(When) Does Tit-for-Tat Diplomacy in Trade Policy Pay Off?

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Abstract. In international relations, short-run incentives for non-cooperation often dominate. Yet, (external) institutions for enforcing cooperation are hampered by national sovereignty, supposedly strengthening the role of self-enforcing mechanisms. This paper examines their scope with a focus on contingent protection aka tit-for-tat in trade policy. By highlighting various strategies in a (linear) partial-equilibrium framework, we show that retaliation of non-cooperative behavior by limiting market access works as a disciplining device independently of supply and demand parameters. Our theoretical results are backed by empirical evidence that countries more frequently involved in WTO-mediated disputes entailing tit-for-tat strategies pursue on average more liberal trade regimes.

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I. Introduction

Tit-for-tat (TFT) behavior, either in the form of pure TFT or in the form of trigger strategies, has been with human kind for a long time, covering almost every sphere of social life. The purpose of TFT may be twofold: (*i*) in a short-term perspective, it may satisfy a thirst for revenge; i.e. cater to retaliation in the narrow sense of the term; (*ii*) in a long(er)-term perspective, it may be intended to enforce cooperative behavior. The threat of future payoffs forgone in case of non-cooperation is supposed to serve as a disciplining device that ensures cooperation. In particular since the seminal work of Axelrod (1984), TFT has been embraced by many social scientists as an important variant of internal informal institutions and thus a means towards a "market-led" evolution of cooperation – provided, players of the game meet frequently enough so that long-term benefits of compliance outweigh any short-term opportunity costs. In this sense TFT is considered a societal pillar, especially when external (formal) institutions are weak.

In particular in the international realm, non-cooperative behavior is often tempting while enforcement of cooperation is riddled with issues of national sovereignty. Prima facie, the weakness of external (or third-party) institutions strengthens the role of internal institutions, that is, rules of conduct or norms that evolve from within, from the behavior of participants themselves. As such, they typically emerge in decentralized fashion without being imposed by some third party.[1]

Nevertheless, TFT or the threat thereof are not undisputed in the theory of international politics, including trade policy. Since Adam Smith published his "Wealth of Nations" in 1776, the prevalent view among trade theorists has been in favor of unilateralism (that is to adopt a cooperative strategy, no matter what others do) instead of some form of reciprocity (of which TFT is a subcase).[2] The skeptical view may be best summarized by a phrase attributed to Joan Robinson (see Bhagwati & Panagariya 2002): even if others throw rocks into their harbors, there is no reason to throw rocks into your own. From this perspective retaliation just shrinks trade volumes further, which hurts the sender as well as the addressee. Even worse, TFT may give rise to trade wars. The 1930s which saw a spiral of ever-rising trade barriers serve as a frequently cited cautionary tale.

A glimpse into the reality of trade relations tells a different story, with TFT an extensively used policy instrument. Despite many attempts to liberalize markets, both

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[1]In distinguishing external and internal institutions, we draw on Lachmann (1986) whose institutional taxonomy has been subsequently refined by Kasper & Streit (1999).

[2]Notably, this does not apply to what has been dubbed by Bhagwati (1990, 1312 et seq.) "aggressive unilateralism", that is the threat of a country to close its markets for foreign competitors in order to extract trade "concessions" from the other country. See also Silverman (1996) for a critical evaluation.

via multilateral and preferential agreements, protectionism prevails, as does retaliation. While some claims with respect to retaliation surely lack credibility in that they are merely the result of special interests successfully seeking protection rather than echoing market regulation abroad,[3] retaliation is as popular as ever. In fact, when it comes to practical trade policy, it is considered by all means a legitimate instrument in disciplining trade partners and to induce them to comply with the rules of the game as laid down in trade agreements.[4] This applies to the bilateral as well as to the multilateral level. At the bilateral level, TFT clashes even gained momentum with the onset of the economic crisis 2007/2008. The recession led to a temporary surge in beggar-thy-neighbor policies as governments almost everywhere struggled with its consequences.[5] At the multilateral level, the re-active use of protectionism in the sense of enforcing "fair trade practices" and compliance with trade agreements has even been explicitly incorporated in the "acquis multilaterale" ever since its birth. The legitimacy of retaliative measures, although per se not in line with the General Agreement on Tariffs and Trade, is incarnated in Art. IV.10 and IV.11 as well as XXII.7 on countervailing measures and their "appropriateness" in case of a declared breach of WTO obligations. They thus constitute an integral part of the Dispute Settlement Process (DSP) at the WTO.[6]

Rather than a kind of third-party enforcement, the DSP primarily disseminates information on what constitutes a violation of the rules of the game. It increases transparency in strategies, which is crucial for lending credibility to a threat as well as to a promise.[7] In addition, WTO-mediation effectively restricts the strategy set, thus ensuring that TFT strategies are not destructive (cf. Schwartz & Sykes 2002; Bown & Ruta 2010; Bowen 2011). Yet, much like bilateral TFT, WTO-mediated TFT is highly disputed. Stressing credibility aspects, Nzelibe (2005) provides a positive evaluation of retaliation as a means of enforcing international agreements on trade, although, on face of it, a "perverse strategy for enforcing free-trade norms" (p. 215). Others disagree, as for instance, Anderson (2002)

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[3]See, for instance, the evidence collected in Hindley & Messerlin (1996), Bhagwati (2002, Ch.1), or, more recently, Mavroidis et al. (2008).

[4]Retaliation and TFT are actually embedded in the more general principle of reciprocity, in particular in a variant labeled by Keohane (1986) as "specific reciprocity". The principle of reciprocity, however, entails additional facets which we will not explore here. See, for instance Rhodes (1989) for an (affirmative) case study approach on whether reciprocity precipitates cooperation.

[5]See e.g. Evenett (2010a) or Rampell (2009). Although most of the decline in trade cannot be attributed to the surge in protectionism, immediate reactions and experience of the 1930s raised fears of countries becoming increasingly protectionist in response to each other's policy. See Baldwin (2009).

[6]Pelc (2010) examines the legitimacy issue in detail. Referring to the WTO, Prusa & Skeath (2004) find that antidumping measures as well can sometimes be classified as TFT behavior, in particular if directed at countries that formerly sued the respective country now claiming a case of antidumping. However, since the TFT motive is one out of four reasons and by far not the most frequent one, we will not dwell on the peculiarities of antidumping procedures.

[7]Cf. Schelling (1960); Myerson (2009). As discussed in Kono (2007), the DSP does not change the basically anarchic nature of international politics in a substantial way but merely affects its efficiency.

who considers WTO-mediated retaliation more of an obstacle rather than a stepping stone to trade liberalization.[8]

Contrary to the unilateralism proposed by traditional trade theory, eclectic evidence thus suggests that TFT is an important policy instrument indeed, both, in the form of unilateral "self-help" and multilateral "backing". This paper therefore looks at the issue of the re-active protectionism through the prism of Axelrod's TFT strategy. Is there a chance of self-enforcing trade liberalization incorporating TFT behavior? If so, can we identify crucial parameters for trade liberalization to obtain? Is a benevolent attitude on the players' side essential (as assumed in Axelrod & Hamilton, 1981, and Axelrod, 1984)? Or can we do without this assumption (as in Smith, 1982, and Sugden, 1986) – and nevertheless identify retaliation as key to sustaining cooperation in trade policies? What does the empirical evidence tell us upon closer inspection?

While questions like these have been explored in the abstract as well as in experimental studies, self-enforcement via TFT has been much less frequently applied to trade issues. Melese et al. (1989) were among the first to explicitly model the payoffs and thus the incentive-compatibility of TFT with trade. They found that, theoretically, TFT erodes the (politically) optimal tariff rate. Despite deserving credit for being one of the first studies incorporating the idea of Axelrod in an explicit trade model, tariffs in their model are solely motivated by the revenue objective. Since their analysis assumes a small open economy, redistribute effects are moreover exclusively within-country, i.e. from consumers to producers. Retaliation abroad exclusively works through a demand channel, thus lowering incomes and thereby the potential for redistribution. However, when it comes to current trade conflicts, the threat of retaliation is more about market access. According to evidence gathered together by Bown (2009) retaliation is directed towards mobilizing the defecting countries' export industries, thereby pushing for political change within the defecting country. Bagwell & Staiger (2002), as well, explored the impact of reciprocity and tried to provide an economic explanation of the WTO dispute settlement.

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[8]Lawrence (2003) is also critical of WTO-mediated TFT, although he does not condemn retaliation under the roof of the WTO per se. By focusing on TFT under the auspices of the WTO we do not examine what proliferates to international treaties, i.e. the economics of treaty formation, ratification and adherence and whether TFT may contribute thereto (see e.g. Sandler 2008). Nor do we explore the seemingly related question of whether WTO membership boosts trade (e.g. Rose 2004; Tomz et al. 2007; Subramanian & Wei 2007; Felbermayr & Kohler 2010; Eicher & Henn 2011), as we do not compare the WTO with outside options. Besides the unilateralism-versus-TFT controversy some critics of TFT in trade policies point out that it injures "innocent" exporters (taking them quasi as hostages), and comes – at least in the short run – at the expense of consumers. However, our aim is not to discuss whether there are alternative strategies that may provide a better means to the end. Therefore, we also cast aside considerations of compensation, "bribes", bundling of issues etc., matters which are extensively discussed in Guzman (2008), Limão & Saggi (2008), Martin & Vergote (2008), and Sykes (2010).

However, unlike Bown, they suppose that trade policy is primarily driven by terms of trade considerations (see also Broda et al. 2008; Ludema & Mayda 2010). In their analysis, the WTO serves to avoid a prisoner's dilemma and thus a Hobbesian state as otherwise countries competitively try to twist the terms of trade in their favor. Yet, as alluded to previously, when tracking WTO-talk as well as trade conflicts in general it is market access that is at the heart of trade policy issues.[9] Although Bagwell & Staiger (2010a) claim that their analysis may be translatable into matters of market access, they do not provide an explicit special-interest model. Liu (2008) examines the evolutionary stability of trade policies; here, as well, the question of market access is neglected, as are consumers.

We explicitly model TFT in international trade policy as possible internal mechanism leading to cooperation. Unlike Melese et al. (1989) who draw on the work of Johnson (1954) and others, we suppose that markets are characterized by imperfect rather than perfect competition, so that the threat of retaliation works through limiting the access for producers to markets abroad, thereby affecting profits. In emphasizing imperfect competition, our basic setup stands in the tradition of partial equilibrium analysis of protectionism in the presence of imperfect competition as it has been established in particular by Brander & Spencer (1981; 1984). However, although being related to this class of models, it features a couple of tweaks in order to obtain closed form solutions that are more easily to interpret and to handle in a recursive setting so as to allow to track down the evolution of (non-)cooperation. Despite being geared towards issues of market access our model nevertheless does not completely blind out terms-of-trade issues, which always pop up with imperfect competition (see, e.g., Bagwell & Staiger 2010b). In addition to the theoretical examination we investigate TFT in trade policy empirically. In order to track down how TFT affects cooperation, we create a new, unique, data set based on information from the WTO dispute settlement gateway, the Heritage foundation, and the Penn World Tables. The results of the econometric estimation support our theoretical findings: at the end of the day, countries that have been more often involved in TFT retaliation pursue a more open trade regime.

Consequently, the paper comes in two parts. In Section II, we lay out a theoretical model for examining the impact of TFT on the average level of protection. This

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[9]See Evenett (2010b) on market access and WTO-sanctioned retaliation; and Magee & Magee (2008), Mrázová (2011), as well as Ossa (2011) for a critique of terms of trade as the primary concern of trade policy. We thus reside more with the protectionism rather than the terms-of-trade story of trade agreements in the classification of Regan (2006) who also criticizes the latter on methodological and empirical grounds, though from a international law perspective. Ethier (2007) argues that the terms-of-trade story is inconsistent with reality, as, in effect, multilateral agreements do not prevent countries from pursuing terms-of-trade objectives. Accordingly, they cannot be the sole reason for them.

Section is divided into four Subsections. First, we present the basic model; second, we introduce TFT; third, we explore TFT trigger strategies, including an examination of WTO-mediated TFT; and, fourth, we explore matters of stability. In Section III, we present the empirical analysis in support of our theoretical results. Section IV concludes.

II. A Theory of TFT in Trade Policies

1. The Basic Model

Suppose people have preferences over the consumption of three sorts of goods: a numéraire c_0 supplied in perfect competition and two sorts of monopolistically supplied goods c_1, c_2. Qua assumption, one of the monopolistically supplied goods (with subscript 1) is produced domestically while the other (with subscript 2) is imported. The latter is possibly subject to trade barriers applied by the Home country, while the former is vulnerable to retaliation by the Foreign country.

Notwithstanding difficulties of aggregation, preferences in Home respectively Foreign are of the following kind:

$$(1) \quad U = c_0 + \alpha \left(c_1 + c_2 \right) - \frac{\beta}{2} \left(c_1^2 + c_2^2 \right); \quad U^\star = c_0^\star + \alpha \left(c_1^\star + c_2^\star \right) - \frac{\beta}{2} \left((c_1^\star)^2 + (c_2^\star)^2 \right)$$

with α, β parameters, c_0, c_1, c_2 quantities consumed in Home and $c_0^\star, c_1^\star, c_2^\star$ respective quantities consumed in Foreign. Variables referring to Foreign are indicated by an asterisk throughout (except for policy parameters t, T). Now suppose that Home imposes a specific tariff t on imports (T in Foreign). Then, utility is maximized subject to constraints $Y = c_0 + p_1 c_1 + (p_2 + t) c_2, Y^\star = c_0^\star + (p_1^\star + T) c_1^\star + p_2^\star c_2^\star$ in Home and in Foreign respectively with aggregate incomes $Y, Y^\star$ taken as given in partial equilibrium. If producers are able to price discriminate between consumers at home and abroad, prices net of tariffs $p_1, p_1^\star$ ($p_2, p_2^\star$) may differ.[10] Utility maximization subject to these constraints thus yields demand for the three types of goods

$$(2) \qquad \begin{aligned} c_0 &= \ Y - p_1 c_1 - (p_2 + t) c_2 \qquad c_0^\star = Y^\star - (p_1^\star + T) c_1^\star - p_2^\star c_2^\star \\[4pt] c_1 &= \ \frac{\alpha - p_1}{\beta} \qquad\qquad c_1^\star = \frac{\alpha - (p_1^\star + T)}{\beta} \\[4pt] c_2 &= \ \frac{\alpha - (p_2 + t)}{\beta} \qquad c_2^\star = \frac{\alpha - p_2^\star}{\beta} \end{aligned}$$

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[10]In assuming that markets are segmented we follow much of the literature on economic policy and intra-industry trade. See Brander & Spencer (1984:201) for a discussion of the segmentation-hypothesis.

In order to simplify the analysis, production is in any case considered to take place along a linear 1:1 input-output production function. Consequently, profits of the monopolistic firm are $\pi_1 = p_1 c_1 + p_1^\star c_1^\star - (c_1 + c_1^\star)$ (analogous in Foreign). Profit maximization subject to demand functions (2) then implies that producers of the goods indexed 1 and 2 in Home and in Foreign indeed charge different prices $p_1, p_1^\star$ ($p_2, p_2^\star$) net of tariffs, depending on whether the goods are consumed domestically or shipped abroad

$$
(3) \qquad\qquad p_1 = \frac{\alpha + 1}{2} \qquad p_2 = \frac{\alpha + (1 - t)}{2}
$$
$$
p_1^\star = \frac{\alpha + (1 - T)}{2} \qquad p_2^\star = \frac{\alpha + 1}{2}
$$

Since $\partial p_2 / \partial t = \partial p_1^\star / \partial T = -1/2$, part of the tariff is rolled back onto the producers while the other part is rolled forward and thus paid by consumers. Inserting prices (3) into demand functions (2) yields demand depending on structural parameters α, β and policy parameters t, T

$$
(4) \qquad\qquad c_1 = \frac{\alpha - 1}{2\beta} \qquad c_1^\star = \frac{\alpha - (1 + T)}{2\beta}
$$
$$
c_2 = \frac{\alpha - (1 + t)}{2\beta} \qquad c_2^\star = \frac{\alpha - 1}{2\beta}
$$

In any case, consumption decreases in tariffs t, T. However, on face of it, domestic profits are not affected by tariffs on imports.[11] Things change though once we allow for Foreign to retaliate in case Home imposes tariffs. If so, tariffs do bite into profits of domestic producers, which may induce cooperative behavior in tariff policies in a basically non-cooperative setting (see also Hungerford 1991 on the issue of cooperative behavior in non-cooperative settings). They thus reflect the market access aspect frequently alluded to in actual trade policy conflicts.

Before examining retaliation in detail, we consider first a one-shot game in which trade policy simply sets tariffs in a non-cooperative manner. With supply and demand as outlined previously, this thought experiment implies the traditional prisoner's dilemma. Supposing that tariff revenue is redistributed to consumers in lump-sum fashion, policy makers may – as in standard trade policy models from the Brander-Spencer strand – focus on maximizing the trade policy impact on consumer surplus (CS), tariff revenue (tc_2) and

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[11]In this aspect we follow findings by Sherman (2002) according to which trade policy is very much the outcome of domestic producers lobbying for market access abroad and a response to other countries' trade policies rather than simply the outcome of national interest groups lobbying for protection.

profits (π_1). The policy makers' objective function V is then

$$(5) \qquad V = CS + tc_2 + \pi_1 = \alpha \left(c_1 + c_2 \right) - \frac{\beta}{2} \left(c_1^2 + c_2^2 \right) - p_2 c_2 + p_1^\star c_1^\star - \left(c_1 + c_1^\star \right)$$

Analogous for Foreign with $V^\star = CS^\star + Tc_1^\star + \pi_2^\star$. Fig. 1 displays the payoffs V, $V^\star$ associated with strategies $t = 0, t$; $T = 0, T$ as functions of trade policies t and T and trade parameters α, β (with A Home and B Foreign).

< Figure 1 about here >

The first entry in each cell refers to Home, the second to Foreign. Inserting demand and prices according to (2) and (3), tariffs are thus set so as to equilibrate the marginal loss in consumer surplus (LHS) and the price reduction on imports (RHS).

$$(6) \qquad t\frac{\partial c_2}{\partial t} = \frac{\partial p_2}{\partial t} c_2 (Home); \quad T\frac{\partial c_1^\star}{\partial T} = \frac{\partial p_1^\star}{\partial T} c_1^\star (Foreign)$$

With $\partial c_2 / \partial t = -1 / \left(2\beta \right)$ and $\partial p_2 / \partial t = -1/2$, the first order condition (6) yields

$$(7) \qquad \tilde{t} = \frac{\alpha - 1}{3}; \quad \tilde{T} = \frac{\alpha - 1}{3}$$

for the Nash equilibrium. Inserting $\tilde{t}, \tilde{T}$ into payoffs of Fig. 1 yields payoffs as a function of parameter values α, β only. Fig. 2 presents outcomes accounting for Nash equilibria.

< Figure 2 about here >

Notably, the ranking of strategies is *independent* of parameter values α, β, thus supporting *in any case* the traditional prisoner's dilemma: from Home's perspective, Cell II $\succ$ Cell I, since $19 \left(\alpha - 1 \right)^2 / \left(24\beta \right) > 3 \left(\alpha - 1 \right)^2 / \left(4\beta \right) \wedge$ Cell IV $\succ$ Cell III, since $47 \left(\alpha - 1 \right)^2 / \left(72\beta \right) > 11 \left(\alpha - 1 \right)^2 / \left(18\beta \right) \ \forall \ \alpha > 1, \beta > 0$, for given strategies $T = 0, T = \tilde{T}$ (vice versa from the perspective of Foreign). Hence, strategies $t = \tilde{t}$, $T = \tilde{T}$ are dominant sustaining the prisoner's dilemma, no matter what the exact numerical values of α and β. Suppose, for example, that $\alpha = 4$; $\beta = 0.5$, so that $t^\star = T^\star = 1$. Then players attain payoffs $(13.5; 13.5)$ in Cell I, $(14.25; 11)$ in Cell II, $(11; 14.25)$ in Cell III, and $(11.75; 11.75)$ in Cell IV. Provided each player takes the other player's strategy as given, both of them thus wind up in Cell IV, despite payoffs being clearly lower than in Cell I.

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2. Sustaining Cooperation in Trade Liberalization via TFT?

However, a strategy of TFT may pay off – and, interestingly, it may pay off independent of actual parameter values α and β. It indeed turns out to be the best reply to itself as long as both parties face each other frequently enough in trade policy conflicts.

Suppose the opposite number plays TFT. Theoretically, then, there are three strategies for Home to respond. Home's policy makers can

1. adopt TFT as well, that is either impose a tariff of $t = \tilde{t} = (\alpha - 1)/3$ or eliminate tariffs altogether, provided the opposite party did so previously. This behavior yields an expected pay off $E\,(TFT, TFT)$;

2. defect all of the time, which means that they impose a tariff of $t = \tilde{t} = (\alpha - 1)/3$ no matter what. Following this policy, they achieve an expected pay off $E\,(D, TFT)$;

3. alternate between defect and cooperate, i.e. $t = \tilde{t} = (\alpha - 1)/3$ and $t = 0$ respectively. The resulting expected payoff is denoted $E\,(D, TFT; C, TFT)$.

All other options turn out to be subcases of these three strategies (see Axelrod & Hamilton 1981: 1393 on the exhausting capacity of these strategies, however, without reference to trade policy conflicts). Provided the probability of the policy makers facing each other again is in any case q, Home can expect the following pay offs in case of strategies one to three:[12]

$$
(8) \quad E\,(TFT, TFT) = \frac{3\,(\alpha - 1)^2}{4\beta}\frac{1}{(1 - q)}
$$

$$
E\,(D, TFT) = \frac{(6\alpha^2 - 12\alpha + 2\alpha t - 3t^2 - 2t + 6)}{8\beta}
$$
$$
+ \frac{(6\alpha^2 - 12\alpha + 6 + 2\alpha t - 2t - 3t^2 - 4\alpha T + 2T^2 + 4T)}{8\beta}\frac{q}{(1 - q)}
$$
$$
= \frac{6\,(\alpha - 1)^2 + t\,(2\alpha - 3t - 2) - 2Tq\,(2\alpha - T - 2)}{(1 - q)\,8\beta}
$$

$$
E\,(D, TFT; TFT, D) = \frac{(6\alpha^2 - 12\alpha + 2\alpha t - 3t^2 - 2t + 6)}{8\beta}\frac{1}{(1 - q^2)}
$$
$$
+ \frac{(3\alpha^2 - 6\alpha - 2\alpha t + t^2 + 2t + 3)}{4\beta}\frac{q}{(1 - q^2)}
$$

Comparing expected results with policies $\tilde{t} = \tilde{T} = (\alpha - 1)/3$ shows that TFT outperforms all other strategies if the probability of facing each other again in a similar setting is higher

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[12]In order to focus as closely as possible on the trade policy aspects in the incentive for cooperation and for ease of demonstration, we refrain from including the pure time component in discounting future pay offs – especially since, in principle, this issue is already accounted for in the probability of facing each other again.

than $q = .3$ since

$$(9) \qquad E\left(TFT, TFT\right) > E\left(D, TFT\right) \qquad\qquad \forall q > .3$$

$$and$$

$$E\left(TFT, TFT\right) > E\left(D, TFT; TFT, D\right) \qquad\qquad \forall q > .3$$

< Figure 3 about here >

Notably, numerical values for β are *irrelevant* in strategy space, as are those for α. They do not matter, despite the fact that the non-cooperative tariff policy eq.(7) *does depend* on the actual parameter value of α. Take for instance the previous numerical example of $\alpha = 4$, $\beta = 0.5$: in this case, Home can expect a pay off of $13.5/\left(1 - q\right)$ (scenario 1), $14.25 + 11.75q/\left(1 - q\right)$ (scenario 2) and $\left(14.25 + 11q\right)/\left(1 - q^2\right)$ (scenario 3). However, as displayed in Fig. 3, scenario 1 outweighs scenario 2 for all probabilities $q > .3$, as is the case with respect to scenario 3. This result corresponds to Axelrod & Hamilton (1981, p. 1393). Hence, their result (based on a generalized prisoner's dilemma) also applies to the particularities of trade policies and trade conflict.[13]

3. TFT trigger strategies

Results of the previous paragraph rest on the assumption that at least one of the participants in the trade conflict is benevolent in the sense that he always starts with a friendly strategy. His strategy becomes protectionist only in case the cooperative behavior is not honored and thus disappointed ("re-active protectionism"). This is the classic assumption in Axelrod. However, this assumption may hold true or not. In order to account for this fact we will in a next step allow for the possibility that policy makers defect right from the beginning by imposing a duty of $t = \tilde{t}$, $T = \tilde{T}$, thereby triggering a strategy of either cooperation or defection. Fig. 4 collects payoffs.

< Figure 4 about here >

As in the previous paragraph, expected payoffs of strategies $(t = 0$, trigger); $(T = 0$, trigger) displayed in Cell I clearly outperform those of Cell II if the probability of meeting

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[13]Axelrod & Hamilton show that the probability q of agents facing each other again in a similar situation must comply with $q \geq$ (Cell II - Cell I)/(Cell II - Cell IV) $\wedge$ $q \geq$ (Cell II - Cell I)/(Cell I - Cell III) in order to induce cooperation. Inserting pay offs of Fig. 1 with $\tilde{t}$ and $\tilde{T}$, cooperation in trade policies is sustained for all values of $q > 0.3$, as is the case according to (9).

again is $q > .3$ since

$$\frac{3(\alpha - 1)^2}{4\beta} \cdot \frac{1}{(1-q)} > \frac{(57 - 10q)(\alpha - 1)^2}{72\beta} \cdot \frac{1}{(1-q)}$$

Comparing pay offs of Cells IV and III and Cells II and IV always yields rankings Cell II $\succ$ Cell IV $\succ$ Cell III since $0 < q < 1$

$$\frac{(57 - 10q)(\alpha - 1)^2}{72\beta} \cdot \frac{1}{(1-q)} > \frac{47(\alpha - 1)^2}{72\beta} \cdot \frac{1}{(1-q)}$$

$$\frac{47(\alpha - 1)^2}{72\beta} \cdot \frac{1}{(1-q)} > \frac{(44 + 3q)(\alpha - 1)^2}{72\beta} \cdot \frac{1}{(1-q)}$$

However, even though Cell I outperforms the rest provided $q > .3$, there is a probability to meet a type of player of this sort or not. Call this Q and assume in a first step that Q were exogenously given. In this case, a trigger strategy pays off if

(10)
$$Q\frac{3(\alpha - 1)^2}{4\beta}\frac{1}{(1-q)} + (1 - Q)\frac{(44 + 3q)(\alpha - 1)^2}{72\beta}\frac{1}{(1-q)}$$
$$> Q\frac{(57 - 10q)(\alpha - 1)^2}{72\beta}\frac{1}{(1-q)} + (1 - Q)\frac{47(\alpha - 1)^2}{72\beta}\frac{1}{(1-q)}$$

Solving for Q yields

(11)
$$Q > \frac{3}{7}\frac{(1-q)}{q}$$

with $\partial Q/\partial q = -3/(7q^2) < 0$. Hence, sufficiently high probabilities are again *independent* of parameters α, β. Moreover, the probability of meeting someone who starts out friendly Q and probabilities q of facing a particular player again are negatively related with respect to cooperation: the higher the fraction Q of players starting out friendly, the lower may be the probability q of facing the same player again with cooperation nevertheless sustained and vice versa. Fig. 5 displays all situations (that is combinations of Q, q) which are capable of sustaining cooperation (see the shaded area in the upper right hand corner).

< **Figure 5 about here** >

4. Stability of TFT in Trade Policies

It cannot be ruled out that some players aka countries do not follow TFT starting cooperatively. This brings matters of evolution to the forefront: will the subset of cooperative

TFT countries prevail or will the share of countries defecting grow in time thus leading to a "trade war"? In order to track changes in the frequency of strategies suppose that countries will adopt the strategy which, on average, yields a higher pay off. This essentially amounts to endogenizing Q. Let $E(V_c)$ and $E(V_d)$ denote the expected pay offs in case of a cooperative and a non-cooperative (i.e. defective) strategy respectively. The former group is initially represented in the world with frequency Q, the latter with frequency $(1-Q)$. Since a country following a cooperative TFT (trigger-) strategy may thus encounter a country behaving cooperatively or non-cooperatively with probability Q and probability $(1-Q)$ respectively, the expected pay off from her strategy is $E(V_c) = QV(t=0, trigger; T=0, trigger) + (1-Q)V(t=0, trigger; T=\tilde{T})$. By analogy, non-cooperative behavior yields an expected pay off $E(V_d) = QV(T=\tilde{T}; t=0, trigger) + (1-Q)V(T=\tilde{T}; t=\tilde{t})$. Hence, on average, the pay off is $E(\overline{V}) = QE(V_c) + (1-Q)(V_d)$. If the probability dynamics is related to how the particular strategy performs relative to the average according to $Q' = QE(V_c)/E(\overline{V})$ and $(1-Q)' = (1-Q)E(V_d)/E(\overline{V})$, any strategy that does better than the average can be expected to be adopted by an increasing number of countries as $\Delta Q = Q(E(V_c) - E(\overline{V}))/E(\overline{V}) > 0$ if $(E(V_c) - E(\overline{V})) > 0$ and $\Delta(1-Q) = (1-Q)(E(V_d) - E(\overline{V}))/E(\overline{V}) > 0$ if $(E(V_d) - E(\overline{V})) > 0$. Inserting values for both strategies according to Fig. 5 shows that the cooperative TFT (trigger-) strategy outperforms its alternative for all Q meeting condition (11). Consequently, if Q attains this critical mass, countries will consider switching to the cooperative TFT trigger strategy, as indicated by the arrow in Fig. 5 at point Z. In this case the so-called replicator dynamics thus contribute to cooperation as the fraction of countries Q following a cooperative TFT (trigger-) strategy grows through time.

< Figure 6 about here >

Though on face of it perverse and in contrast to much of traditional trade theory calling for unilateral trade liberalization, tit-for-tat diplomacy can indeed foster world wide trade liberalization. This applies to all values of Q within the shaded area of Fig. 5. Figure 6 shows the Q-dynamics for two examples. Supposing that $q = 0.5$, the upper branch starts at $Q = 0.5$, the lower branch at $Q = 0.25$. For $Q = 0.5$, the share of countries that follow a cooperative TFT (trigger-) strategy converges to $Q = 1$ whereas for $Q = 0.25$ it converges to $Q = 0$.

III. Empirical Analysis of WTO-mediated TFT

Before investigating the impact of countries' TFT behavior on their level of protection empirically, we distill a narrow hypothesis subsuming the core findings of the theoretical section. The hypothesis can serve as guideline for the econometric analysis below. In a nutshell, our theory argues that countries that have been involved more often in trade conflicts (as mediated by a higher q or Q) provide a more liberal trade regime.

1. Meeting the Data

In order to investigate the relation between TFT behavior under the roof of the WTO and trade liberalization empirically, we constructed a unique data set using information from the WTO Dispute Settlement Gateway, the economic freedom indices (provided by the Heritage Foundation, 2010) and the Penn World Tables. The WTO carefully collects all trade disputes that arise between their member countries within its Dispute Settlement Database. It lists the date a trade conflict surfaced, the matter in dispute and the countries involved as complainants or respondents. Based on this information, we build variables that meet our theoretical specification. The theoretical framework suggests that frequencies q, Q are of utmost importance which may be operationalized by the number of trade conflicts a country has been involved in. Thus, counting the WTO information up to a specific year, we obtain three variables: "total" (i.e. capturing all trade conflicts a country has been involved in), "complainant" (i.e. capturing the number of trade conflicts where a country acts as complainant), and "respondent" (i.e. reporting the number of conflicts a country is in the position of being respondent). These variables are used as proxies for the countries' TFT behavior.[14] In order to focus on the level of protection, we use the "trade freedom index", calculated by the Heritage Foundation. The Heritage Foundation provides ten indices measuring different components of economic freedom, inter alia trade freedom, labor freedom, fiscal freedom, or investment freedom, assigning each of them a grade between 0 and 100. The trade-freedom index measures the absence of tariff and non-tariff barriers that affect exports and imports of goods and services. In order to control for different macroeconomic aspects we enrich the data with information from the Penn World Tables, including the population of a country, real GDP per capita,

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[14]Note that all three variables may represent TFT behavior. However, the variable that is the most direct proxy of what our theoretical section considered as TFT is "complainant". "Complainant" captures protectionist reactions to trade violations very directly, whereas "respondent" captures all trade violations, including those that may not have the character of retaliation. Yet, who is responsible for having raised a quarrel is sometimes already in dispute, as for instance is demonstrated in the Airbus-Boeing conflict.

as well as the consumption, the investment, and the government share in GDP.[15]

In combining the data and generating the needed variables, our data set contains annual country-level information (restricted to WTO members for the years 1995 to 2010) on the trade freedom (that is how liberal the trade policy of a country is), the number of trade conflicts the country has been involved in (distinguishing between total conflicts, being complainant, or being respondent), the population, GDP per capita, and the consumption, investment, and government share in GDP.

2. Descriptive Statistics

Before starting with the econometric analysis we will highlight the most important aspects by describing the data in more detail. The trade conflicts in the WTO Dispute Settlement Gateway are listed chronologically since 1995. The Dispute Settlement Gateway provides information about the date the dispute was requested, the complaining country, the respondent country, and the matter in dispute. In order to create our dispute variables we summed up the disputes by country over time, distinguishing between countries acting as complainants, as respondents, as well as their total involvement in disputes. A first descriptive overview of the "dispute variables" is given in Table 1.

< Table 1 about here >

Table 1 shows that 71 countries have been involved in disputes (until 2010). Among them, there are 23 high-income economies (real GDP per capita > 20,000) and 29 low-income economies (GDP per capita < 10,000). On average, a country is involved in 20 "total disputes" (either as complainant or as respondent), appears around 15 times as complainant and around five times as respondent. High-income economies are on average more often involved in disputes then low-income economies. Calculating the difference between the appearance as complainant and respondent, the table shows that on average, a country is 10 times more often complaining a dispute than acting as respondent.

Table 2 displays the number of trade disputes in which a sample of selected countries has been involved until 2010. As can be seen, the EC (240 total disputes) and the US (228 total disputes) are involved in the highest number of disputes. China and India, by contrast, have only been involved in 32 and 60 disputes respectively. The difference

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[15]The original data sets are freely available at *i)* the WTO Dispute Settlement Gateway http://www.wto.org/english/tratop_e/dispu_e/dispu_e.htm, *ii)* the website of the Heritage Foundation http://www.heritage.org/index/ which also provides a rich descriptive explanation of the indices, and *iii)* the Penn World Tables website http://pwt.econ.upenn.edu/index.html.

between acting as complainant or respondent varies substantially from country to country. While the EC was 92 times more often complaining then responding, the US are relatively often acting as respondent and thus, only have a difference of 12.[16]

< **Table 2 about here** >

Shifting the focus on the trade-freedom index (capturing information on the countries' trade policy), we can keep the descriptive story short since the Heritage Foundation already provides a comprehensive set of descriptive statistics. However, just to give a short impression of the variable used, Table 3 presents a descriptive summary.

< **Table 3 about here** >

According to this data, countries have on average a trade-freedom index of around 78 percent, with variation between 45 and 90 percent. High-income economies show on average a much higher trade freedom index than low-income economies. Considering specific countries, Table 4 shows that the EC, the US, but also Canada or Australia score comparatively high in terms of trade-freedom with 85 percent or higher. China and other developing economies, by contrast, exhibit a much smaller index value.[17]

< **Table 4 about here** >

Before regressing the country's trade freedom on its disputes and other control variables, we present some scatter plots, providing a first impression of the relationship. Fig. 7 plots trade freedom on the different dispute variables and draws the line of fitted values. As we can see, besides a bulk of countries exhibiting no disputes, there is a slight, but positive relation between being involved in a trade dispute and overall trade freedom. Note that the y-axis is scaled from 0 to 100 and thus covers a lot of ground: the slope looks quite small, but it is actually around 15 to 20 percent.[18]

< **Figure 7 about here** >

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[16]The evolution of the sample of countries that are involved in trade disputes over time is displayed in Fig. 8, 9, 10, and 11 in the Appendix.

[17]Fig. 12 in the Appendix shows the trade-freedom index for a sample of economies over time.

[18]Fig. 13, 14, and 15 in the Appendix present the scatter plots for a sample of countries.

3. Econometrics: How Tit-For-Tat in Trade Policy
Affects Trade Liberalization

In this section, we investigate the core hypothesis distilled from the theoretical examinations empirically: Are countries that face each other more frequently in trade disputes pursuing a more liberal trade policy? Does the number of trade disputes a country is involved in increase the trade freedom of that country? In order to investigate these questions econometrically we start as a first step with a pooled analysis using the standard OLS-estimator, regressing

$$(12) \qquad \text{Trade Freedom}_i = \beta_0 + \beta_1 \text{Disputes}_i + \gamma X_i + \epsilon_i$$

with "Trade Freedom" of country i as endogenous variable, "Disputes" as explanatory variable of interest, X as a matrix capturing different macroeconomic control variables, and an error term ϵ. As "Disputes" we focus on the three different variables created on the basis of the WTO dispute settlement data: (i) "total disputes" capturing any dispute a country has been involved in, (ii) "complainants" observing how often a country acts as complainant, and (iii) "respondents" capturing how often a country has been accused of illegitimate protectionist measures. As macroeconomic control variables we include the population of a country, real GDP per capita, as well as the consumption, the investment, and the government share in GDP. Additionally, we include a dummy controlling for the lowest-income economies, since they are usually not attacked via retaliation.[19] With respect to the dispute variables we are able to neglect any endogeneity problem: by counting the number of disputes up to a specific year, the variables ensure a pure exogenous influence on trade freedom, that is the index observed at that specific year. However, concerning the macroeconomic control variables, an interdependent relation with the contemporaneous trade freedom index could lead to endogeneity problems and thus, to biased estimation results. In order to test whether possible endogeneity could significantly affect estimation results, Durbin-Wu-Hausman tests are applied. Results show that the only variable where an endogenous structure might cause problems is the population of a country. Thus, we use the lagged version of that variable (indicated by "lag") as instrument to avoid possible endogeneity problems. In order to consider possible outliers and to ensure the consistency and the comparability of the results, the variances of the models are estimated using the

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[19]Lowest-income economies are identified using the World Bank country classification, which draws on the World Bank Atlas Method (http://data.worldbank.org/about/country-classifications).

Huber / White / Sandwich estimator instead of the traditional calculation.

In a first step, we decided to pool the data since this form of analysis meets the core of our theoretical suggestions according to which the number of trade conflicts a country has been involved exhibits a positive effect on its trade regime "at the end of the day" (or at the end of a specific time period). Table 5 presents the results.[20]

< **Table 5 about here** >

Columns (1), (2), and (3) summarize results from the first bivariate estimations. By regressing the endogenous variable trade freedom on the different dispute variables, the same pattern emerges as expected from the scatter plots presented in the descriptive section above. Being involved in a larger number of trade disputes leads to an overall higher trade freedom of a country. The effect is highly statistically significant at the level of 1 percent. This holds for all three dispute variables. Simply controlling for the dispute variables can already explain up to around eight percent of the overall variance of the models. Columns (4), (5), and (6) present the results after controlling for several macro variables. With the control variables, the explained variance of the regressions rises up to 45 percent. As can be seen from the columns, the results confirm the positive effect achieved in the first bivariate regressions, however, with small differences between the dispute variables. While being involved in a large number of total disputes as well as acting often as complainant significantly increase the country's level of trade freedom, being respondent also has a positive effect, however, with a t-value of .90 slightly outside the usual reported range of statistical significance. Considering the control variables, it can be seen that GDP per capita as well as the consumption, investment and government share in GDP affect trade freedom of a country significantly positive, whereas the population of a country has a significant negative effect.[21] These results support the core suggestion of our theoretical model: the more often a country is involved in trade disputes, the more liberal is its trade policy.[22]

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[20] It is important to note that this form of analysis counts the number of conflicts, but does not account for their duration. However, since the dispute settlement gateway of the WTO clearly links complainants, respondents, and countries that join the conflict, the data assures that a conflict is not counted twice, even if it may last for several years.

[21] We additionally ran regressions replacing population by the countries' real GDP. As population, real GDP has a significant negative effect on trade freedom. Results of the dispute and the other control variables do not change when replacing population by real GDP (neither in sign, nor in significance).

[22] In order to assess the economic importance of the estimated effects, we also conducted the analysis for the standardized beta coefficients. Even when being not the most important effects, results show that the dispute variables are economically relevant. A one standard deviation increase of variable complainant e.g. decreases trade freedom by .08 standard deviation.

Interesting results also emerge when distinguishing countries according to income levels. Columns (1), (2), and (3) of Table 6 present results. As estimation procedure we follow an interaction-variable approach, interacting the income level of a country with the respective dispute variables. As the countries' income levels we consider low income (less than 10,000 GDP per capita), middle income (between 10,000 and 20,000 GDP per capita), and high income (more than 20,000 GDP per capita). Results for total disputes (column 1) show that, in general, being involved in a larger number of trade disputes increases the country's trade freedom. The increase is highly significant at the five-percent level for low-income economies. For middle-income and high-income economies, the increase is also positive, but to a lower extent and lower levels of statistical significance (for middle-income economies with a t-value of 1.42, the effect lies slightly outside the significant ten-percent range usually reported). A similar pattern emerges also for the dispute variable complainant (column 2). There, being involved in TFT conflicts increases the trade-freedom index at high levels of statistical significance for countries of all income levels. For being respondent (column 3), we do not achieve these strong significant positive effects. The macroeconomic control variables are robust in tendency and significance, as presented in Table 5 and discussed above. Overall, these results show that the lower the income level of a country, the stronger and the more significant is the positive effect of the amount of trade disputes on trade freedom.

< **Table 6 about here** >

Another interesting effect appears when considering whether the number of trade disputes a country has already been involved in is relatively low or relatively high. This is a first step toward the investigation of the dynamics of the dispute process. Columns (4), (5), and (6) of Table 6 present the results. In this respect, "low" interacts the respective dispute variable with countries that only had a low number of disputes in the past (less than 5 disputes), "middle" characterizes countries having been involved in 5 to 20 disputes, and "high" refers to countries with more then 20 disputes. Results again show that on an overall account being involved in trade disputes increases the trade freedom of a country. However, if the country has not yet been involved in too many disputes (that is "low"), the positive effect has the largest magnitude and mostly also a higher level of significance. Similar for being respondent: the effect is significant positive for countries not being involved in too many disputes yet, though the effect is not statistically significant for countries already being involved in more disputes (what is the reason behind the overall

insignificant effect in column (6) of Table 5). Results of the pooled regressions presented in Tables (5) and (6) directly support the core findings of our theoretical model: countries that have been involved in a larger number of trade disputes in the past provide a more liberal trade regime. The effect is stronger and more significant for low-income economies and for countries not having been involved in too many disputes yet.

Within a next set of estimations we take the panel structure of our data into account. This may be a first step toward examining the dynamics of the process: How does the trade-freedom index change, if countries are involved in additional disputes? However, consider that this kind of analysis slightly deviates from the core of our theoretical findings (that countries more often involved in trade disputes provide in the long run a more liberal trade regime). In order to consider the panel structure, we regress

$$(13) \qquad \text{d Trade Freedom}_{it} = \beta_0 + \beta_1 \text{d Disputes}_{it} + \beta_2 \text{time}_t + \gamma dX_{it} + v_i + \epsilon_{it}$$

with "Trade Freedom" as the endogenous variable and "Disputes" as one of our dispute variables. The exogenous variable "time" captures the time trend and the macroeconomic control variables are represented by matrix X. Possible unobserved heterogeneity is captured by v_i. Thus, ϵ is a usual error term. The "d" before the variables indicates that we use percentage changes here (instead of the level approach in the pooled regression presented above). Consider that the exogenous variables of interest (the dispute cases) are in a counted form. Therefore, the fixed or random effect estimator that investigates the time variation within each cross section, may lead to objectionable results. In order to assess the variation between the cross section observations, we use the between-effects estimator. Table 7 presents the results. All the variables are in percentage changes except the dispute variables, capturing absolute changes since they are in a "count-data" form.

< **Table 7 about here** >

Results show that the effects are similar to the pooled case. In columns (1), (2), and (3), a positive tendency emerges for the dispute variables, indicating that an increase in disputes increases the trade freedom index. However, not at statistical significant levels. In columns (4), (5), and (6), the dispute variables are again interacted with the income levels of the countries. As in the pooled analysis, disputes increase the trade freedom index statistically significant for low-income economies, whereas with increasing income

19

levels, the impact gets less significant. However, consider that the overall fit of the results, depicted by the F-values, is rather poor. Thus, our empirical results in Tables 5 and 6 support the theoretical analysis whereas the dynamics of the process, while being backed by the empirical results, do not deliver additional significant insights.

IV. Conclusions

International trade relations frequently run the risk of being propelled by short-run incentives which are biased towards non-cooperative behavior. The ongoing US-Chinese trade conflicts are just one example. In order to please national interest groups with vested interests in the status quo governments may, for instance, engage in reducing market access for foreign competitors. In the long run, the politically driven short-sightedness hurts innovative, internationally operating companies and consumers alike. Yet, external (aka international) institutions for containing short-run interests are hampered by national sovereignty and thus are weak qua construction. Therefore, internal mechanisms that emerge qua evolution from the behavior of the participants in international relations themselves carry importance. In fact, they may work as an alternative device for national governments in strengthening cooperative behavior and a long(er)-run perspective, provided they are self-enforcing.

In this contribution, we focus on tit-for-tat (TFT) strategies as one specific form of self-enforcing, internal institutions as envisioned by Axelrod. On face of it, tit for tat, i.e. answering non-cooperation with non-cooperation, seems to be a move in the opposite direction, namely towards non-cooperation rather than cooperation – even if, on a long-term account, the latter turns out to be Pareto-superior. Nevertheless, tit for tat is popular in everyday life and according to Axelrod rightly so as it might well help to establish a more rather than a less cooperative-friendly environment. Axelrod's idea of retaliation as a possible game-theoretic response and in fact means to enforce cooperation has been widely discussed within the social sciences. However, there, as was the case with Axelrod, tit for tat is examined on a rather general account with the pay offs usually presumed rather than derived from an actual economic model. So far, it found only sluggishly its way into applications such as theoretical and empirical investigations into the political economy of international trade conflicts.

Using a partial equilibrium framework we thus incorporate Axelrod's idea in an explicit trade model. In this setting, governments regulate market access by setting tariffs considering the joint impact on (local) consumer surplus, profits and tariff revenue. Not

quite surprisingly, here as well, the threat of retaliation qua mutually limiting market access may work as a disciplining device towards trade liberalization. The frequency with which participants find themselves in similar situations turns out to be crucial, as is the case in Axelrod. Contrary to Axelrod though, incentives of participants include direct and indirect effects and thus actual repercussions implied by trade relations. However, surprisingly, our results hold even independently of actual supply and demand parameters. Since in any case outcomes rest on the assumption that at least one of the participants starts with a benevolent, i.e. pro-trade, strategy, we extend the basic model by examining TFT trigger strategies as well. By including TFT trigger strategies we are able to show that there is a trade off between the character of the trading partner and the frequency of interaction, even though both may reduce the likelihood of protectionist traps when considered separately. When discussing the stability of outcomes, we also present solutions that endogenize incentives by tracking the evolution of the protectionist atmosphere in world trade in general. Whereas most contributions of traditional trade theory call for unilateral trade liberalization, our theoretical results show that TFT diplomacy can work as a self-enforcing mechanism fostering world wide trade liberalization (even) where unilateral trade liberalization fails to do so.

In addition to the theoretical investigations, we examine the impact of TFT behavior on trade openness empirically. In order to do so, we collect information from the WTO Dispute Settlement Gateway, the Heritage Foundation, as well as the Penn World Tables and create a unique data set. Estimating different forms of openness on the frequency at which countries face each other within the scope of the dispute settlement mechanism under the umbrella of the WTO, the empirics support our theoretical findings in two respects: *i)* the WTO as an external institution in fact relies heavily on internal mechanisms resting on the principles of evolution, *ii)* the more often countries are involved in conflicts within the dispute settlement mechanism, the more they finally behave in a cooperative manner with respect to market access. According to our estimates, TFT behavior is particularly relevant for market access in case of low-income countries and countries that, on an overall account, have not yet been involved in too many disputes. International organizations are thus well-advised to draw on evolutionary aspects in their mechanism design, even though, prima facie, they appear to be a substitute rather than a complement.

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A

	t = 0	t = t
T = 0	$\dfrac{3(\alpha-1)^2}{4\beta}$ $\dfrac{3(\alpha-1)^2}{4\beta}$ Cell I	$\dfrac{6\alpha^2-12\alpha+2\alpha t-3t^2-2t+6}{8\beta}$ $\dfrac{3\alpha^2-6\alpha-2\alpha t+t^2+2t+3}{4\beta}$ Cell II
T = T	$\dfrac{3\alpha^2-6\alpha-2\alpha T+T^2+2T+3}{4\beta}$ $\dfrac{6\alpha^2-12\alpha+2\alpha T-3T^2-2T+6}{8\beta}$ Cell III	$\dfrac{6\alpha^2 - 12\alpha + 2\alpha t - 3t^2 - 2t + 6 - 4\alpha T + 2T^2 + 4T}{8\beta}$ $\dfrac{6\alpha^2 - 12\alpha + 2\alpha T - 3T^2 - 2T + 6 - 4\alpha t + 2t^2 + 4t}{8\beta}$ Cell IV

B

Figure 1. Payoffs in Trade Conflicts in a One-shot Game

A

	$t = 0$	$t = \tilde{t}$
$T = 0$	$\dfrac{3(\alpha-1)^2}{4\beta}$ $\dfrac{3(\alpha-1)^2}{4\beta}$ Cell I	$\dfrac{19(\alpha-1)^2}{24\beta}$ $\dfrac{11(\alpha-1)^2}{18\beta}$ Cell II
$T = \tilde{T}$	$\dfrac{11(\alpha-1)^2}{18\beta}$ $\dfrac{19(\alpha-1)^2}{24\beta}$ Cell III	$\dfrac{47(\alpha-1)^2}{72\beta}$ $\dfrac{47(\alpha-1)^2}{72\beta}$ Cell IV

B

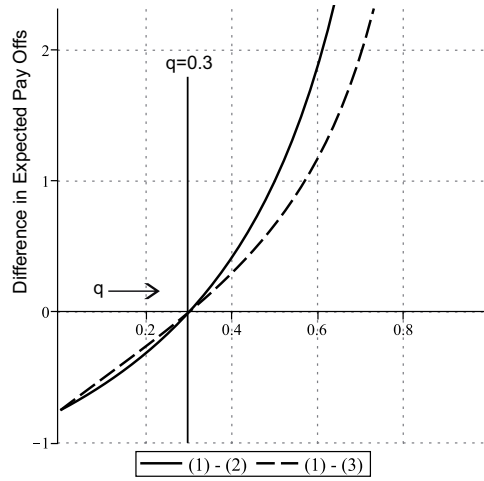Figure 2. Payoffs with $\tilde{t} = \tilde{T} = (\alpha - 1)/3$

Figure 3. Relative Performance of Tit-for-tat

$$\text{A}$$

	$t = 0, trigger$	$t = \tilde{t}$
$T = 0, trigger$	$\dfrac{3\,(\alpha-1)^2}{4\beta} \cdot \dfrac{1}{(1-q)}$ $\dfrac{3\,(\alpha-1)^2}{4\beta} \cdot \dfrac{1}{(1-q)}$ Cell I	$\dfrac{(57-10q)\,(\alpha-1)^2}{72\beta} \cdot \dfrac{1}{(1-q)}$ $\dfrac{(44+3q)\,(\alpha-1)^2}{72\beta} \cdot \dfrac{1}{(1-q)}$ Cell II
$T = \tilde{T}$	$\dfrac{(44+3q)\,(\alpha-1)^2}{72\beta} \cdot \dfrac{1}{(1-q)}$ $\dfrac{(57-10q)\,(\alpha-1)^2}{72\beta} \cdot \dfrac{1}{(1-q)}$ Cell III	$\dfrac{47\,(\alpha-1)^2}{72\beta} \cdot \dfrac{1}{(1-q)}$ $\dfrac{47\,(\alpha-1)^2}{72\beta} \cdot \dfrac{1}{(1-q)}$ Cell IV

B (label for rows)

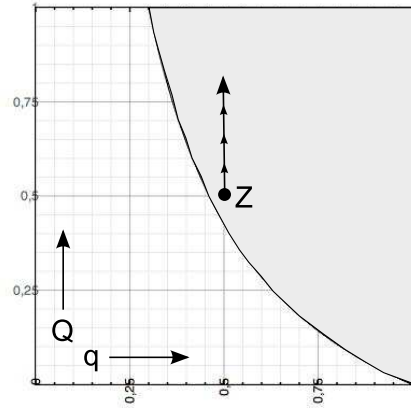Figure 4. Trigger Strategies in Trade Policies
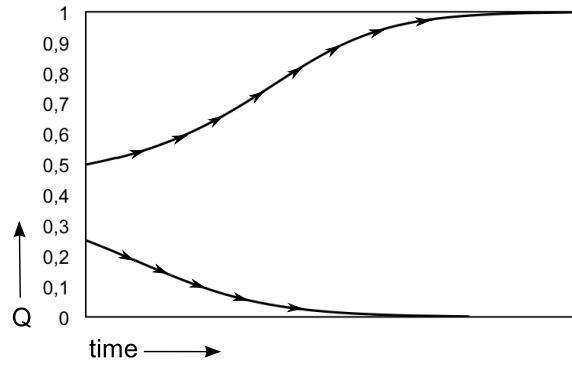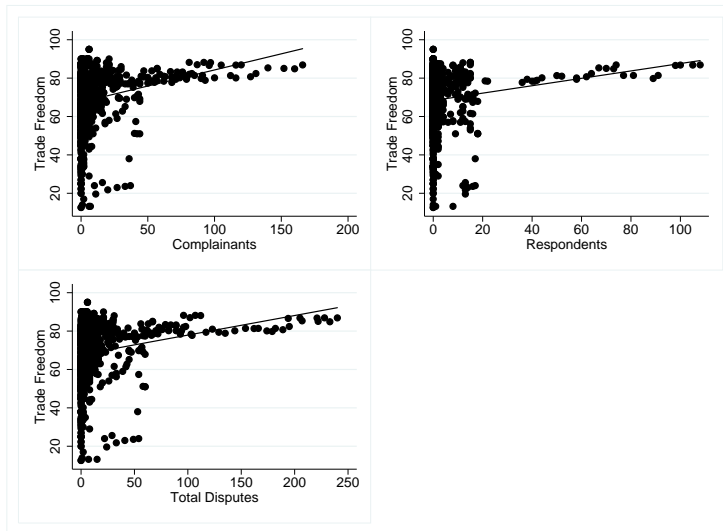
Figure 5. q versus Q

Figure 6. Q-Dynamics

Figure 7. Scatter Plots with Fitted Values: Trade Freedom and Dispute Variables

Table 1. Descriptive Statistics: Dispute Variables (year = 2010)

Variables	N	mean	sd	min	max
total disputes	71	20.07	43.00	0	240
- high-income economies	23	33.22	59.45	1	207
- low-income economies	29	8.14	11.15	0	58
complainant	71	14.86	29.05	0	166
- high-income economies	23	23.61	38.17	0	140
- low-income economies	29	6.34	8.08	0	40
respondent	71	5.24	15.74	0	108
- high-income economies	23	9.61	23.96	0	98
- low-income economies	29	1.79	3.69	0	18
difference	71	9.62	18.20	-4	92
- high-income economies	23	14.00	22.98	-2	73
- low-income economies	29	4.55	5.77	-4	22

difference = number of complainants - number of respondents
high-income economies: GDP per capita > 20,000 (year 2007)
low-income economies: GDP per capita < 10,000 (year 2007)
Source: Information from the WTO Dispute Settlement Gateway, own calculations

Table 2. Descriptive Statistics: Dispute Variables for Specific Economies in 2010

Variables	EC	US	Canada	China	India	Japan	Australia	Mexico	Brazil
total disputes	240	228	112	32	60	98	67	73	58
complainant	166	120	97	15	44	83	57	59	44
respondent	74	108	15	17	18	15	10	14	14
difference	92	12	82	-2	26	68	47	45	30

difference = number of complainants - number of respondents
Source: Information from the WTO Dispute Settlement Gateway, own calculations

Table 3. Descriptive Statistics: Trade Freedom (year = 2010)

variable	N	mean	sd	min	max
trade freedom	71	78.56	9.76	44.8	90
- high-income economies	23	84.05	6.92	57	95
- low-income economies	28	70.61	9.11	51.2	85.6

high-income economies: GDP per capita > 20,000 (year 2007)
low-income economies: GDP per capita < 10,000 (year 2007)
Source: Heritage Foundation (www.heritage.org/index), own calculations.

Table 4. Descriptive Statistics: Trade Freedom for Specific Economies in 2010

variable	EC	US	Canada	China	India	Japan	Australia	Mexico	Brazil
trade freedom	86.9	86.9	88.1	72.2	67.9	82.4	85.1	82.0	69.2

Source: Heritage Foundation (www.heritage.org/index), own calculations.

Table 5. Effects of Trade Disputes on the Countries' Trade Freedom (Pooled Analysis)
– Endogenous Variable: Trade Freedom –

	(1)	(2)	(3)	(4)	(5)	(6)
total disputes	.1177*** (13.26)	-	-	.0320** (2.31)	-	-
complainants	-	.1954*** (13.71)	-	-	.0607*** (3.14)	-
respondents	-	-	.2194*** (11.19)	-	-	.0331 (.90)
population (lag)	-	-	-	−.0000*** (−6.65)	−.0000*** (−6.82)	−.0000*** (−6.44)
GDP per capita	-	-	-	.0007*** (11.62)	.0007*** (11.50)	.0007*** (12.69)
consumption	-	-	-	.1574*** (3.13)	.1534*** (3.09)	.1720*** (3.42)
investment	-	-	-	.2411*** (3.99)	.2343*** (3.86)	.2512*** (4.20)
government share	-	-	-	.1186 (1.32)	.1127 (1.25)	.1312 (1.47)
d (lowest income)	-	-	-	−8.5788*** (−3.52)	−8.6273*** (−3.55)	−8.6065*** (−3.53)
obs	930	930	930	703	703	703
R-squared	.0641	.0792	.0306	.4598	.4613	.4578
Prob>chi2	.0000	.0000	.0000	.0000	.0000	.0000

(t-Statistics in parentheses)
* / ** / *** significant at 10 / 5 / 1 percent

Table 6. Effects of Trade Disputes on the Countries' Trade Freedom (Pooled Analysis)
– Endogenous Variable: Trade Freedom –

| | Income Level | | | Number of Trade Disputes | | |
	Total	Compl.	Resp.	Total	Compl.	Resp.
	(1)	(2)	(3)	(4)	(5)	(6)
low	.1350**	.2182***	.1312	1.4010***	1.4619***	2.1745***
	(2.03)	(2.64)	(.57)	(4.67)	(5.30)	(5.55)
middle	.0790	.1600**	−.0009	.4850***	.3728***	−.0121
	(1.45)	(2.08)	(−.01)	(5.46)	(4.48)	(−.11)
high	.0234*	.0415**	.0315	.0428***	.0738***	.0185
	(1.65)	(2.05)	(.86)	(3.02)	(3.72)	(.51)
population (lag)	−.0000***	−.0000***	−.0000***	−.0000***	−.0000***	−.0000***
	(−6.56)	(−6.78)	(−6.12)	(−6.69)	(−6.67)	(−6.59)
GDP per capita	.0007***	.0007***	.0007***	.0008***	.0007***	.0008***
	(11.11)	(11.06)	(12.06)	(12.13)	(11.88)	(13.31)
consumption	.1678***	.1654***	.1722***	.1757***	.1674***	.2175***
	(3.26)	(3.27)	(3.33)	(3.51)	(3.34)	(4.31)
investment	.2464***	.2362***	.2530***	.2316***	.2146***	.2950***
	(4.09)	(4.11)	(4.11)	(4.03)	(3.65)	(5.05)
government share	.1325	.1311	.2377***	.1303	.1558*	.2513***
	(1.43)	(1.42)	(2.64)	(1.41)	(1.70)	(2.70)
d (lowest income)	−8.0689***	−8.0482***	−8.4980***	−6.8839***	−7.8806***	−6.5581***
	(−3.27)	(−3.28)	(−3.42)	(−2.86)	(−3.31)	(−2.62)
obs	703	703	703	703	703	703
R-squared	.46.24	.4650	.4580	.4817	.4793	.4771
Prob>chi2	.0000	.0000	.0000	.0000	.0000	.0000

(t-Statistics in parentheses)
* / ** / *** significant at 10 / 5 / 1 percent

Table 7. Effects of Trade Disputes on the Countries' Trade Freedom (Panel Analysis)
– *Endogenous Variable: Trade Freedom (percentage change)* –

	All Economies			Income Level (Interaction Variables)		
	Total (1)	Compl. (2)	Resp. (3)	Total (4)	Compl. (5)	Resp. (6)
dispute	.0002 (.09)	.0001 (.04)	.0008 (.16)	-	-	-
low	-	-	-	.0142** (2.15)	.0169* (1.86)	.0581*** (2.68)
middle	-	-	-	−.0058 (−.60)	−.0110 (−.75)	−.0054 (−.21)
high	-	-	-	−.0002 (−.08)	−.0002 (−.06)	−.0010 (−.18)
time	.0181 (.84)	.0180 (.83)	.0183 (.85)	.0167 (.80)	.0180 (.85)	.0145 (.70)
population	2.0189* (1.86)	2.0047* (1.82)	2.0244* (1.90)	1.3740 (1.26)	1.4061 (1.25)	1.4022 (1.35)
GDP per capita	.7158* (1.81)	.7114* (1.77)	.7157* (1.85)	.6702* (1.74)	.6700* (1.70)	.6381* (1.73)
consumption	.8097 (1.30)	.8040 (1.28)	.8097 (1.32)	.8534 (1.41)	.8107 (1.31)	.9340 (1.59)
investment	.1511 (1.23)	.1517 (1.23)	.1508 (1.23)	.1714 (1.43)	.1689 (1.39)	.1737 (1.48)
government share	.2604 (.81)	.2587 (.80)	.2628 (.81)	.1916 (.61)	.1812 (.57)	.2397 (.78)
d (low income)	−.0072 (−.29)	−.0073 (−.30)	−.0071 (−.29)	.0011 (.04)	−.0006 (−.02)	.0026 (.11)
obs	694	694	694	694	694	694
groups	59	59	59	59	59	59
Prob>chi2	.2170	.2174	.2158	.1081	.1437	.0560

(z-Statistics in parentheses)
* / ** / *** significant at 10 / 5 / 1 percent
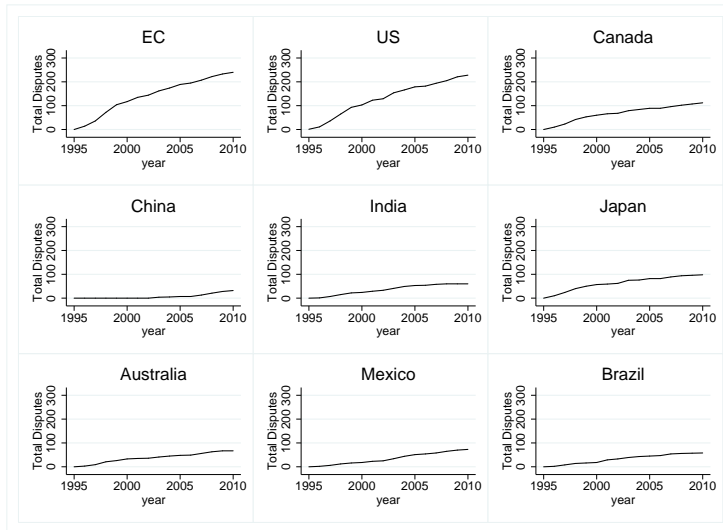
Appendix

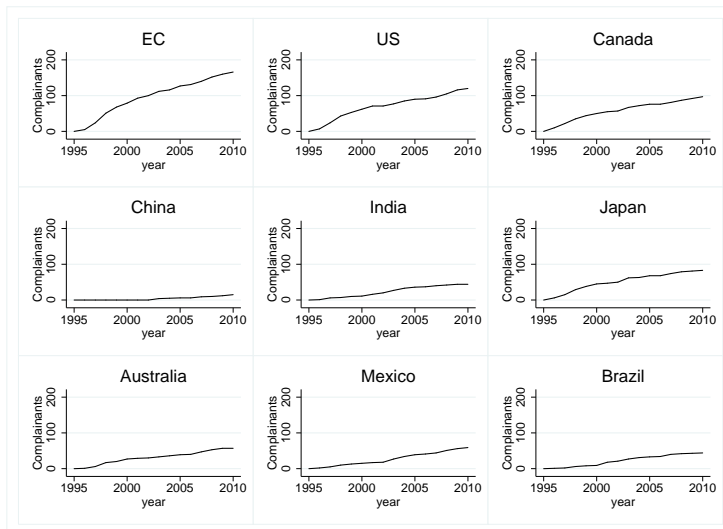Figure 8. Number of Total Disputes by Selected Countries Over Time

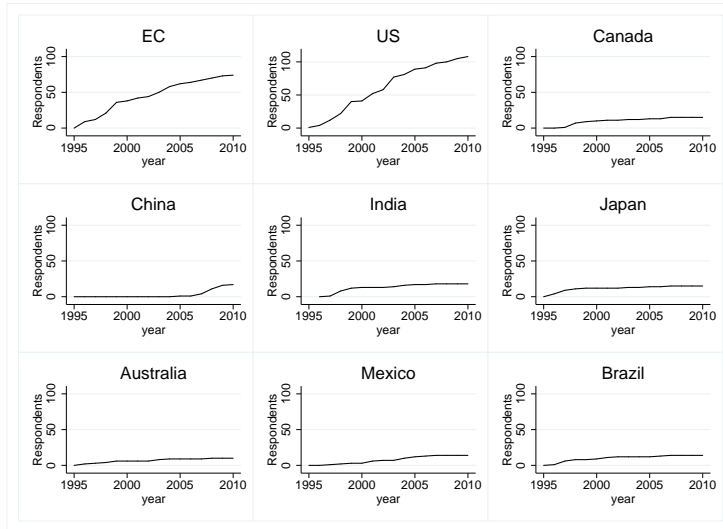Figure 9. Number of Complainants by Selected Countries Over Time

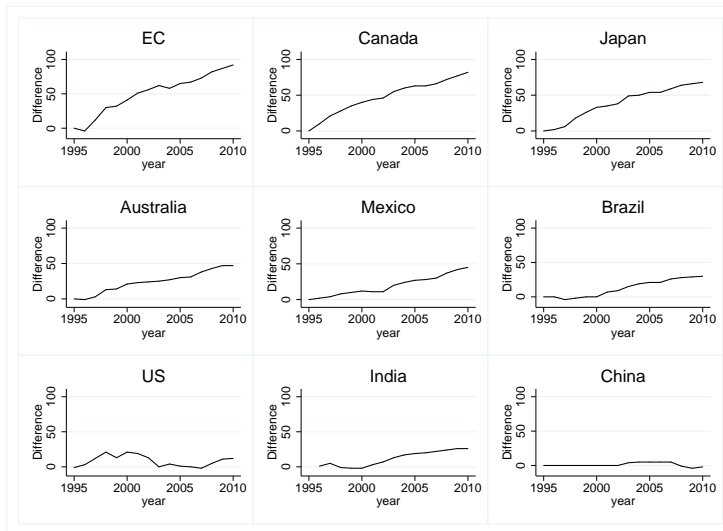Figure 10. Number of Respondents by Selected Countries Over Time

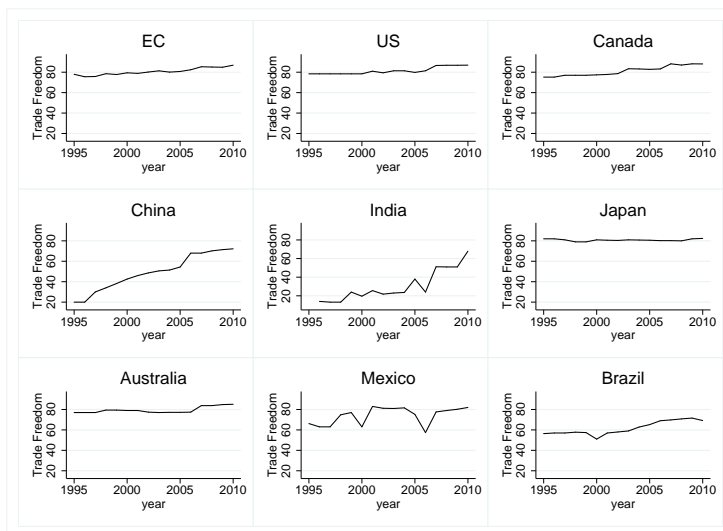Figure 11. Difference (Compainants - Respondents) by Selected Countries Over Time
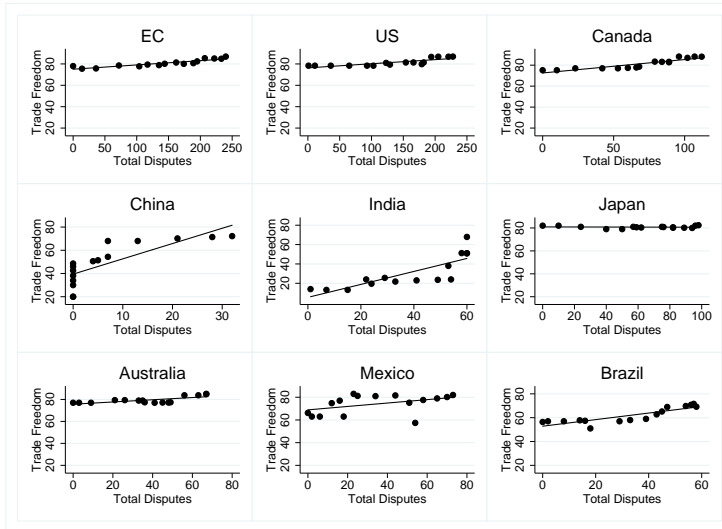

Figure 12. Trade Freedom by Selected Countries Over Time

42

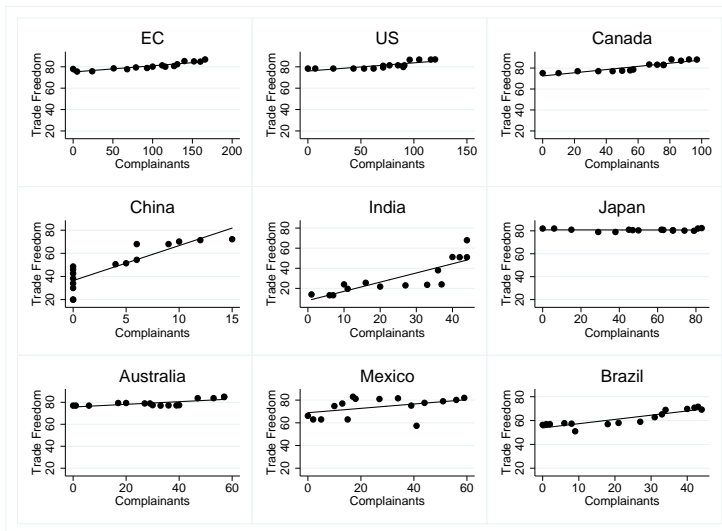Figure 13. Scatter Plots with Fitted Values by Selected Countries: Total Disputes

Figure 14. Scatter Plots with Fitted Values by Selected Countries: Complainants
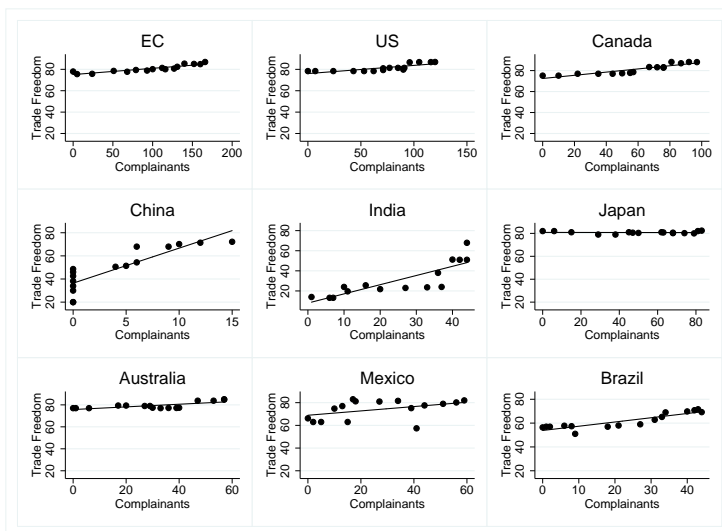

Figure 15. Scatter Plots with Fitted Values by Selected Countries: Respondents

43