sigma)(l) = 1 & \textit{if } l > \bar{t} \end{array}, \qquad \bar{t} \in L$$

Each equilibrium has one of two forms. First, it may be a separating equilibrium where signals are used in equilibrium by different sets of types and trade barriers are used in correspondence to the signal sent by the higher cost types. On the other hand, if $\bar{t} = \bar{l}$, it may be a trivial pooling equilibria where the home producer is transferred $\bar{l}$ regardless of the signal.

A natural question is how the optimal policy differs when commitment power is removed. The following proposition states that if it is not optimal to "separate" in the mechanism design problem, then there cannot be a separating equilibrium in the signalling game, since the equilibrium of the signalling game is always incentive compatible, and therefore could be implemented by the consumer in the mechanism design problem.

Proposition 3 *Suppose the unique solution to the mechanism design problem is a constant transfer to all types. Then any equilibrium of the signalling game has a constant transfer to all types.*

This fact implies that the set of models where trade barriers may arise under the signaling game is (weakly) a subset of the set of models where trade barriers can arise as an optimal mechanism. However, for a given model where a separating equilibrium exists, trade barriers may be used for a larger set of costs than in the commitment case. That is, it may be the case that the mechanism assigns a transfer to some low cost types and a trade barriers to others, but for the same underlying parameters the equilibrium of the signaling game either does not separate at all, or uses trade barriers more or less frequently (that is, for a larger or smaller subset of l), as compared to the mechanism.

5 Degrees of Protection

Our simple model did not embody the notion that consumers could choose fractional shares from each of the two producers. The linear utility considered in Section 3 implies that there the solution to $m(l)$ is always at a corner. In this section, we extend the model to allow for the possibility that the citizen might prefer only partial protection of the domestic producer.

To allow for curvature in the problem, we let the benefit to the domestic producer to be

$$R_l\left(t(\widehat{l}), m(\widehat{l})\right) = t(\widehat{l}) - g\left(m(\widehat{l})\right) l$$

where g is a positive, twice continuously differentiable, decreasing, convex function with $g(0) = 1$ and $g(1) = 0$. Convexity implies that, as the market share of the home producer is reduced, the burden on the home producer becomes greater and greater. This embodies the idea that it may be low cost to reduce output of home producers by a little (because of factors that can easily flow to new uses), but that some factors may be very costly to switch to other uses. The previous sections consider the special case where $g(m) = 1 - m$.

Complete information. As in the last section, we study first the complete information case as the benchmark of what would occur under textbook assumptions. In this case, it may be optimal for the consumer to purchase a fraction of the product at home simply because of the convexity of the producers' loss, even under complete information. The consumer chooses policies $m^c(l)$ and $t^c(l)$ that solve, for each l,

$$\max_{m^c(l),t^c(l)} \quad b(1-m^c(l)) - t^c(l)$$
$$\text{subject to } t^c(l) = lg\left(m^c(l)\right)$$

Whenever interior, the first order conditions with respect to $m^c(l)$ are:

$$-b - lg'(m^c) = 0,\ m \in (0,1) \tag{7}$$
$$-b - lg'(m^c) \geq 0,\ m = 1 \tag{8}$$
$$-b - lg'(m^c) \leq 0,\ m = 0 \tag{9}$$

and it can be verified that m^c is increasing in l. As in the previous section, we interpret m^c as the amount of free trade, since producers would be willing to pay (through, for instance, lower prices) to get at least this much market share.

Incomplete information. Consider now the incomplete information case. The mechanism design problem for the consumer is notationally unchanged compared to problem (2), save the allowance that m can now vary on the interval $[0,1]$. To construct the optimal policy we note that the producer with the lowest rent will be the one with loss $\bar{l}$ since any other producer can report $\bar{l}$ and get at least as much utility, therefore $R_l\left(t(\bar{l}), m(\bar{l})\right) \geq R_{\bar{l}}\left(t(\bar{l}), m(\bar{l})\right)$. As a result, $R_{\bar{l}}\left(t(\bar{l}), m(\bar{l})\right) = 0$ and incentive compatibility guarantees that all types l get at least zero utility (the amount they get with $m(l) = 1$ and $t(l) = 0$, i.e. complete trade protection and no transfer).

Next we characterize m and t. First we derive the following intermediate result: since producers with higher l value m more highly, any incentive compatible mechanism must have m increasing in l

Lemma 1 *Any m satisfying $l = \arg\max_{\widehat{l}} R_l(t(\widehat{l}), m(\widehat{l}))$ has $m(\widehat{l})$ is increasing in l*

The proof is in the appendix. For any $m(l)$ that is increasing, define

$$t(l) = lg(m(l)) + \int_l^{\bar{l}} g(m(i))di \tag{10}$$

This transfer amount makes $m(l)$ incentive compatible, since $t'(l) - lg'(m(l))m'(l) = 0$. Note that

$$R_l(t(l), m(l)) = \int_l^{\bar{l}} g(m(i))di$$

therefore

$$\frac{dR}{dl} = -g(m(l)) \tag{11}$$

As l falls, $R_l(t(l), m(l))$ rises at rate $g(m(l))$ due to the typical sort of information rent. Note that the information rent is decreasing in $m(l)$. This is the benefit to m that can make it optimal to have $m(l) > 0$, unlike the complete information case.

We can concisely write the consumer's problem as

$$\max_{m(l)} \int \left((1 - m(l))b - \left(lg(m(l)) + \int_l^{\bar{l}} g(m(i))di \right) \right) f(l)dl$$
$$\text{subject to } m(l) \text{ increasing}$$

For any increasing function $m(l)$, we choose $t(l)$ as in (10) so that incentive compatibility is satisfied and $R_{\bar{l}}(t(\bar{l}), m(\bar{l})) = 0$.

Disregarding the constraint that m be increasing for a moment, the solution to the maximization $m(l)$ solves

$$\begin{aligned} -b - lg'(m) - F(l)g'(m) &= 0,\, m \in (0,1) && (12) \\ -b - lg'(m) - F(l)g'(m) &\geq 0,\; m = 1 && (13) \\ -b - lg'(m) - F(l)g'(m) &\leq 0,\; m = 0 && (14) \end{aligned}$$

Note that (12) implies, using the implicit function theorem, that

$$\frac{dm}{dl} = \frac{-(1 + f(l))g'(m)}{(l + F(l))g''(m)} > 0,\; \forall l : m(l) \in (0,1)$$

so in fact the constraint that $m(l)$ be increasing is satisfied everywhere.

One way to interpret the transfer is that it is paid to any factors of production who would have produced the units $m^c - m$ that are lost under trade. The marginal producer is indifferent between taking its share of transfer and not, whereas all others that receive the transfer are better off, the policy is a Pareto improvement.

The proposition that follows present the main result of this section: incomplete information always leads to a weakly higher use of home production compared to the complete information case. In other words, there is some positive amount of trade protection embodied in the optimum prescribed by the mechanism.

Proposition 4 *The optimal mechanism implies:*

> *(a)* $m(\underline{l}) = m^c(\underline{l})$
>
> *(b) For all* $l \in L,\ m^c(l) \leq m(l)$
>
> *(c) For any* $l \neq \underline{l}$ *with* $m^c(l) \in (0,1),\ m^c(l) < m(l)$

Under incomplete information, there is an extra benefit of increasing m: the rate of change in the information rent in (11) decreases. This extra benefit leads the consumer to make $m(l)$ bigger than $m^c(l)$. The intuition for part (c) rests on the fact that, under complete information, when $m^c(l)$ is interior, there is no marginal effect of changing $m^c(l)$. That means that, under incomplete information, at $m^c(l)$, the marginal effect of increasing m is only the decrease the information rent, with is a strictly positive benefit.

A simple example embodies these results. Let $\underline{l} = 0$, $\bar{l} = 1$, $b = 1$, $g(m) = 1 - \sqrt{m}$ and $F(l) = l$, the uniform distribution. One can compute from (12) that $m(l) = l^2$, and from (7) that $m^c(l) = \frac{1}{4}l^2$. In other words, for any l, there are four times as much of the good produced at home under the mechanism relative to the complete information solution. With probability one, $l \neq \underline{l}$ and there is trade protection, $m(l) > m^c(l)$.

6 Conclusion

This paper provides a novel explanation to the puzzle of why we observe seemingly inefficient trade barriers. Our explanation complements other existing explanations that rely on incomplete information or various form of "political failure".

When losses are unobserved, cash transfers may generate more information rents than in kind transfers. As a result, trade barriers may be part of an optimal solution. In fact, it may be the case that some degree of trade barriers are used for a wide variety of cases.

Because we study Pareto improvements, our results are not particular to a specific political arrangement for policy-making. Of course, as various authors have shown (see references in Footnote 2), political environments may influence trade outcomes. Our purpose here is simply to show that barriers can arise from a Pareto problem, and hence may not be as puzzling as they first appear, nor may they require sophisticated political models to explain them. Incorporating incomplete information aspects of compensation into political models of policy making is an interesting avenue for future research.

A Appendix: Proofs

A.1 Proof of Proposition 1

Let $L_0 = \{l : m(l) = 0\}$ and $L_1 = \{l : m(l) = 1\}$

Claim 1 *The transfer is constant whenever the trade barrier policy is constant, that is $t(l) = t_0$ for all $l \in L_0$ and $t(l) = t_1$ for all $l \in L$.*

If not, then there are $l, l' \in L_i$ such that $t(l) < t(l')$. But then the home producer with cost l has incentive to report cost l' to get a greater transfer and the same m

Claim 2 *$m(l)$ is increasing in l.*

If either L_0 or L_1 is empty, the result is trivially true. If both are non-empty, then, suppose that the claim is false. Then there exists l_1 and l_0 with $l_0 > l_1$ and $m(l_0) = 0$, $m(l_1) = 1$. Incentive compatibility requires $t_0 \geq l_0$, otherwise type l_0 prefers the trade barrier and therefore reports $\widehat{l} = l_1$. Incentive compatibility also requires

$$\begin{aligned} R_{l_0}(t_0, 0) &\geq R_{l_0}(t_1, 1) \\ R_{l_1}(t_1, 1) &\geq R_{l_1}(t_0, 0) \end{aligned}$$

Rewriting the first term in each inequality using (1):

$$\begin{aligned} R_{l_0}(t_0 - l_0, 1) &\geq R_{l_0}(t_1, 1) \\ R_{l_1}(t_1 + l_1, 0) &\geq R_{l_1}(t_0, 0) \end{aligned}$$

But that implies $t_0 - l_0 \geq t_1$ and $t_1 + l_1 \geq t_0$, which cannot hold for $l_0 > l_1$, a contradiction.

Claim 3 *$t_0 = \bar{t} = \max_{l \in l_0} l$ and $t_1 = 0$*

Constraint (4) implies $t_0 \geq l$ for all $l \in l_0$ and $t_1 \geq 0$. If $t_0 > \bar{t}$ and $t_1 > 0$, the consumer can lower both t_0 and t_1 by the same amount, raise her payoff, and maintain incentive compatibility. If $t_0 = \bar{t}$ and $t_1 > 0$, then, for any $l_1 \in l_1$, $R_{l_1}(t_1, 1) > R_{l_1}(0, 1) > R_{l_1}(t_0, 0)$, since $t_0 < l_1$. As a result, the consumer can lower t_1 and maintain incentive compatibility. If $t_0 > \bar{t}$ and $t_1 = 0$, then, for any $l_0 \in l_0$, $R_{l_0}(t_0, 0) > R_{l_1}(0, 1)$, and, again, the consumer can lower the transfer t_0 and maintain incentive compatibility. Therefore it must be the case that $t_0 = \bar{t}$ and $t_1 = 0$

This completely characterizes mechanism (5) in the statement of the proposition. ■

A.2 Proof of Proposition 2

For a signal to be a best response for the home producer of type l it must be the case that

$$l = \arg\max_{\widehat{l}} R_l((t \circ \sigma)(\widehat{l}), (m \circ \sigma)(\widehat{l})) \tag{A1}$$

As a result, any equilibrium must be one that is of the form that is incentive compatible in the mechanism design problem and Claims 1-3 in the proof of proposition 1 follow immediately. Since it is never optimal for the citizen to respond to a signal with both a trade barrier and a transfer, it is also true that whenever there is a trade barrier the cash transfer is zero (as in Claim 3 in the proof of proposition 1) ■

A.3 Proof of Proposition 3

Assume by contradiction that the solution to the mechanism design problem is a transfer t_0 to all types and that there exists an equilibrium of the signalling game $[\widetilde{t}(\cdot), \widetilde{m}(\cdot), \widetilde{\sigma}(\cdot)]$ where the consumer uses trade barriers after observing some signals, that is $\widetilde{m}(\sigma) = 1$ for some σ in the range of $\widetilde{\sigma}(\cdot)$. Now consider the policy $[t(\cdot), m(\cdot)]$ in the mechanism design problem with :

$$\begin{aligned} t(l) &= \widetilde{t} \circ \widetilde{\sigma}(l) \\ m(l) &= \ \widetilde{m} \circ \widetilde{\sigma}(l) \end{aligned} \qquad \forall l$$

and consider a strategy for the consumer in the signaling game $[t'(\cdot), m'(\cdot)]$ that mimics the solution to the mechanism design problem, i.e.

$$\begin{aligned} t'(\sigma) &= t_0 \\ m'(\sigma) &= 0 \end{aligned} \qquad \forall \sigma$$

Since in the signaling model the consumer is choosing a best reply, $[\widetilde{t}(\sigma), \widetilde{m}(\sigma)]$ must be weakly preferred to strategy $[t'(\sigma), m'(\sigma)]$ for all σ. This means that $[t(\cdot), m(\cdot)]$ must do at least as well as a constant transfer of t_0 from the consumer's point of view. Moreover, home producer equilibrium behavior (A1) implies that $[t(\cdot), m(\cdot)]$ is incentive compatible. This implies that the constant transfer cannot be the unique solution to the mechanism design problem, a contradiction ■

A.4 Proof of Lemma 1

Take $l' > l$. Incentive compatibility for l implies $(t(l) - g(m(l))l) \geq (t(l') - g(m(l'))l)$. Likewise, incentive compatibility for l' implies $(t(l') - g(m(l'))l') \geq (t(l) - g(m(l))l')$. Summing, we get

$$
\begin{aligned}
(t(l) - g(m(l))l) + \big(t(l') - g(m(l'))l'\big) &\geq \big(t(l') - g(m(l'))l\big) + \big(t(l) - g(m(l))l'\big) \\
-g(m(l))l - g(m(l'))l' &\geq -g(m(l'))l - g(m(l))l' \\
g(m(l))l' - g(m(l))l &\geq g(m(l'))l' - g(m(l'))l \\
g(m(l)) &\geq g(m(l'))
\end{aligned}
$$

Since g is decreasing, m must be increasing for this to hold ■

A.5 Proof of Proposition 4

(a) Since $F(\underline{l}) = 0$, the optimality equations are identical for the two problems..

(b) If $l = \underline{l}$ or $m(l) = 1$ or $m^c(l) = 0$, there is nothing to prove. So suppose $m(l) < 1$ and $m^c(l) > 0$ for $l > \underline{l}$. Then, from (12) and (14):

$$-b - lg'(m(l)) - F(l)g'(m(l)) \leq 0$$

and, from (7) and (8),

$$-b - lg'(m^c(l)) \geq 0$$

But $F(l) > 0$ and $g' < 0$, so

$$-b - lg'(m(l)) \leq 0 \leq -b - lg'(m^c(l))$$

and so $g'(m(l)) \geq g'(m^c(l))$, which implies that $m(l) \geq m^c(l)$.

(c) From (b), we know $m^c(l) \leq m(l)$. Suppose equality holds for $l \in (0, 1)$, they from (7) and (12) we derive $-b - lg'(m^c(l)) = 0 = -b - lg'(m(l)) - F(l)g'(m(l))$. But since $g' < 0$, this cannot hold for $l \neq \underline{l}$, since $F(l) > 0$ ■

B Appendix: the case where $b < \bar{l}$

When $b < \bar{l}$, there are two regions. For $l \in [\underline{l}, b]$, the optimal policy for the consumer under complete information would be to use consumer the foreign good and transfer l to the home producer. For $l \in [b, \bar{l}]$, the consumer would rather consume the home good than consume the foreign good and make the transfer (at l, consumer is indifferent between the two policies). This corresponds, for the home producers, to a range of absolute and comparative disadvantage ($[\underline{l}, b]$) and a range or absolute disadvantage but comparative advantage ($[b, \bar{l}]$).

A simple implication of (6) is the following.

Proposition 5 *If $\bar{t} > 0$, then $\bar{t} < b$*

One incentive compatible policy, that also makes the home producer at least as well off as when he produces, is to set $\bar{t} = b$. Note that, under this policy, the consumer gains exactly nothing relative to the case where he always consumes the home good, since he gives away the entire gain b whenever he chooses free trade. The proposition, however, shows us that the consumer can do something even better: the optimal policy has $\bar{t} < b$, so that some cases in the range $(\bar{t}, b)$, incomplete information makes the consumer move from consuming the foreign good to consuming the home good. In other words, we observe trade barrier for these values of l.

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