Implementation of Trade Agreements Under Asymmetric Information and Welfare Gains from a Multilateral Regime

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Abstract

This paper aims to identify efficiency gains that can be provided by multilateral dispute resolution processes even though they might not have any enforcement power. Under certain conditions, a dispute resolution system can diffuse information about a bilateral relationship quite efficiently to the rest of the world even if it cannot alter behavior ex post. The new information can be valuable by identifying the private information of players more efficiently and afecting the behavior of the players in later periods. This will impose discipline on bad types, reward good behavior in the initial stages and provide welfare gains. However, when informational asymmetry is one sided, we show that a multilateral information dissemination mechanism cannot provide further information and, therefore, benefts, compared to a simple reputational equilibrium. On the other hand, it can be quite valuable when asymmetry is two-sided by providing narrower information sets about types. This is where the main benefts of the GATT system are likely to be found.

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1 Introduction

International treaties, especially trade agreements, are plagued by many problems from a contract theory point of view. First there are no international courts or police to enforce them which means they have to be self-enforcing. Second, they are incomplete in the sense there are many issues that are not verifiable and/or too costly to be included in the contract. Third, there are many informational asymmetries which cause moral hazard and adverse selection problems that result in welfare losses. In light of these problems, any mechanism that can improve the outcomes and provide Pareto gains becomes extremely valuable.

Our aim in this paper is to identify efficiency gains that might be provided by dispute resolution processes of multilateral institutions such as the World Trade Organization (WTO/GATT). These gains will be realized through solving some of the problems listed above. Even though WTO/GATT does not have any formal enforcement power, its involvement in many stages of a trade relationship (especially during the resolution of disputes) is an evidence of the high demand for its services (Jackson [1997]).

The gains from multilateralism is not a new idea in the literature. Maggi [1999], for example, argues that multilateral punishment can increase the efficiency levels of trade agreements through higher levels of punishment (as opposed to unilateral punishment) when cheating occurs. In Ozden [1999], we argued that multilateral negotiations can improve the Pareto efficient frontier through exchange of policies. In this paper, we will be addressing another potential benefit from multilateralism. We will argue that, under certain conditions, a dispute resolution system can disseminate information about a bilateral relationship quite efficiently to the rest of the world. This information can be valuable by identifying the private information of players more efficiently and affecting the behavior of the players in later periods. This ex post dispute resolution mechanism will impose discipline in the initial stages against cheating and will be main avenue for welfare gains.

To explore these idea we will construct a series of models. In the first model, there are two countries and one of them has private information about her type. After the initial trade liberalization agreement is signed, both countries need to undertake certain investment/actions for liberalization to bear fruits. These can be costly political and economic policies such as worker relocation programs or elimination of trade-prohibitive domestic policies. The important point is
that these are too numerous and costly to be included in the initial trade agreement. This situation is the standard hold-up problem that is closely identified with Klein, Crawford and Alchian [1978] and that arises from incomplete contracts. If the first country is a "bad" type, then she will behave opportunistically and renege on her promises. The second country, without perfect information about the type of the trading partner, will undertake the socially efficient investment only if the probability of a bad type is low enough.

A multilateral environment can impose discipline on the opportunistic behavior of "bad" types if its actions became public information and other countries would refuse to even sign the initial agreement. Fearing such retaliation, a bad type will be more reluctant to renege on a promise and have the incentive to establish a good reputation. However, we will assume that the rest of the world can only observe if the agreement failed (via lower trade volume) or not, but not specific actions. In short, the threat of non-cooperation in the future provides Pareto gains. In this framework, we can introduce a voluntary dispute resolution process to which the two countries agree beforehand. This resolution process simply identifies initial actions, determines the guilty party and requests compensation, but can not enforce the judgement. The surprising result is that this does not improve welfare since, in the world of one-sided informational asymmetry, all actions can be perfectly inferred from the outcomes. An extra mechanism does not reveal any extra information and cannot improve upon the initial equilibrium.

Fortunately, conclusions are not as pessimistic when there is two-sided asymmetric information. This can be due to the possibility of both countries having two types or due to the presence of an external shock that can lead to a lower trade volume. In this case, the rest of the world can not perfectly identify the countries' types from the outcomes since the type space is multidimensional and there is no one-to-one correspondence between types and actions. The dispute resolution process will reveal new information that will enable the rest of the world to update their beliefs about the types of these two countries more efficiently. This causes the reputation mechanism to work better by rewarding good types and punishing bad types more effectively. The result is further Pareto gains.

What do these results imply for the WTO/GATT system? At a theoretical level, it enables us to see the limitations of the dispute resolution process. The information diffusion can not provide further Pareto gains under every circumstance. For there to exist Pareto gains, there needs
to be multidimensional uncertainty. Furthermore, there needs to be mechanisms that create the incentives to establish and maintain reputation. This motivation can be one of the reasons of the slow nature of the liberalization process since it takes time to disseminate information and establish reputations. Therefore, it becomes crucial for WTO/GATT to have an open environment where information is transmitted immediately and clearly. Finally, the fact that GATT can not enforce its decisions does not mean it does not preform a useful service. By providing better information about players' true types, GATT can enable the rest of the world to provide the necessary discipline and punishment.

The next section will provide the motivation for the paper and Section 3 introduces the initial model. Section 4 establishes the Pareto superior reputational equilibrium. Section 5 introduces a multilateral dispute resolution process that can disseminate information and shows the absence of Pareto gains. Section 6 modifies model by introducing two-sided informational problems. Section 7 provides a reputational equilibrium and shows the existence of further gains from GATT in this case. Conclusions follow.

2 The Story

The motivation for the model comes from a typical dispute that is brought to the GATT/WTO for settlement under Article XXIII. These two countries will have signed an agreement in the past which called for reciprocal lowering of tariffs and other trade barriers. The challenger claims that the initial benefits that she expected to receive from the agreement never materialized mainly due to certain prohibitive domestic policies the defending country enacted (or friendly policies he failed to enact) afterwards (Yarbrough and Yarbrough [1987]). These policies can include labor or health standards, extra taxes that mainly target imports or competition policies that favor domestic import-competing firms. In the language of the GATT, the concessions that the challenger received are nullified and/or impaired" at the outcome. It is important to note that the actual breach of legal obligations is neither necessary nor sufficient under the GATT rules to initiate the dispute settlement process (Jackson [1997]). In an important case, GATT panel stated that nullification or impairment can be caused by actions that could not reasonably have been anticipated" by the plaintiff at the time of negotiations (Hudec [1975]). In other words, GATT recognizes the
incomplete nature of trade agreements and addresses the importance of resolving the disputes that arise from this.

In most circumstances, the challenger requests to cancel the initial concessions that she provided or to enact other protective measures (probably in another sector) to compensate for her loss. The defender claims that he complied with the initial agreement and lowered his trade barriers. The domestic policies in question have been in place at the time or were never part of the initial negotiations or do not cause the damage that the challenger claims to exist. The claim can even be that, as a sovereign country, the government has the right to implement any policy it deems to be in the best interest of its people. The trade concessions are still in place and they are not nullified. Thus the case is without merit and should be dismissed.

The important point is that both sides are likely to be correct in their claims. When a trading partner lowers her tariffs, the increase in exports to this market and, therefore, welfare gains are not guaranteed. The importing country can easily undo the lowering of protectionism through a multitude of opportunistic domestic policies, even though these might be less efficient than direct tariffs (Yarbrough and Yarbrough [1987]). For example, an increase in port fees, subsidies to domestic production, excessive technical requirements that foreign goods will have a hard time to match would limit the expected increase in trade volume. Some other policies can be more complicated. Allowing domestic producers to control downstream distribution channels to limit the foreign companies' access to the consumers is one of the favorite criticisms of American trade negotiators against Japan. A completely different possibility is that structural changes in the economy need to take place for the liberalization and the increase in the trade volume to occur. There might be need to have workers shifted from the import-competing sector to the export sector or to have certain infrastructure projects completed. Relocation of workers is rarely a smooth process, both in economic and political terms. It might require extensive retraining programs at great economic costs and possible conflicts with labor unions with significant political costs. Since all of these changes are costly, especially in the short run, governments might be reluctant to undertake them which would lead to the nullification of concessions and disappointment of the trading partners.

All of the above cases would provide legitimacy to the challenging country's case. Despite the claims to the contrary, the defending country might actually have implemented the costly policies
and resisted the pressure (or the temptation) to implement other protectionist policies. Since these actions are already sunk, the challenger might want to take advantage of the situation and refuse to implement her own costly policies or renegotiate their initial agreement to obtain further gains that were not available in the initial negotiation stage. In short, the true realization of the full benefits of a liberal trade agreement requires both parties to undertake further actions and/or to promise not to implement certain policies. In return, trading partners need to commit to not to engage in post-contractual opportunism. GATT dispute settlement process is keenly aware of the fact that simple lowering of trade barriers is a first step in the right direction to reach a Pareto superior outcome, but is rarely the complete journey.

This is the main scenario we will analyze in this paper. We will assume that the two countries have already signed a treaty that lowers tariffs. However, they need to undertake costly actions for the true benefits of the treaty to be realized and for the trade volume to increase above the pre-treaty level. The uncertainties about the motivation of the other party will cause the countries to refrain implementing these potentially profitable actions. The rest of the world only observes the trade volume (not the actions) and will try to infer their types from the outcome. GATT dispute resolution process simply announces what actions each party to the rest of the world.

3 The Model

A crucial observation for the motivation of this paper is the fact that the dispute in this scenario would never occur in a world of perfect information and complete contracts. All of the problems associated governments who implement domestic policies that favor local producers or do not undertake the required investments can be easily resolved by an explicit trade agreement. Once the contract lists the actions that are allowed and/or prohibited, all of the claims for "nullification" will be preempted. Prevention of post-contractual actions by opportunistic trading partners after certain sunk investments are made is more problematic. If the other government is known to be opportunistic (i.e., a bad type), then the treaty would either specify excessive penalties against opportunism (if it enforceable) or it would not be signed in the first place. In short, in a world of perfect information, parties would sign a complete contract that would anticipate all future contingencies. Even if the economic environment included uncertain events that will be resolved
after the initial negotiation stage, the contract can specify actions to be taken for each possibility\(^1\). Therefore, the dispute resolution process of the GATT aims to resolve contractual problems that arise ex-post, mainly caused by asymmetric information or incompleteness of contracts. The model we present here will address these issues.

There are two trading partners, A and B, who realize that there are welfare gains to be obtained from reciprocal lowering of their trade barriers. The full realization of the benefits to both countries from low tariffs require them undertake costly actions which we will call investments for the remainder of the paper. As we stated above, these might include political costs (such as "fighting the previously protected sectors and resisting their demands for domestic policies that discriminate in their favor) or economic costs (such as retraining workers who will lose their jobs during the restructuring of the economy and investments in infrastructure.) These costs can not be contracted upon in the trade agreement but, in the GATT terminology, countries have reasonable expectations that they will be implemented\(^2\).

In the first model, there is no uncertainty about B who is a good type. The payoff for B is represented by \(v(a;b)\) where \(a\) is the action of A and \(b\) is the action of B. Action \(a\) takes two values: it is equal to \(c\) ("cooperate") if investment is undertaken and is equal to 0 otherwise. The same holds for action \(b\). If \(a = c\), then B prefers to invest as well. On the other hand, if \(a = 0\), then B will not want to invest. Also, B prefers that both invest and obtain the benefits of trade liberalization rather than none of them investing. Finally, she prefers that at least A invest if B is not going to invest. Therefore, her preference ordering is the following:

\[
v(c;c) > v(c;0) > v(0;0) > v(0;c)
\]

The payoffs to government A from different investment outcomes depends on its type (for example, how strong the domestic anti-free trade lobbies are) and whether B performed the investment. The strength of the government is denoted by \(L\) which can be strong, \(s\), or weak, \(w\). A strong government can withstand pressures from lobby groups and aims to maximize total domestic welfare rather than the payoffs of a narrow interest group. A weak government can not resist the political

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\(^1\)We are ignoring the problems associated with the enforcement of contract when there are no courts or police, even in the world of complete contracts. This obviously is a serious problem for international trade agreements but it is beyond the scope of this paper. See Dixit [1987] for an introduction.

\(^2\)In the next section, we will see that the good type will implement these policies in equilibrium.
pressures for protectionism at the expense of domestic welfare. The true value of $L$ is known by $A$ while government $B$ only has information on its probability distribution. We will assume that $B$ knows that the government is strong with probability $p$ where $0 \cdot p \cdot 1$ and $A$ knows these beliefs as well. This feature forms the asymmetric information in the model and it cannot be contracted upon directly in the model. The payoffs for $A$ will be denoted by $u(L; a; b)$ where $L$ is her type and $a; b$ are the respective actions of the governments. For any level of strength and for any action by $A$, government $A$ prefers that $B$ invests:

$$u(L; a; c) > u(L; a; 0) \quad \text{for all } L \in \{s, w\}, a \in \{c, 0\}$$

If the government of $A$ is weak, she prefers not to invest regardless of the investment by $B$. Also, weak $A$ prefers low tariffs with investment to high tariffs with no investment. Thus, the preference ordering by a weak type of $A$ is given by the following:

$$u(w; 0; c) > u(w; c; c) > u(w; 0; 0) > u(w; c; 0)$$

On the other hand, if she is strong, $A$ prefers to invest only if $B$ invests. The preferences of a strong type are given by the following ordering:

$$u(s; c; c) > u(s; 0; c) > u(s; 0; 0) > u(s; c; 0)$$

We will also assume that investments are socially efficient regardless of the type of $A$.

Having established the preference orderings of two governments, now we can set up the structure of the game. We assume that they initially met in period 1 to lower their tariffs from their initial high levels and undertake investments. The tariffs are implemented immediately and but the investment decision by $B$ can only be undertaken at period 2. The investment level is observable by $A$ but is not contractible at period 1 so the text of the treaty can only include the tariff level. After observing $B$'s investment decision in period 2, $A$ decides whether to stick to the initial agreement and implement her investment or to renege on the treaty and never implement the promised investment. At that point, the investment by $B$ is a sunk cost and the decision is irreversible. The initial low trade volume will increase and provide welfare benefits if and only if both sides implement investments. This is the variable that the rest of the world can observe. The actual investment decisions of the countries are not observed by anybody else.
Before we proceed to find the equilibrium outcome of this game, we will make some observations that will simplify the rest of the analysis considerably. The agreement of low tariffs is irrelevant if one of the countries does not invest. Since both countries actually know their contingent actions (or their strategies) for the rest of the game, we will not include a formal bargaining over tariffs in this stage. Without loss of any generality, we can assume that both sides agree to low tariffs even though they might know they will not invest since this does not affect their payoffs.

We can find the equilibrium of this simple game by backward induction arguments. In period 3, a weak A will renge on the initial agreement and not invest whether regardless of B's investment decision in the previous stage. On the other hand, if she is strong, A will invest only if B did implement the investments in period 2. In other words, if there was no investment in period 2, there will be no investment by A regardless of her type. If there was an investment, only the strong type will invest.

Given the equilibrium strategies for both type of A in period 3, B will invest only if the probability of investment by A is high enough. The expected payoff from investment is $pv(c; c) + [1 - p]v(0; c)$ while the payoff from not investing is $v(0; 0)$. Therefore B will invest if and only if

$$p \geq p^w, \quad \frac{v(0; 0)}{v(c; c)} \leq \frac{v(0; c)}{v(0; 0)}$$

where $p^w$ is the minimum probability level of weak lobby needed for investment. If $B$ believes that $p < p^w$, then she knows that she will not invest in period 2 regardless of what might have transpired between the two governments in period 1. Low trade volume will occur and no benefits will be realized.

Now, we can characterize the perfect Bayesian equilibrium strategies of this game. B will invest in period 2 if and only if $p \geq p^w$. A weak A will renge on the agreement and not invest regardless of B's decision in period 2. A strong A will invest only if B invest in the previous period$^3$.

In equilibrium, it is possible that A is a strong type but Pareto efficient outcome of low tariffs, positive investments and high trade volume are not reached. There is no mechanism in place in this scenario for a strong government to convince B to invest in period 2. Any signal that can be

$^3$As we stated earlier, when $p < p^w$ there are other equilibria. The first states that A offers $(l; c)$ and B rejects this offer. The second one states that A simply does not make an offer. Since all of these equilibria lead to the same payoffs, we ignore them for simplicity.
sent in the period 1, can costlessly be replicated by the weak types and therefore it is not credible and does not reveal any information. It is also possible that A is weak and takes advantage of B by reneging on an initial agreement after her investment and causing her to obtain a payo® lower than her default option. Both of these equilibrium outcomes are socially inefficient and there is no way to prevent them. The aim of the next sections is to nd mechanisms through which we can eliminate some of these inefficient equilibria. We will argue that a multilateral environment which allows the establishment of reputation can serve this purpose.

4 The Role of Reputation

There are numerous models and papers on the role reputation in games and other strategic situations. For reputation to exist, we need to be in an asymmetric information world in which the type of an actor is not known with certainty by others. Furthermore, we need to be in a repeated or a multistage environment so that reputation can build up and have impact on the equilibria of the games. Finally, reputation needs to be costly to acquire and this cost needs to be higher for bad types so that it can have signalling value in the future stages. Also, the more fragile (more easy to lose) the information is and more easily it can be transmitted to relevant parties, the more valuable it becomes.

In the famous chain-store paradox, Kreps and Wilson [1982] and Milgrom and Roberts [1982] consider a chain-store which faces potential entry by competitors in a number of markets in each period. It has the option toght or to acquiesce when entry occurs. For a tough monopolist, the optimal choice is toght. A weak one, on the other hand, will prefer to acquiesce if entry occurs. Of course the rst best for a monopolist is an entry not to occur so that she can enjoy monopoly pro®ts. For an entrant, the optimal choice is to enter if the monopolist will acquiesce and to stay out if she willght. If the type of monopolist is public information, the equilibrium is obvious. If she is tough, no entry occurs. If she is weak, entry always occurs and she does notght. If her type is not public information and there is one market for entry, then entry will occur if the probability of a tough type is low enough. The interesting equilibrium occurs if the type is unknown and there are multiple (but ndite) periods in which a different entrant decides to enter after observing the outcomes in previous periods. The reputation might be valuable here. A weak
monopolist might find it worthwhile to fight in the initial stages to convince the potential entrants that he is tough to deter entry. The short-term price of the reputation will be worth it only if there are high enough number of potential entrants and the information about fights can be easily disseminated to outsiders.

The same logic can easily be applied to international negotiations and relationships such as the one we described in the previous section. We will modify the game along the following lines and see if reputational incentives can provide Pareto gains. Government A interacts with government B in the first stage of the game exactly as described above. Once their period 3 is over and they realized their payoffs, A opens negotiations with B. The game between A and B is identical to the previous game between A and B except with the fact that B observes the trade volume outcome between A and B without observing their investment decisions. High trade volume implies that both countries invested and especially A did not take advantage of the sunk investment of B. Low trade volume, on the other hand, might imply that either B did not invest or A took advantage of the situation despite the investment. This observation of trade volume is still valuable since it will enable B to update her beliefs about A’s type and possibly change her behavior in the future. The change in the beliefs of B is equivalent to a reputation for A. A high volume observation by B would strengthen her beliefs that A is a strong type (an increase in p) and would make her more likely to invest when it is her turn. This would give a weak A an incentive not to renege against B which is the source of the Pareto gains we are looking for. The actions of A in the first game serve as a costly signal of her type. If other countries could observe the investment decisions by B or could not observe the outcome of the game at all, reputation would have no value. In the first case, when they observe the trade volume they would automatically know the cause. In the second case, the sacrifice by A would not be transmitted and would not cause them to update their beliefs.

The equilibrium of this new game again has to be Perfect Bayesian which needs to satisfy the following: (i) At each information set, when it is her turn to make decision, each player has a belief or a probability distribution over the nodes in the information set. (ii) Strategies must be rational at every information set, in the sense that they have to be optimal given the beliefs and the

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4 It is crucial to emphasize the contractual properties of the investment promised by B. It is observable by only A and B and is not verifiable by any other government. This is why its inclusion in the initial treaty would not have any effect.
hypothesized future moves of the other players. (iii) The beliefs need to be updated using Bayes' rule and other players' equilibrium strategies.

Again several observations are in order before we start the formal analysis. (1) If equilibrium calls for $B^1$ to invest, then strong $A$ will also invest since this is the optimal strategy. (2) Suppose the equilibrium strategy calls for $A$ to invest regardless of her type. Then the same equilibrium strategy need to require $B^1$ to invest in period 2 since that is her best response against (a future) investment by $A$.

Now we will characterize an equilibrium. Let $p$ be the common belief of $B^1$ and $B^2$ about the probability of a strong $A$ at the very beginning of the game 1 before $A$ and $B^1$ play. First define

$$p^x = \frac{v(0;0) - v(0;c)}{v(c;c) - v(0;c)}$$

$$\frac{1}{4}(p) = \frac{p - 1}{p - p^x}$$

$$p^{xx} = (p^n)^2$$

The equilibrium strategies are given by the following:

1. If $p > p^x$: $B^1$ will invest. $A$, regardless of her type will invest only if $B^1$ invested. In the second game, $B^2$ will invest, if she observes high trade volume in the previous game. She will not invest if she observes low volume. Strong $A$ will invest only if there was investment by $B^2$ and weak $A$ will never invest.

2. If $p^x > p > \frac{1}{4}(p)$: $B^1$ will always invest. Strong $A$ will invest only if $B^1$ invested. Weak $A$ will invest with probability $\frac{1}{4}(p)$ if $B^1$ invested and she will not invest otherwise. In the second game, $B^2$ will invest if she observes high trade volume and does not invest otherwise. Strong $A$ will invest only if $B^2$ invested and weak $A$ will never invest.

5There is another simpler equilibrium but the conclusions of the paper do not change. We will present it here for completeness.

1. If $p > p^x$: $B^1$ will invest. $A$, regardless of her type will invest only if $B^1$ invested. In the second game, $B^2$ will invest, if she observes high trade volume in the previous game. She will not invest if she observes low volume. Strong $A$ will invest only if there was investment by $B^2$ and weak $A$ will never invest.

2. If $p^x > p$: $B^1$ will not invest and strong $A$ will invest if $B^1$ invested while a weak $A$ will never invest. In the second game, $B^2$ will invest only if she observe high trade volume previous game. Strong $A$ will invest only if there was an investment by $B^2$ while a weak $A$ will never invest.
3. If $p^{\text{rel}} > p$, $B^1$ will not invest and strong $A$ will invest if $B^1$ invested while a weak $A$ will never invest. In the second game, $B^2$ will invest only if she observes high trade volume previous game. Strong $A$ will invest only if there was an investment by $B^2$ while a weak $A$ will never invest.

To show that these strategies form an equilibrium, we need to show that deviations by any player do not form an equilibrium and beliefs are consistent. The formal proof is given in Appendix A, but we will look at the certain features of the equilibrium more closely.

If the initial probability of a strong type, $p$ is high, then $B^1$ will always invest regardless of the reputational concerns of $A$ and both $B^2$ and a weak $A$ are aware of this. Since a strong $A$ always invests, low volume can only imply a weak $A$ since strong $A$ will always invest. If a weak $A$ invests then $B^2$ will not update her beliefs about $p$ and she will invest since she cannot tell them apart. Since weak $A$ will find it optimal to hide his true nature\footnote{Since $u(w; c; c) + u(w; 0; c) > u(w; 0; c) + u(w; 0; 0)$.}, he will invest in the first game against $B^1$ not to reveal his identity to $B^2$. In this case, both the value of good reputation and the cost of a bad reputation are high.

If the probability of a strong type is in the middle range, weak types do not need to mimic the strong types all the time. Suppose the equilibrium required again weak types to invest. Again, $B^2$ only observes high trade volume and can not distinguish between strong and weak types and can not update her beliefs. However, her belief of $p$ is still lower than the threshold level of $p^{\text{rel}}$ so she will not invest. Then a weak $A$'s payo\textregistered will be $u(w; c; c) + u(w; 0; 0)$. On the other hand, if equilibrium requires weak $A$ not to invest in game 1, $B^2$ would also recognize this and would never invest under low volume observation. The total payo\textregistered for a weak $A$ would be $u(w; 0; c) + u(w; 0; 0)$. If a weak $A$ were to invest only with probability $\frac{1}{4}$ then $B^2$ would update her beliefs about a strong $A$ to a higher level denoted by $b = \frac{p}{p + (1 - p)^{\frac{1}{4}}}$. If a weak $A$ were to choose $\frac{3}{4}$ such that $b = p^{\text{rel}}$, then $B^2$ would invest and weak $A$'s total payo\textregistered would be $\frac{1}{4}u(w; c) + \frac{1}{4}u(w; 0; c) + \frac{1}{4}u(w; 0; c) + [1 - \frac{1}{4}]u(w; 0; 0)$ which is higher than the previous two cases. We should note that if $\frac{3}{4}$ were too high then $b$ would be low and $B^2$ would not invest. That is why $\frac{3}{4}$ is an increasing function of $p$. Furthermore, $B^1$ will invest only if the probability of investment in the next period is high enough. This probability is $p + (1 - p)^{\frac{1}{4}}$ which creates lower boundary denoted as $p^{\text{rel}}$. Again, in this range, $B^2$ knows that $B^1$ is definitely investing. Low volume definitely implies weak type whereas high volume implies weak type only with probability $1 - b$. In this case the observation of the trade volume is valuable.
to a certain extent since, as opposed to the previous range, high volume leads to better information about strong type (higher $p$).

When the initial probability of strong type is too low, it is not possible to reveal enough information in the first game to convince $B^2$ that there is high enough chance of strong $A$. Since $B^1$ does not invest, no information will be revealed about the type of $A$ even if she invested since trade volume will still be low. Reputation is too costly to acquire and, therefore, weak types will never invest.

It is very clear how the power reputation improves the equilibrium and provides efficiency gains compared to the previous case. If the previous section’s game was simply repeated twice with no informational linkages ($B^2$ does not observe the trade volume) and with the same ex-ante beliefs by $B^1$ and $B^2$, the equilibrium would be identical in two games. We can summarize the equilibrium outcome in the following table:

<table>
<thead>
<tr>
<th>Range for $p$</th>
<th>Game repeated twice</th>
<th>Reputation Game</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p &gt; p^x$</td>
<td>Both $B^1$ and $B^2$ invest</td>
<td>Both $B^1$ and $B^2$ invest</td>
</tr>
<tr>
<td></td>
<td>Strong $A$ always invests</td>
<td>Both types of $A$ invest in game 1</td>
</tr>
<tr>
<td></td>
<td>Weak $A$ never invests</td>
<td>Only strong $A$ invest in game 2</td>
</tr>
<tr>
<td>$p^x &gt; p &gt; p^{xx}$</td>
<td>No investment by $B^1$ and $B^2$</td>
<td>$B^1$ invests, $B^2$ invests w/ prob. $p + (1 - p)\frac{1}{4}$ Strong $A$ invests.</td>
</tr>
<tr>
<td></td>
<td>Neither type of $A$ invest in either game</td>
<td>Weak types invest w/ prob $\frac{1}{4}$ in Game 1 and never in Game 2</td>
</tr>
<tr>
<td>$p^{xx} &gt; p$</td>
<td>No investment by $B^1$ and $B^2$</td>
<td>No investment by $B^1$ and $B^2$</td>
</tr>
<tr>
<td></td>
<td>Neither types of $A$ invest.</td>
<td>Neither types of $A$ invest.</td>
</tr>
</tbody>
</table>

The equilibrium outcome is identical for low expectations of a strong type. However, when the expectations are really high ($p > p^x$), we guarantee the complete commitment to the initial agreement and positive investment in the first game by weak types. This enforcement through reputation is quite valuable for $B^1$ and she reaps the benefits by guaranteed high trade volume. We have improvements for medium levels of $p$ (where $p^x > p > p^{xx}$) as well. Previously, we had no

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7 We should make sure to distinguish equilibrium strategies and outcomes. Strategies list the actions and beliefs for all players at each node even though they might not be reached. Outcome simply states the actions and payoffs along the nodes that are reached.
investment in this range. Now, we have investment in the \textsuperscript{rst} game with probability 1 and with positive probability \((p + (1 - p)^\frac{1}{2})\) in the second game. Similarly strong types enjoy guaranteed investment and \(\text{payo} \circledast u(s; c, c)\) in both games. Weak types are forced to implement investment at least some of the time in game \textsuperscript{1} not to reveal their true type. The only player to get hurt is \(B^2\) since she gets \(\text{payo} \circledast pv(c; c) + (1 - p)v(0; c)\). This is lower than what her \(\text{payo} \circledast \) would be otherwise without the new information which is \(v(0; 0)\). However we can show the total social welfare is higher in this reputational equilibrium.

As expected, weak types always renege in the second game since it is the last game and there is no value for reputation after this. If this game was repeated many times, we expect no cheating by weak types in more games and for even lower cut-off levels of \(p\). As the shadow of the future gets longer, the fragility and therefore the value of reputation increases. In short, reputation is a valuable enforcement mechanism when there is asymmetric information which can be (at least partially) revealed through actions.

Finally, we should note that the benefits of reputation on strong types and the discipline it provides on weak types improve as he plays the game with higher number of \(B\)'s (assuming they can observe the trade volumes of all previous games). If the game is repeated enough number of times, then weak \(A\) will always invest in initial stages regardless of the value of \(p\). This is simply due to the fact that the cost of revealing her true type become too high as she expects to meet higher number of trading partners. In the limit case where there are an infinite number of \(B\)'s, we can show that there is an equilibrium in which a weak \(A\) always invest. This is a simple application of the famous folk theorem of finitely repeated games as in the chain-store paradox.

5 The Role of the GATT

In the previous section, we showed how repetition of the game and the strategic value of information diffusion can provide Pareto gains through reputational mechanisms. In particular, we see significant improvements in earlier stages of a game when there are gains from establishing reputation and hiding their true types for weak players. This causes them to cooperate with the other players and to invest due to the fear of future retaliation and loss of credibility with other players. Reputation is acquired through the observation of a signal (trade volume) that is imperfectly cor-
related with actions of the players. It is important to re-emphasize that $B^2$ only observes whether if there is high volume (both invested) or low volume (at least one of them did not invest). If she observes low volume, she does not know whether this is due to $B^1$'s or $A$'s (or both) failure to invest. She can only drive inferences from her observations and update her beliefs. One might think that a better information transmission mechanism can improve the equilibrium even further. This is where GATT dispute resolution process will enter the picture.

First we should explain the main features of the process. Article XXIII provides the main legal basis for the dispute settlement in GATT but the actual procedures were developed over decades of practice and they had three main features (Jackson [1997]). First, as we stated earlier, dispute settlement procedure can be invoked by a plaintiff on the grounds of "cancellation or impairment" of benefits that were "reasonably expected" at the time of initial agreement and does not require actual breach of legal obligations. This is the recognition of the incomplete nature of trade agreements and the possibilities of opportunistic behavior by governments. The second feature is about the actual process of dispute resolution. GATT authorizes the CONTRACTING PARTIES (members) to investigate, recommend action and give rulings on the matter. The main institution to carry out these actions is the panel of experts who would act as representatives of GATT, not their own governments. Then their findings and recommendations would be submitted to all of the CONTRACTING PARTIES for final decision. This process reveals the importance GATT attached to the credibility of the panel as well the as the to the dissemination of information to all members since all of the processes are handled publicly. The third feature is the ability to authorize (by all CONTRACTING PARTIES) a plaintiff to "suspend equivalent concessions" against a defendant if he is found guilty. Members were keenly aware of the limited enforcement power of the GATT decisions, but this punishment stage was important for the credibility of the system. The fact that the vast majority of the cases were resolved before reaching this stage is interpreted as evidence of the success of the system (Hudec [1975]).

In the previous section, we have shown that a reputation mechanism can increase the efficiency and prevent opportunistic behavior. Now, we will aim to see if a GATT dispute resolution system described above can provide further efficiency gains. Suppose $A$ and $B^1$ conduct their initial agreement under the auspices of the GATT and agree to refer all disputes to a GATT panel. To represent this process, we will make the following changes to the underlying game to introduce a
very simplified version of the GATT dispute resolution process. After period 3 in the first game, A can go to the GATT claim that the promised investment was not undertaken by B which significantly nullifies the benefits he expected to receive. This is definitely true for both the strong and the weak type since \( u(s; c; c) > u(s; 0; 0) \) and \( u(w; c; c) > u(w; 0; 0) \). Furthermore, A can claim that this is the reason why he should not have to implement low tariffs. A can demand B to undertake her investments that were \"reasonably expected\" and promise to implement his low tariffs only after that. Similarly, if there is no investment by A in stage 3 of the first game, B can go to the panel, claim that she fulfilled her obligations by investing and demand A to invest as well. The GATT panel has limited enforcement power and can not force any government to undertake any investments or implement any policies they do not want to. The only power within GATT's arsenal is to reveal to the rest of the members whether if the investment is actually undertaken or not. GATT panel can, of course, demand B or A to invest to receive the full benefits of trade liberalization but can not punish them if they do not want to follow the judgement. The acceptance of the decision of the GATT panel has to be voluntary. The main benefit of the mechanism occurs when B infers from the panel's conclusion whether the cause of the low trade volume was the absence of investment by A or B and updates her beliefs about \( p \) to change her behavior.

We will now try to see if this information revelation by GATT can improve welfare. When \( p > p^* \), B invests and both types of A invest along the equilibrium path as we stated in the previous section. Therefore there is no dispute led and no new information revealed. If \( p^* > p > p^{**} \), B will always invest but there is probability \( (1; 1/4) \) that we observe low volume since a weak A invests with probability \( 1/4 \). Then B can go to the GATT panel and request A to implement low tariffs as promised. If \( p < p^{**} \), B does not invest. Now, there is a legitimate case for a suit and both types of A will go to the GATT. In short, we will see a dispute led by B only when \( p^* > p > p^{**} \) and by A when \( p < p^{**} \).

A suit led by B and the decision of the GATT panel simply states that A did not invest. Since strong types always invest, this will tell B that A is weak. But B already knows this from the observation of low trade volume and that \( p^* > p > p^{**} \). Similarly when \( p < p^{**} \), a suit led by

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As stated, this model is intended to capture the main elements of the dispute resolution process to analyze its impact on the efficiency properties of initial agreements. It does by no means reflect the complete process. See Jackson [1989] and Hudec [1993] for extensive legal treatment.
A leads to the conclusion that \( B^1 \) did not invest. But \( B^2 \) already knows that \( B^1 \) will not invest when \( p < p^m \) and this does not reveal any information about A's type. The most significant point of this section is that this multistage game has a separating equilibrium. \( B^2 \) knows which action \( B^1 \) will take depending on the value of \( p \). This information with the observation of low trade volume fully reveals the type of \( A \). Therefore the GATT panel cannot provide any further information to \( B^2 \) and improve welfare!

An important feature of this game is that initial beliefs of \( B^1 \) and \( B^2 \) about \( A \)'s type are identical. In other words, \( B^2 \) exactly knows what \( B^1 \) will do in period 2 of game 1 and therefore the GATT panel's announcement is redundant. An observation of low volume when \( p > p^b \) is enough for \( B^2 \) to infer that \( A \) did not invest and she does not update her beliefs about \( p \). On the other hand, low trade outcome when \( p^a > p > p^m \), confirms that \( A \) is a weak type and prevents \( B^2 \) from investing when it is her turn. A dispute brought by \( B^1 \) simply states that \( A \) is a weak type while a dispute by \( A \) tells her that \( B^1 \) did not invest. Therefore there is no additional information provided by the dispute resolution process.

This interesting and strong result is due to one-sided asymmetric information. The reputational incentives cannot be made more effective when only one party cares about her reputation. This result does not mean there are no welfare gains created by a multilateral and independent dispute resolution process. We will modify the existing games to provide in the next section to provide a motivation for the presence of a GATT panel and the value of the information it can disseminate.

6 Two Sided Asymmetric Information

The game will be almost identical to the one in the previous sections. First \( B \) will decide to invest or not and she will be followed by \( A \). The benefits of low tariffs will be realized only when both sides invest. However, there is asymmetric information about the types of both countries. Strong types prefer high investment over low investments while the reverse is true for weak types. The payoffs for \( B \) are denoted by \( v(L;a;b) \) where \( L \) is her type, \( b(a) \) is the investment chosen by \( B \) (\( A \)). Similarly, \( A \)'s payoff is given by \( u(L;a;b) \). Investments \( a \) and \( b \) can be positive (\( c \)) or zero. To simplify the model, we will assume that the two countries already agreed on low tariffs. If only one government invests, trade volume will not increase but there are political costs for the side who
did invest and got cheated. First B will choose her investment and A will respond after observing her decision. The preferences of the strong B are similar to the preferences of the same type of A from the previous section:

$$v(s; c) > v(s; c; 0) > v(s; 0; 0) > v(s; 0; c)$$

The preferences of the weak B are also similar to the preferences of the weak A with a slight change:

$$v(w; c; 0) > v(w; c; c) = v(w; 0; 0) > v(w; 0; c)$$

We will assume that the weak B is indifferent between both investing and neither government investing and she will choose that both invest if there ever was a decision to be made between the two.

Identical relationships hold for the payoffs of A as in the previous section. We will assume that each government knows her type and believes that the other one is strong with probability $q$. Again we will use backward induction to find the equilibrium which will be the following: If A is weak, his dominant strategy is not to invest. If he is strong, he will only invest if B had done so in the previous period as well. If B is weak, he will never invest. If she is strong, she will invest if

$$q > q^* = \frac{v(s; c; 0)}{v(s; c; c)} \frac{v(s; 0; c)}{v(s; 0; 0)}$$

This is very similar to the equilibrium of the game where there was asymmetric information about the type of A. The probability of strong A needs to be high enough for B to take the risk of investing.

7 Reputation and Efficiency Gains

In this section, we will extend this model to see if there are any gains from reputation as we did in the previous section. Suppose A will meet another trading partner B in the next stage who can only tell if there was investment by both parties since it shows in the trade statistics. If one of the

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9This assumption prevents multiple equilibrium by ensuring that weak B does not invest unless the probability of weak A investing is less than 1.

10A weak $B^1$ will invest only if probability of strong A is high enough. If we assume that $q < 1$, then there is 2 small enough that weak $B^1$ will never invest.
parties does not invest, then trade volume does not increase and B^2 can not tell who the culprit is. For simplicity, we will assume that B^2 can be only a strong type so that if she is sure A is strong, she will invest. Our aim is to find out if reputational pressures can cause weak types of A to invest which might prompt some strong B^1s to invest who would not otherwise.

First let’s look at the region where \( q > q^1 \). In this area, a strong B^1 will invest regardless of the reputational consequences since the probability of strong A is high enough. A weak B^1, on the other hand, will never invest and B^2 knows these strategies. If B^1 did not invest, neither type of A will invest since the trade volume outcome will be low regardless of their action and it will send a signal about their type. If B^1 invested, a strong A will definitely invest and assume that a weak A will invest with probability \( \frac{1}{4} \) which will be function of \( q \). Then we can define the following probabilities:

\[
\begin{align*}
\bar{\xi} &= P[\text{strong A|high trade volume}] = \frac{q}{q+(1_i q)^{1/4}} \\
\bar{\xi} &= P[\text{strong A|low trade volume}] = \frac{q}{1+q(1_i^{1/4})}
\end{align*}
\]

The second probability was zero in the previous section since low trade volume necessarily implied a weak A. Here, the weak volume could be caused by a weak B^1 and GATT dispute resolution mechanism’s role in identifying this fact will be the source of the welfare gains. It is easy to show that \( \bar{\xi} > \bar{\xi} \) for any value of \( \frac{1}{4} \) which means higher volume is a stronger signal of a strong type.

In the second game, B^2 will invest when he observes high trade volume if \( \bar{\xi} > q^1 \). Similarly B^2 will invest when he observe low volume if \( \bar{\xi} > q^1 \). We can state the following:

\[
\bar{\xi} > q^1 \text{ if } \frac{1}{4} < \frac{1}{\bar{\xi}}, \quad \frac{q}{1_i q} \frac{1_i}{q^1}
\]

However \( \frac{1}{\bar{\xi}} > 1 \) for all values of \( q \) so we will always have \( \bar{\xi} > q^1 \). This means whenever B^2 observes a high trade volume, she will invest. Similarly

\[
\bar{\xi} > q^1 \text{ if } \frac{1}{4} > \frac{1}{\bar{\xi}}, \quad 1_i \frac{1_i}{q^1} + \frac{1}{q}
\]

So if a weak A would like B^2 to invest no matter what the trade volume turns out to be, she has to invest with probability \( \frac{1}{4} \) in the first game after B^1 invests.

Now, we can analyze the equilibrium strategies for the rest of the parameter range. For \( q < q^1 \), the values of \( \bar{\xi} \) and \( \bar{\xi} \) stay the same as given above. However, we will have \( \frac{1}{\bar{\xi}} < 1 \) for all values
of $q$ in this range and the maximum value $\frac{1}{4}$ can take will be $\frac{1}{\sqrt{2}}$. For $q < q^*$, we have $\frac{1}{\sqrt{2}} < \frac{1}{4}$ which means $\frac{1}{4} < q^*$ and $B^2$ will not invest anymore when she observes low trade volume in the first game.

If we look at the decision faced by strong $B^1$, the probability of investment in the next stage is $q + (1 - q)\frac{1}{\sqrt{2}}$. Strong $B^1$ will invest if and only if $q + (1 - q)\frac{1}{\sqrt{2}} > q^*$ or $q > q^{**} \cdot (q^*)^2$. So we can state the equilibrium:

1- For $q > q^*$: A strong $B^1$ will invest and a weak $B^1$ will never invest. A strong $A$ will invest in the first game if $B^1$ invested and a weak $A$ will invest with probability $\frac{1}{4}$. Neither type of $A$ will invest if $B^1$ did not invest. In the second game, $B^2$ will invest regardless of the trade volume from the first game. Strong $A$ will invest only if $B^2$ invested. Weak $A$ will never invest.

2- For $q^* > q > q^{**}$: A strong $B^1$ will always invest and a weak $B^1$ will never invest. A strong $A$ will invest in the first game if $B^1$ invested and a weak $A$ will invest with probability $\frac{1}{\sqrt{2}}$ if $B^1$ invested. Neither type of $A$ will invest if $B^1$ did not invest. In the second game, $B^2$ will invest only if the trade volume from the first game is high. Strong $A$ will invest only if $B^2$ invested. Weak $A$ will never invest.

3- For $q^{**} > q$: Regardless of her type $B^1$ will not invest. A strong $A$ will invest in the first game only if $B^1$ invested. A weak $A$ will never invest. In the second game, $B^2$ will invest only if the trade volume from the first game is high. Strong $A$ will invest only if $B^2$ invested. Weak $A$ will never invest.

Again it is easy to see the gains from reputation and the ability of $B^2$ to observe (even if only partially) the outcome of game 1. For the region, $q > q^*$ we are guaranteed that a weak $A$ will invest with positive probability if $B^1$ is strong (and had invested) which was not the case before. This causes $B^2$ to invest regardless of what happens which benefts strong $A$. For $q^* > q > (q^*)^2$, we have investment by strong $B^1$ which was not the case before. We also have investment with positive probability by weak $A$ and investment by $B^2$ which again provide welfare gains. For $(q^*)^2 > q$, there is no change compared to the previous case. We can create a similar table comparing the outcomes in different equilibria:
Range for $q$ & Game repeated twice & Reputation Game \\
$q > q^*$ & Strong $B^1$ and $B^2$ invest, weak $B^1$ does not. Strong $A$ invests Weak $A$ never invest & Strong $B^1$ and $B^2$ invest, weak $B^1$ does not invest. In game 1, strong $A$ invests and weak $A$ invest with prob $1/4$. In game 2, only strong $A$ invests \\
$q^* > q > q^{**}$ & No investment by $B^1$ and $B^2$. Both types of $A$ do not invest & $B^1$ invests, $B^2$ invests if high vol. In game 1, strong $A$ invests and weak $A$ invest with prob $1/4$. In game 2, only strong $A$ invests. \\

The efficiency gains from the reputation mechanism are clear. First, the cut-o® point for $q$ for strong $B^1$ to invest goes down since $A$ is more likely to invest. Second, some weak types of $A$ will invest (only with probability $1/4$ or $1/4$, of course) compared to never investing in the previous case. Third, $B^2$ updates her belief about $q$ to a higher level after observing high volume. This means she is more likely to invest. Again, weak types of $A$ will always cheat in the last stage since they have no incentive to maintain a reputation.

Finally, if we compare the outcome of the two games, we can see the impact of two-sided asymmetric information. First, suppose that $p = q$ so that the cut-o® points are the same. For high $p$, strong $A$ initially invested with probability 1 but now, he will invest with only probability $1/4$ since $B^2$ can interpret this as weak $B^1$ rather than weak $A$. For medium range of $p$ and low range the outcomes are the same. Again, if the game were to repeated more often (there are more $B$'s), the welfare gains would increase and weak $A$ will always invest in the initial stages regardless of the value of $q$.

8 G A T T Dispute Resolution Process

Now, we will introduce GATT dispute resolution mechanism as credible information disseminating agency as in the previous sections. Suppose $A$ can go to the GATT and claim that the other party
did not adhere to the initial agreement and did not invest. Similarly $B^1$ can “lie a dispute and state that $A$ did not carry out his obligation even though $B^1$ invested. Suppose, the only thing GATT can do is to state whether if the low trade volume is due to the lack of investment on $B^1$’s or $A$’s part.

When there is uncertainty about both $B^1$’s and $A$’s types, low trade volume observation by $B^2$ can be due to lack of investment by either side in game 1 when $q > q^{mm}$. GATT’s dispute resolution process and the panel’s decision will be valuable since it will announce whether if $B^1$ invested or not which is not observable by $B^2$. This is valuable even though a weak $B^1$ will not change her behavior upon a complaint by $A$ since she does not face future interactions with other GATT members and GATT decision can not be enforced.

If $q > q^i$ and $B^2$ observes low trade volume, then she will lower her beliefs about the probability of strong $A$ to $\bar{q}$ in the previous section. However, this is still high enough for her to invest. If the trade volume in game 1 is due to non-investment by weak $B^1$, then $A$ will “lie a complaint. The dispute resolution process of GATT investigates the complaint and announces who is responsible for low trade volume. This is equivalent to announcing the action of $B^1$ and in essence her type. With this information, the probability of $A$ being strong stays at $q$ rather than going down to $\bar{q}$. On the other hand, if $B^1$ “lies a complaint after low trade volume, the GATT decision will reveal the type of $A$. If $B^2$ knows that $B^1$ invested and $A$ did not, then probability of $A$ being strong becomes zero instead of $1$; $\bar{q}$ as it is in the previous case. Since weak $A$ knows that his type will be perfectly revealed in the dispute resolution process, he will invest with probability 1 (rather than with probability $1/4$) after $B^1$ invests. In short, the information provided by the GATT enables $B^2$ to have better information about $A$’s type and behave differently when her turn arrives to deal with $A$. This information, in return, will provide a bigger stick to punish a weak type $A$ and enable the parties to reach a Pareto superior equilibrium in game.

The benefits of a GATT dispute resolution and information dissemination process are less valuable if $q^m > q > q^{mm}$. In this region, low volume implies that the probability of strong $A$ is $\bar{q}$. If the GATT panel announced that $B^1$ is guilty, $B^2$ would increase her belief about strong $A$ to $q$ but this is still too low to convince her to invest. On the other hand, if GATT announced that $A$ is guilty then $B^2$’s belief would go down to zero, but she does not gain anything since she was not going to invest anyway. GATT’s information does not change the actions of $B^2$ which means weak
A will not behave differently either. In short, superior information from GATT does not provide efficiency gains for low values of $q$.

The same conclusions will hold if there were other sources of uncertainty, other than the types of the governments. Suppose, there is positive probability $r$ such that trade volume stays at low despite both governments investments. Then $B^2$ would interpret this as one of them not investing (and $A$ being weak type) and decide not to invest. GATT panel can clarify the communication problem and enable all three countries to reach a Pareto superior outcome.

The efficiency gains from a GATT dispute resolution and information dissemination mechanism will be more valuable if there are more countries that $A$ will interact in the future. In other words, GATT actually limits the ability of large countries, such as the US and the EU, to cheat on their obligations against smaller countries.

9 Conclusion

The aim of this paper was to identify under what conditions a multilateral dispute resolution process can provide efficiency gains even though it does not have any enforcement powers. One of the main benefits of a multilateral system can be its ability to di®use information and the scenario we laid out has this feature. In our rst model, we have two countries where the type of one of them is private information. The other country needs to take a costly action for the benefits to be realized, however, a bad opponent can take advantage of the situation by reneging on an initial promise. If the party with private information repeats the same game with other players and these other players can (partially) observe the outcome of the initial game to update their beliefs about her type, a Pareto superior reputational equilibrium can be sustained. In this case, some of the bad types will behave well and higher levels of investment will be undertaken. The threat of future through a bad reputation can provide discipline. Next we added a multilateral agency who can disseminate information. The important result of this section is that when asymmetric information is one sided, then a multilateral agency can not improve upon the equilibrium by further information. The strategies of the player lead to perfect separation and the rest of world can perfectly infer the actual event from the outcome.

This pessimistic result does not mean there is no need for multilateral agencies. Our next model
had two-sided asymmetric information where players take actions without perfect knowledge of each other's types. First, we showed that there is Pareto superior reputational equilibrium with higher investment and lower cheating. Then we showed how a dispute resolution process can provide better information about the true types of the players to the rest of the world compared to simple observation of the outcome. The reason is that there is no separating equilibrium in which each type takes a certain action. Since both sides mix their strategies, identifying the actions of even one of the players improves the information set of outsiders. This leads to better punishment and reward mechanisms and to further Pareto gains.

The models in this paper are extremely stylized and simplistic. They do not address many of the important details of a dispute resolution process and its many other benefits. However, they show that the future stages of a game have important consequences for the efficiency of the initial agreement and dissemination of information can vastly improve the outcome. Furthermore, the nature of the informational problems is crucial. For example, multilateral processes can only improve upon two-sided private information problems. Since these are the more challenging problems, mechanisms like GATT are likely to provide further gains.

10 Appendix

$p > p^*$: It is optimal for $B^1$ to invest since the probability of a strong $A$ is high enough. Then strong $A$ will also invest. If a weak $A$ does not invest, $B^2$ will update her belief and set $b = 0$ and will not invest. The final payoff for weak $A$ will be $u(w; 0; c) + u(w; 0; 0)$. If she invests, there will be no change in the beliefs of $B^2$ and she will invest. Then weak $A$ can take advantage of this and will not invest. His final payoff will be $u(w; c; c) + u(w; 0; c)$ which is higher. Thus, in equilibrium, weak $A$ will invest in the first game, but will not in the second game.

$p^* > p > p^\text{min}$: If $B^1$ invests, strong $A$ will invest. Assume that weak $A$ will invest with probability $\frac{1}{4}$ (which we will solve later.) After observing high trade volume, $B^2$ will update her beliefs about $A$'s type and set $b = \frac{p}{p + \frac{1}{4}(1 - p)}$ and will invest only if $b > p^*$. Given this, $A$ will choose $\frac{1}{4} = \frac{p^* (1 - p) - p}{p^* (1 - p) - 1}$ such that the condition will hold with equality. (Note that $\frac{1}{4} > 1$ if $p > p^*$ so that weak $A$ will always invest.) Thus, $B^2$ will invest only if she observes investment. Given the value of $\frac{1}{4}$ $B^1$ will invest if the probability of investment in the next stage $p + \frac{1}{4}(1 - p)$ is higher than $p^*$.
which means if \( p > (p^*)^2 = p^{xx} \).

\( p^{xx} > p \): Now \( B^1 \) will not invest so strong \( A \) will not invest either which takes away the incentive for weak \( A \) to imitate him. \( B^2 \) will not update her beliefs and will not invest since the probability of strong \( A \) is too low. Therefore nobody will invest along the equilibrium path.
References


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