Dangerous liaisons:
An endogenous model of international trade and human rights

Olga Chyzh

Departments of Political Science and Statistics, Iowa State University

Abstract

This article applies recent advances in network analysis to highlight a central tension faced by policy-makers—balancing the benefits of engaging with the international system and the associated domestic policy costs. International trade rewards certain domestic practices, such as respect for domestic human rights. Enforcing such practices, however, is politically costly, and sometimes prohibitive, to state leaders who rely on political repression to stay in power. In such cases, domestic elites often resort to an alternative strategy of securing the benefits of international trade—setting up indirect trade channels through intermediary states. These competing incentives are modeled within a single framework using a formal game, in which actors-states form trade-links (direct or indirect) with other states, while simultaneously choosing their optimal level of domestic human rights protections. The model suggests that there may be an inverse relationship between a state's embeddedness within a network of indirect trade and respect for human rights: indirect trade channels serve as loopholes that allow domestically troubled states to enjoy the benefits of trade without pressure for domestic improvement. The predictions are supported by the results of the empirical analyses of the international trade and repression data (1987-2000), conducted using a coevolutionary actor-oriented longitudinal-network model, RSiena—a statistical estimator that closely mimics the theoretical model.

Keywords: indirect trade, network analysis, network game, human rights, repression

Corresponding author: ochyzh@iastate.edu

Appendix A Stable Networks and Their Shapes

Equilibria Concepts: Strong Pairwise Nash Stability

The game's equilibria consist of two parts, which correspond to the two decisions made by actors: (1) the set of links that they would like to make, and (2) the choice of own type (high or low) $D = \{0, 1\}$. Since forming a link requires the consent of both players, we have to move beyond the Nash equilibrium concept (and its standard refinements) to consider coordinated actions on the part of coalitions (at least pairs) of players (Jackson & Wolinsky, 1996; Jackson, 2008). Jackson & Wolinsky (1996) address this by proposing the concept of *pairwise Nash stability.* Pairwise stability involves two rules about a network: (1) no player can raise her payoff by deleting a link that she is directly involved in and (2) no two agents can both benefit (at least one strictly) by adding a link between themselves. More formally, the graph g is pairwise stable if:

1. $\forall ij \in g, u_i(g) \geq u_i(g - ij)$ and $u_j(g) \geq u_j(g - ij)$

   and

2. $\forall ij \notin g$, if $u_i(g) < u_i(g + ij)$ then $u_j(g) > u_j(g + ij)$.

We say that g is *defeated* by g' if $g' = g - ij$ and (1) is violated for ij, or if $g' = g + ij$ and (2) is violated for ij. Condition (2) embodies the assumption that, if i strictly prefers to form the link ij and j is just indifferent, then the link ij will be formed. A network is *pairwise Nash stable* if it is both Nash stable and pairwise stable.

Type Stability

The second part of the equilibria for this game concerns actors' binary choice of type $D = \{0, 1\}$. Here, I use the standard Nash equilibrium concept: an action profile $d_i^* \in D$ is a Nash equilibrium if no unilateral deviation in strategy by any single player is profitable for that player, that is:

$$d_i \in D_i, d_i \neq d_i^* : u_i\left(d_i^*, d_{-i}^*\right) \geq u_i\left(d_i, d_{-i}^*\right). \tag{5}$$

In order to solve the game, I combined the equilibria concepts described above into a new equilibrium concept—*strong pairwise Nash stability.* A network is defined to be strongly Nash stable if it is both pairwise Nash stable and type stable.

Pairwise Stable Network Shapes

The shape of the equilibrium networks will depend on the relationship between link cost c, trade benefits δ, and trade partner attractiveness (operations' costs) α. In terms of domestic operations' costs, there will be three types of equilibria, separated by two threshold cost σ_1^* and σ_2^*, so that all states play *Respecter* ($d = 1$) when $\sigma < \sigma_1^*$, some states play *Respecter* ($d = 1$), while others play *Abuser* ($d = 0$) when $\sigma_1^* < \sigma < \sigma_2^*$, and all states play the *Abuser* type ($d = 0$) when $\sigma > \sigma_2^*$.

The model has a large number of equilibria. I begin with three types of *symmetrical* equilibria, and then extend the discussion to the relevant features of *asymmetrical* equilibria. The model is solved in two stages: first, I identify the most common *symmetrical* shapes that trade networks take on at different cost ranges, then I identify the Nash stable type choices for each possible network position. The first stage of the analysis reveals three common *symmetrical* shapes that trade networks can take on depending on the cost of links: *complete* networks or *cliques*, *stars*, and *circles* or *rings* (see Figure 5).[19]

A *complete* network or a *clique* is a network in which each player has a link to each other player: $g \in g^N$ is a complete network if $\forall i \in g, j \in g : ij = 1$. An empirical example of a complete trade network is a trade union, such as the European Union (EU) or the North Atlantic Free Trade Agreement (NAFTA).

A *star-shaped* or a *hub–and–spokes* network is a network in which all players are linked to one central player—*the hub*—and there are no other links: $g \in g^N$ is a star if $g \neq \emptyset$ and there exists $i \in N$ such that if $jk \in g$, then either $j = i$ or $k = i$. Individual i is the center of the star. Empirical examples of star-shaped networks include colonial trade networks with the colonizer as the center of the star and the colonies as the *vertices* or *spokes*(the British or French Empires and their colonies, etc.).

Finally, a *circle* or a *ring* is a network in which each player has direct links with exactly two other players. The most prominent example comes from nuclear proliferation literature, which commonly refers to the "rings" of non-nuclear developing countries with varying technical capabilities trading knowledge in attempts to enhance each other's nuclear potential.

Since making/maintaining direct links is costly, as the cost c increases, states form networks

[19] Of course, the existing trade networks rarely fall neatly into these three shape categories. Therefore, the three shapes identified here are best thought of as the ideal types.

with fewer direct links. When the cost of forming/maintaining links is low, states form complete networks, as the cost increases, states forgo direct links for the indirect ones—as the indirect links allow for deriving the network benefits without paying the costs. Finally, when the cost of links is high, states choose to form networks with the minimal number of direct links, maximizing their reliance on the indirect links. This relationship between the cost of links and network shapes is formally stated in Proposition 1.

Proposition 1 (stated on p. 44, an extension of Jackson & Wolinsky (1996)). In the symmetric connections model:

i For $c + \sigma < \alpha_i \alpha_j \left(\delta - \alpha_{ijl}\delta^2\right)$, the unique pairwise stable network is the complete graph, g^N.

ii. For $\alpha_i \alpha_j \left(\delta - \alpha_{ijl}\delta^2\right) < c + \sigma < \alpha_i \alpha_j \delta$, a star encompassing all players is pairwise stable, but not necessarily the unique pairwise stable graph.

iii. For $\alpha_i \alpha_j \delta < c + \sigma$, any pairwise stable network which is non-empty is such that each player has at least two links.

Proof of Proposition 1. i. In this cost range, any players who are not directly connected will benefit from forming a link. Equation (3) can be rearranged in the following way, so that the costs of forming a link are on the left side and the benefits are on the right ride of the equation:

$$\alpha_i \sum_{j=1}^{n} \prod_{l \in P} \alpha_l \delta - \sigma - k_i c_{ij} = 0 \tag{6}$$

$$\sigma + k_i c_{ij} = \alpha_i \sum_{j=1}^{n} \prod_{l \in P} \alpha_l \delta \tag{7}$$

The sufficient condition for the actors to always prefer a direct link over an indirect one is that the difference between the benefit from a direct link and the benefit from an indirect link is at least as high as the cost of a direct link. Based on equation (4), this difference can be expressed as:

$$\alpha_i \alpha_j \delta - \alpha_i \alpha_j \alpha_{ijl} \delta^2, \tag{8}$$

where α_{ijl} represents the domestic type (Abuser or Respecter) of the intermediate link between i and j. Equation (5) simplifies in the following way:

$$\alpha_i \alpha_j \delta - \alpha_i \alpha_j \alpha_{ijl} \delta^2 = \alpha_i \alpha_j \delta \left(1 - \alpha_{ijl}\delta\right). \tag{9}$$

ii. In this cost range, the benefit of turning indirect links into direct ones do not justify the costs. Each connected player will have at least one direct link and derive additional benefit from indirect links without paying the costs of turning them into direct ones.

iii. In this range, pairwise stability precludes “loose ends”, so every connected player will have at least two links.

□

The Center of Star-Shaped Networks

We can obtain an interesting extension of Proposition 1.iii by examining the conditions under which the star network's center takes the costly action $d = 1$ to improve its type. It can be shown that states will form a star network with a Respecter state at the center when $c < \alpha_i \alpha_j \left(\delta - \delta^2\right)$, while the necessary condition for a network with a Abuser state at the center is $c < \alpha_i \alpha_j \alpha_l \left(\delta - \delta^2\right)$ or simply $c < \alpha_i \alpha_j \alpha \left(\delta - \delta^2\right)$, since $\alpha_l = \alpha$ for this case. Since $\alpha < 1$, it follows that $\alpha_i \alpha_j \left(\delta - \delta^2\right) > \alpha_i \alpha_j \alpha \left(\delta - \delta^2\right)$. This means that when $\alpha_i \alpha_j \alpha \left(\delta - \delta^2\right) < c < \alpha_i \alpha_j \left(\delta - \delta^2\right)$, we will observe star networks with *Respecter* centers, but not star networks with *Abuser* centers. This can be restated as Lemma 1.

Lemma 1. *When $\alpha_i \alpha_j \alpha \left(\delta - \delta^2\right) < c < \alpha_i \alpha_j \left(\delta - \delta^2\right)$, we will observe star networks with Respecter centers, but not star networks with Abuser centers.*

Complete Networks

Lemma 2. *i. A necessary condition for an equilibrium consisting of a complete network of Respecter states is $\sigma < (n-1)(1-\alpha)\delta$.*

ii. A necessary condition for a complete network ofAbuser states equilibrium is $\sigma > (n-1)(1-\alpha)\delta$.

Proof of Lemma 2.

i. In a complete networks of Respecter types, no state can benefit by unilaterally playing $d = 0$ when:

$$U_i(1) - U_i(0) > 0; \tag{10}$$

$$U_i\left(1\right) = \left(n-1\right)\delta - \left(n-1\right)c - \sigma; \tag{11}$$

$$U_i\left(0\right) = \left(n-1\right)\alpha\delta - \left(n-1\right)c. \tag{12}$$

Substituting (11) and (12) into the left-hand side of (10), we obtain:

$$U_i\left(1\right) - U_i\left(0\right) = \left(n-1\right)\left(1-\alpha\right)\delta - \sigma.$$

Equation (10) holds when:

$$\left(n-1\right)\left(1-\alpha\right)\delta - \sigma > 0$$

or

$$\sigma < \left(n-1\right)\left(1-\alpha\right)\delta.$$

ii. In a complete network of Abuser states, no state can improve its utility by unilaterally deviating to playing $d = 1$ when

$$U_i\left(d=1\right) - U_i\left(d=0\right) < 0; \tag{13}$$

$$U_i\left(d=1\right) = \left(n-1\right)\alpha\delta - \left(n-1\right)c - \sigma; \tag{14}$$

$$U_i\left(d=0\right) = \left(n-1\right)\alpha^{\delta} - \left(n-1\right)c. \tag{15}$$

Substituting (14) and (15) into the left-hand side of (14), we obtain:

$$U_i\left(d=1\right) - U_i\left(d=0\right) = \left(n-1\right)\left(1-\alpha\right)\alpha\delta - \sigma.$$

Equation (13) holds when:

$$(n-1)(1-\alpha)\alpha\delta-\sigma<0$$

or

$$\sigma>(n-1)(1-\alpha)\alpha\delta.$$

□

Star Networks

Lemma 3 (Center of a Star)**.** *The center of a star-shaped network i_c plays $d=1$, when $\sigma<(1-\alpha)(n-1)\alpha\delta$, and $d=0$ otherwise.*

Proof of Lemma 3. The center of a star-shaped network i_c plays $d=1$ when:

$$U_{i_c}(1)-U_{i_c}(0)>0. \tag{16}$$

$$U_{i_c}(1)=k_d\delta+k_a\delta-(n-1)c-\sigma; \tag{17}$$

$$U_{i_c}(0)=k_d\alpha\delta+k_a\alpha^2\delta-(n-1)c. \tag{18}$$

Substituting (17) and (18) into the left-hand side of (16), we obtain:

$$\begin{aligned}U_{i_c}(1)-U_{i_c}(0)&=k_d\delta+k_a\delta-(n-1)c-\sigma-k_d\alpha\delta\\&-k_a\alpha^2\delta+(n-1)c=(1-\alpha)(k_d\delta+k_a\alpha\delta)-\sigma.\end{aligned}$$

Equation (16) holds when:

$$(1-\alpha)(k_d\delta+k_a\alpha\delta)-\sigma>0$$

or

$$\sigma < (1-\alpha)\left(k_d\delta + k_a\alpha\delta\right).$$

□

Lemma 4 (Spokes of a Star)**.** *When the link formation cost c allows for star-shaped equilibria:*

i. If the center of a star plays $d = 1$, the spokes play $d = 1$ when $\sigma < (1-\alpha)\left(\delta + \delta^2(n-2)\right)$, and $d = 0$ otherwise.

ii. Stars with Respecter spokes will never have a Abuser center.

Proof of Lemma 4.

i. If the center of a star playes $d = 1$, the spokes of a star play $d = 1$ when:

$$U_{i_v}(1) - U_{i_v}(0) > 0. \tag{19}$$

$$U_{i_v}(1) = \delta + (n-2)\delta^2 - c - \sigma. \tag{20}$$

$$U_{i_v}(0) = \alpha\delta + (n-2)\alpha\delta^2 - c. \tag{21}$$

Substituting (20) and (21) into the left-hand side of (19), we obtain:

$$U_{i_v}(1) - U_{i_v}(0) = \delta + (n-2)\delta^2 - c - \sigma - \alpha\delta$$
$$- (n-2)\alpha\delta^2 + c = (1-\alpha)\left(\delta + \delta^2(n-2)\right) - \sigma.$$

Equation (19) holds when:

$$(1-\alpha)\left(\delta + \delta^2(n-2)\right) - \sigma > 0$$

or

$$\sigma < (1-\alpha)\left(\delta + \delta^2 (n-2)\right).$$

ii. If the center of a star plays $d = 0$, "vertices" of a star play $d = 1$ when:

$$U_{i_v}(1) - U_{i_v}(0) > 0. \tag{22}$$

$$U_{i_v}(1) = \alpha\delta + (n-2)\alpha\delta^2 - c - \sigma; \tag{23}$$

$$U_{i_v}(0) = \alpha^2\delta + (n-2)\alpha^2\delta^2 - c. \tag{24}$$

Substituting (23) and (24) into the left-hand side of (22), we obtain:

$$U_{i_v}(1) - U_{i_v}(0) = (1-\alpha)\left(\alpha\delta + \alpha\delta^2 (n-2)\right) - \sigma.$$

Equation (22) then holds when:

$$(1-\alpha)\left(\alpha\delta + \alpha\delta^2 (n-2)\right) - \sigma > 0$$

or

$$\sigma < (1-\alpha)\left(\alpha\delta + \alpha\delta^2 (n-2)\right).$$

Then, by lemma 3, we should observe a star with an Abuser center and Respecter spokes when:

$$(1-\alpha)(n-1)\alpha\delta < \sigma < (1-\alpha)\left(\alpha\delta + \alpha\delta^2 (n-2)\right). \tag{25}$$

Inequality (25), however, can only hold iff:

$$(1-\alpha)(n-1)\alpha\delta < (1-\alpha)\left(\alpha\delta + \alpha\delta^2(n-2)\right). \tag{26}$$

Suppose (26) is true, then

$$(1-\alpha)(n-1)\alpha\delta - (1-\alpha)\left(\alpha\delta + \alpha\delta^2(n-2)\right) < 0.$$

By simplifying, we obtain:

$$\alpha(1-\alpha)\left(\delta - \delta^2\right)(n-2) < 0 \tag{27}$$

This is a contradiction, because $\alpha > 0$, $(1-\alpha) > 0$, $\left(\delta - \delta^2\right) > 0$, and $(n-2) > 0$ by definition, which means that (27) must be positive.

□

Lemma 5 (Homogeneous Star Networks)**.**

i. Star networks consisting of Respecter states only are possible when:

$$\sigma < (1-\alpha)\left(\delta + \alpha\delta^2(n-2)\right).$$

ii. Star networks consisting of Abuser states are possible when $\sigma > (1-\alpha)(n-1)\alpha\delta$*.*

Proof of Lemma 5.

i. As shown in Lemma 3, the center of a star will play $d = 1$ when

$$\sigma_c < (1-\alpha)(n-1)\delta, \tag{28}$$

and the spokes of a star will play $d = 1$, when

$$\sigma_v < (1-\alpha)\left(\delta + \alpha\delta^2(n-2)\right). \tag{29}$$

One can see, however, that for all possible parameter values, $\sigma_c > \sigma_v$, which means that (28) is always satisfied when (29) is.

We can check this by subtracting (29) from (28).

$$\sigma_c - \sigma_v = (1-\alpha)(n-1)\delta - (1-\alpha)\left(\delta + \alpha\delta^2(n-2)\right)$$

By simplifying, we obtain:

$$\sigma_c - \sigma_v = \delta(1-\alpha)(n-2)(1-\alpha\delta).$$

Note that all of the terms in the above equation are positive: $\delta > 0$, $(1-\alpha) > 0$, $(n-2) > 0$, and $(1-\alpha\delta) > 0$.

This shows that (29) is the necessary condition for formation of stars consisting of Respecter states.

ii. Analogously, a star consisting of Abuser states is possible when neither its center no its spokes can gain by playing $d = 1$ or when

$$\sigma_c > (1-\alpha)(n-1)\alpha\delta \tag{30}$$

and

$$\sigma_v > (1-\alpha)\left(\alpha\delta + \alpha\delta^2(n-2)\right). \tag{31}$$

We can show that $\sigma_c > \sigma_v$, which means that (31) is always satisfied when (30) is:

$$\sigma_c - \sigma_v = (1-\alpha)(n-1)\alpha\delta - (1-\alpha)\left(\alpha\delta + \alpha\delta^2(n-2)\right)$$

By simplifying, we obtain:

$$\sigma_c - \sigma_v = \alpha(1-\alpha)\left(\delta - \delta^2\right)(n-2). \tag{32}$$

Since by definition $\alpha > 0$, $(1-\alpha) > 0$, $\left(\delta - \delta^2\right) > 0$, and $(n-2) > 0$, $\sigma_c - \sigma_v > 0$.

□

Circles

Lemma 6 (Circle Networks.)**.**

i. When n is odd, all states in a circle network will play $d = 1$ when

$$\sigma < 2(1-\alpha)\left(\frac{\delta - \delta^{\frac{n-1}{2}}}{1-\delta}\right), \tag{33}$$

and $d = 0$ otherwise.

ii. When n is even, state i that is a part if a circle network plays $d = 1$ when $\sigma < 2(1-\alpha)\left(\frac{\delta-\delta^{\frac{n-2}{2}}}{1-\delta} + \frac{1}{2}\delta^{\frac{n}{2}}\right)$, and $d = 0$ otherwise.

Proof of Lemma 6.

i. When n is odd, state i that is a part of a circle network plays $d = 1$ when:

$$U_i(d=1) - U_i(d=0) > 0. \tag{34}$$

Let us first derive state i's utility from playing $d = 1$ in circle networks, assuming that all other states play $d = 1$. Note that this utility is slightly different for circles made up of odd and even numbers of states n. For an odd number of states, the utility of playing $d = 1$ in a circle network is:

$$U_i(d=1) = 2\delta + 2\delta^2 + ... + 2\delta^{\frac{n-1}{2}} - 2c - \sigma = \sum_{k=1}^{\frac{n-1}{2}} \delta^k - 2c - \sigma.$$

This function can be transformed in the following way using the *geometric series* formula:[t]

$$U_i(d=1) = 2\left(\frac{1}{1-\delta} - \frac{\delta^{\frac{n-1}{2}}}{1-\delta} - 1\right) - 2c - \sigma.$$

[t]According to the geometric series formula, $\sum_{n=0}^{\infty} x^n = \frac{1}{1-x}$, for $|x| < 1$.

This simplifies to

$$U_i\left(d=1\right)=2\left(\frac{\delta-\delta^{\frac{n-1}{2}}}{1-\delta}\right)-2c-\sigma. \tag{35}$$

Analogously, we can show that the utility of playing $d = 0$ (assuming all other players play $d = 1$) is defined as:

$$U_i\left(d=0\right)=2\alpha\left(\frac{1}{1-\delta}-\frac{\delta^{\frac{n-1}{2}}}{1-\delta}-1\right)-2c. \tag{36}$$

Substituting (35) and (36) into the left-hand side of (34), we obtain:

$$U_i\left(d=1\right)-U_i\left(d=0\right)=2\left(\frac{1}{1-\delta}-\frac{\delta^{\frac{n-1}{2}}}{1-\delta}-1\right)-2c-2\alpha\left(\frac{1}{1-\delta}-\frac{\delta^{\frac{n-1}{2}}}{1-\delta}-1\right)+2c-\sigma.$$

This simplifies to

$$U_i\left(d=1\right)-U_i\left(d=0\right)=2\left(1-\alpha\right)\left(\frac{1}{1-\delta}-\frac{\delta^{\frac{n-1}{2}}}{1-\delta}-1\right)-\sigma. \tag{37}$$

Equation (34) then holds when:

$$2\left(1-\alpha\right)\left(\frac{1}{1-\delta}-\frac{\delta^{\frac{n-1}{2}}}{1-\delta}-1\right)\sigma>0$$

or

$$\sigma<2\left(1-\alpha\right)\left(\frac{1}{1-\delta}-\frac{\delta^{\frac{n-1}{2}}}{1-\delta}-1\right).$$

ii. When n is even, if all other states play $d = 1$, state i plays $d = 1$ in a circle network when:

$$U_i\left(d=1\right)-U_i\left(d=0\right)>0. \tag{38}$$

$$U_i\left(d=1\right)=2\left(\frac{\delta-\delta^{\frac{n-2}{2}}}{1-\delta}+\frac{1}{2}\delta^{\frac{n}{2}}\right)-2c-\sigma; \tag{39}$$

$$U_i\left(d=0\right)=2\alpha\left(\frac{\delta-\delta^{\frac{n-2}{2}}}{1-\delta}+\frac{1}{2}\delta^{\frac{n}{2}}\right)-2c. \tag{40}$$

Substituting (39) and (40) into the left-hand side of (38), we obtain:

$$U_i\left(d=1\right)-U_i\left(d=0\right)=2\left(\frac{\delta-\delta^{\frac{n-2}{2}}}{1-\delta}+\frac{1}{2}\delta^{\frac{n}{2}}\right)-2\alpha\left(\frac{\delta-\delta^{\frac{n-2}{2}}}{1-\delta}+\frac{1}{2}\delta^{\frac{n}{2}}\right)-\sigma.$$

Equation (38) then holds when:

$$2\left(\frac{\delta-\delta^{\frac{n-2}{2}}}{1-\delta}+\frac{1}{2}\delta^{\frac{n}{2}}\right)-2\alpha\left(\frac{\delta-\delta^{\frac{n-2}{2}}}{1-\delta}+\frac{1}{2}\delta^{\frac{n}{2}}\right)-\sigma>0$$

or

$$\sigma<2\left(1-\alpha\right)\left(\frac{\delta-\delta^{\frac{n-2}{2}}}{1-\delta}+\frac{1}{2}\delta^{\frac{n}{2}}\right).$$

□

Appendix B Predictions

The game has a large number of equilibria (see Table 3 below). This paper's interest in the relationship between indirect/direct links and type is best pursued by focusing on classes of equilibria rather than any equilibrium in particular. This paper focuses on the symmetrical network shapes, i.e. assumes that, in the presence of multiple equilibria, actors will choose to form equilibria with the longest shortest path of 2 between any two actors. While other non-symmetrical equilibria shapes are possible (see, e.g., Jackson & Wolinsky, 1996), this assumption is grounded in work by Galeotti, Goyal & Kamphorst (2006: 353) who formally prove that "centrality and short average distances between individuals are robust features of equilibrium networks."for similar results, see][]AlbertBarabasi:2002,RogersKincaid:1981[21]

The cost of link formation, c, separates equilibria into several main classes distinguished by the shapes of the networks that form.When the cost of link formation c is greater than the total direct and indirect benefits of forming any links, the equilibrium is an *empty* network—or a network in which no player is connected to any other player (see Figure 5.a). As the cost of link formation, c, decreases, however, there is a threshold, c_c^*, at which actors are indifferent between forming an empty network or a *circle*—a network in which each actor has exactly two direct links (see Figure 5.b). In a circle network, the cost of link formation, c, is still greater than the benefit from any single direct link $\alpha_i\alpha_j\delta$, or $c > \alpha_i\alpha_j\delta$, yet this cost is made up by the additional benefits from the indirect links (recall that indirect links are free).

As the cost of link formation, c, decreases even further, it reaches the second threshold $c_b^* = \alpha_i\alpha_j\delta$, at which the cost of forming a link is made up by the benefit derived from this link. When the cost of link formation c is below this threshold, the equilibrium network configuration also depends on the difference in benefits between a direct and an indirect link or the relationship between c and $c_a^* = \alpha_i\alpha_j\delta - \alpha_i\alpha_l\alpha_j\delta^2$. When the difference in benefits is low or $c_a^* < c_b^*$, which means that the gain in benefits from forming a direct link rather than an indirect link does not outweigh the cost of link formation c, states predominantly rely on indirect links. Within this cost range of c, we will observe *star-shaped* equilibrium networks (Figure 5.c). A *star-shaped* or a *hub–and–spokes* network is a network in which all players are linked to one central player—*the hub*—and there are no other

[21] In an empirical application, Dorussen & Ward (2008: 197) express a very similar idea, arguing that "the most empirically plausible [. . .] are short ones using just one intermediary."

links: $g \subset g^N$ is a star if $g \neq \emptyset$ and there exists $i \in N$ such that if $jk \in g$, then either $j = i$ or $k = i$. State i is the center of the star. The star-shaped equilibria persist within the link formation cost range c, under which the benefits from direct links outweigh the cost of forming them, yet indirect links still yield greater net benefits than direct links (as indirect links are free).

Finally, as the link formation cost, c decreases to $c \leq c_a^*$, the discounted benefits associated with indirect links no longer justify the "saving" in cost and all actors choose to form direct links to one another, which results in a *complete* network (Figure 5.d). A *complete* network or a *clique* is a network in which each player has a link to each other player: $g \subset g^N$ is a complete network if $\forall i \in g, j \in g : ij = 1$.

This can be summarized in Proposition 1.

Proposition 1 (See Table Appendix B of appendix)**.** *There exist threshold values of link formation cost c, such that:*

1. *when $c < c_a^*$, actors form a complete network;*
2. *when $c_a^* < c < c_b^*$, there exists an equilibrium in which actors form a star-shaped or a circle network;*[22]
3. *and when $c_b^* < c$, there exists an equilibrium in which actors form a circle or an empty network.*

Deriving predictions regarding the relationship between indirect/direct links and actor type requires variation in both actors' number of direct/indirect links and actor type choice: i.e. if number of links and type choice are constant among players, we cannot derive predictions about the relationship of interest. Hence, I focus on a class of equilibria, to which I will refer as *heterogeneous equilibria* and define as equilibria, in which at least one actor makes a different type choice than all other actors. More formally, a heterogeneous equilibrium network has the property of $D_i \neq D_{-i}$ for at least one player i. The simplest example of a heterogeneous equilibrium is a star equilibrium, in which the center node plays $D = 1$, while the spokes play $D = \alpha$. As demonstrated in Table 3 of this appendix, such a network is an equilibrium when $\alpha^2\delta - \alpha^2\delta^2 < c < \alpha\delta$ and $(1-\alpha)\left(\delta + \alpha\delta^2(n-2)\right) < \sigma < (1-\alpha)(n-1)\alpha\delta$. The focus on star-shaped equilibria is also empirically justified, as during the time period under investigation, the trade network is neither

[22] Note that other equilibria, such as circles, are also possible in this cost range.

fully connected (which would imply that c is much smaller than assumed) nor sparsely connected (which would imply that c might be higher than assumed). In the data used for the empirical analysis, approximately 35% of dyads are not directly connected by a trade link (for similar sample statistics, see Helpman, Melitz & Rubinstein, 2008: fn 21).

Heterogeneous Equilibria

Within the link formation cost range of $c_a^* < c < c_b^*$ or, more precisely, $\alpha^2\delta - \alpha^3\delta^2 < c < \alpha^2\delta$, the game has n pure strategy star-shaped equilibria, in each of which one actor serves as the *center* of the star and others act as *spokes*. An interesting property that results from the asymmetry of this equilibrium class is that the center and the spokes obtain different payoffs, and hence have different incentive structures for their type decisions (see Figure 6). Specifically, the center of the star obtains the net benefit of:

$$U_c = (n-1)\left(\alpha^2\delta - c\right). \tag{41}$$

Actors located at the spokes of the star, in the meantime, obtain:

$$U_s = \alpha^2\delta + (n-2)\,\alpha^3\delta^2 - c. \tag{42}$$

This difference in utilities comes into play, because actors' type decision depends on the cost of *Respecter*, σ, as actors will play *Respecter* when its cost σ is compensated by the additional benefits that can be accrued as a result of increasing one's own type α_i. The center player will choose *Respecter* when:

$$\sigma \leq \alpha\delta\,(1-\alpha)\,(n-1) = \sigma_c^*. \tag{43}$$

A player located at the spoke, on the other hand, will choose *Respecter* when:

$$\sigma \leq (1-\alpha)\left(\alpha\delta + \alpha^2\delta^2\,(n-2)\right) = \sigma_s^*. \tag{44}$$

Since σ_c is always greater or equal to σ_s^*, star-shaped equilibria can be further grouped into three sub-classes, based on the values of σ. When $\sigma > \sigma_c^*$, all states will play *Abusers* (i.e., choose not to protect domestic human rights). As the cost of human rights protection, σ, decreases to $\sigma_s^* \leq \sigma \leq \sigma_c^*$, we will observe heterogeneous networks with a human rights protecting *Respecter* center, but human rights *Abusers*-spokes. As σ decreases and reaches the range of $\sigma \leq \sigma_s^*$, all actors will play *Respecter*, independent of their position.

This can be summarized in Proposition 2.

Proposition 2 (See Table 3 of appendix)**.** *Within the range of link formation cost $c_a^* < c < c_b^*$, there exist threshold values of Respecter cost σ, such that:*

1. *when $\sigma < \sigma_s^*$, the star-shaped equilibria will consist of Respecter;*
2. *when $\sigma_s^* < \sigma < \sigma_c^*$, the star-shaped equilibria will consist of a Respecter center and Abusers as spokes;*
3. *and when $\sigma_c^* < \sigma$, the star-shaped equilibria (and all equilibria) will consist of Abusers.*

Type heterogeneity within star-shaped equilibria allows for deriving predictions on the relationship between actors' number of indirect links and type. More specifically, direct and indirect links to *Respecters* yield higher utility to other players, which means that (1) in all equilibria, *Respecter* states will have the same or higher direct degree, and (2) in equilibria that allow for heterogeneous types, *Respecters* will have higher degree than *Abusers*.

Proposition 3. *Within the range of link formation cost $c_a^* < c < c_b^*$, Respecters have a weakly higher direct degree.*

Proof of Proposition 3. Proposition 3 can be proven using a proof by contradiction. Suppose there is a pairwise stable network that consists of a *Respecter* R and an *Abuser* A, so that A has a higher direct degree than R. States R and A will then either be unconnected (Figure 7) or connected (Figure 8).

Scenario 1. R and A are not connected (Figure 7):

For A to have a greater direct degree means that A has at least one direct link. This implies that the cost of link formation c must be at least less than $\alpha\delta$ (if A's direct link is a *Respecter*). If $c < \alpha\delta$, however, then R and A can both increase their utilities by forming a link between themselves, hence this network is not pairwise stable—a contradiction.

Scenario 2. R and A are connected (Figure 8):

Let us check the type stability part of the equilibrium. State A will not deviate from its type choice $d = 0$ as long as its utility from $d = 0$ is greater than its utility from $d = 1$ or

$$\sigma > \delta (1 - \alpha) (n - 1) . \tag{45}$$

Analogously, R will not deviate from its regime decision $d = 1$ as long as:

$$\sigma < (1 - \alpha) \left(\alpha\delta + \alpha\delta^2 (n - 2)\right) . \tag{46}$$

Hence, this network is regime stable as long as there exists a range of σ, such that:

$$\delta (1 - \alpha) (n - 1) < \sigma < (1 - \alpha) \left(\alpha\delta + \alpha\delta^2 (n - 2)\right) . \tag{47}$$

Such a range exists if:

$$\delta (1 - \alpha) (n - 1) < (1 - \alpha) \left(\alpha\delta + \alpha\delta^2 (n - 2)\right) . \tag{48}$$

Dividing through by $\delta (1 - \alpha)$, we obtain:

$$n - 1 < \alpha + \alpha\delta (n - 2) , \tag{49}$$

or

$$\alpha > \frac{(n - 2) + 1}{\delta (n - 2) + 1} . \tag{50}$$

Since by assumption $0 < \delta < 1$, and $n > 2$ (since the network in Scenario 2 must have at least 3 actors), the numerator of the left-hand side of Inequality (50) is always greater than the denominator, which leads their ratio to be greater than 1. However, $\alpha < 1$, by assumption, which means that Inequality (50) will never hold. Hence, there is a contradiction. □

The intuition behind Proposition 3 is that, all else equal, any direct or indirect benefits that accrue from a trade link with an *Abuser* are discounted by α: conducting business in states with poor human rights practices or weak rule of law is associated with an efficiency loss. Thus, all else equal, when choosing between an *Abuser* and a *Respecter* trade partner, any state will always prefer the *Respecter* trade partner, irrespective of its own type. Or, in less technical language, states prefer to make a trade link with a state with more rather than less favorable domestic business climate.

Next, let us explore the relationship between an actor's number of indirect links and its incentive to play *Respecter*—the central relationship of interest in this paper. The prediction linking the effect of indirect links is formulated in Proposition 4.

Proposition 4.

Actors with higher indirect degree have a weakly lower incentive to play Respecter than states with lower indirect degree.

Proof of Proposition 4. In homogeneous equilibria (i. e. in equilibria, in which all actors play the same strategy), there is no variation in actor's network positions or payoffs. Hence, in homogeneous equilibria, there is also no variation in actors incentive to play *Respecter*.

The proof will therefore focus on heterogeneous equilibria. Let us denote an actor's incentive to play *Respecter* as I and assume that actor i plays *Respecter* when $I_i \geq \sigma_i$, i.e. when the actor i's incentive for playing *Respecter* is equal to or outweighs the cost of playing *Abuser*.

Let us denote any link of the shortest path $l \geq 2$ as an indirect link, and let us denote actor i's number of direct links as k_i. Since an equilibrium network will always consist of at most one non-empty component Jackson (see Proposition 6.2 of 2008: 161), we can say that actor i will have $n - k$ indirect links. Then, within any heterogeneous equilibrium, an actor's incentive to play *Respecter* will be at most:

$$I_i = (1 - \alpha) \left(k_i \alpha \delta + (n - k_i) \alpha^2 \sigma^2\right), \tag{51}$$

assuming that all indirect links are of the shortest path $l = 2$, and where $n = N - 1$, N is the total number of actors. Note that I_i increases with k_i and decreases with $n - k_i$, as k_i and $n - k_i$ act as weights on $\alpha\delta$ and $(\alpha\delta)^2$, and $\alpha < 1$, $\delta < 1$. Hence, an actor's incentive to play *Respecter* increases with its number of direct links and decreases with its number of indirect links. □

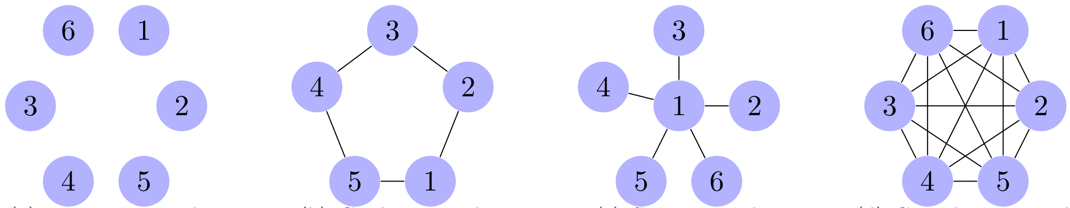
Proposition 4 is counter-intuitive. At first glance, it seems that increases of any type of trade partners—direct or indirect—would increase a state's incentive to choose *Respecter*. The equilibria analysis, however, leads to the opposite prediction. The logic is that within the star equilibria, no player can increase its number of indirect links without decreasing its number of direct links. In fact, within the star equilibria, each player's numbers of direct and indirect links have a perfect negative correlation: the center has exactly $n-1$ direct links and no indirect links, while each spoke has exactly 1 direct link and $n-2$ indirect links. This relationship holds for a fixed number of players N, which ensures that that players cannot gain in indirect links without losing in direct links. This assumption is reasonable for the study of the international states, whose number remains roughly the same throughout the time-period covered in this paper.

In less formal language, states with less favorable business conditions intentionally select themselves into indirect trade relationships—relationships that, while yielding slightly lower trade benefits, also put less pressure on their domestic affairs, such as governments' commitment to respecting human rights or enforcing the rule of law. All else equal, indirect trade is a conscious choice and a viable alternative to states that do not wish to improve their domestic business conditions. States that choose indirect trade do this strategically, trading in the lost benefit associated with trading through an intermediary for the benefit of avoiding outside influences on their domestic affairs. While the Ukrainian government is well aware of the efficiency losses associated with conducting business through more reliable third parties, such as Cyprus or the Netherlands, it chooses to pay this calculated cost in the face of a larger cost associated with respecting human rights, enforcing domestic rule of law, lowering its corporate taxes, building up its administrative capacity, etc. States that rely on a larger number indirect trade relationships, moreover, have a lower incentive to invest in improving their domestic business conditions. Given the game equilibrium they are in, the cost of making domestic changes is too prohibitive and would not be offset by the resulting improvements in trade benefits. Hence, as the number of a state's indirect trade relationships increases, its incentive to play *Respecter* goes down.

Table III. Symmetrical Strong Nash Stability Equilibria at Varying Costs c and α.

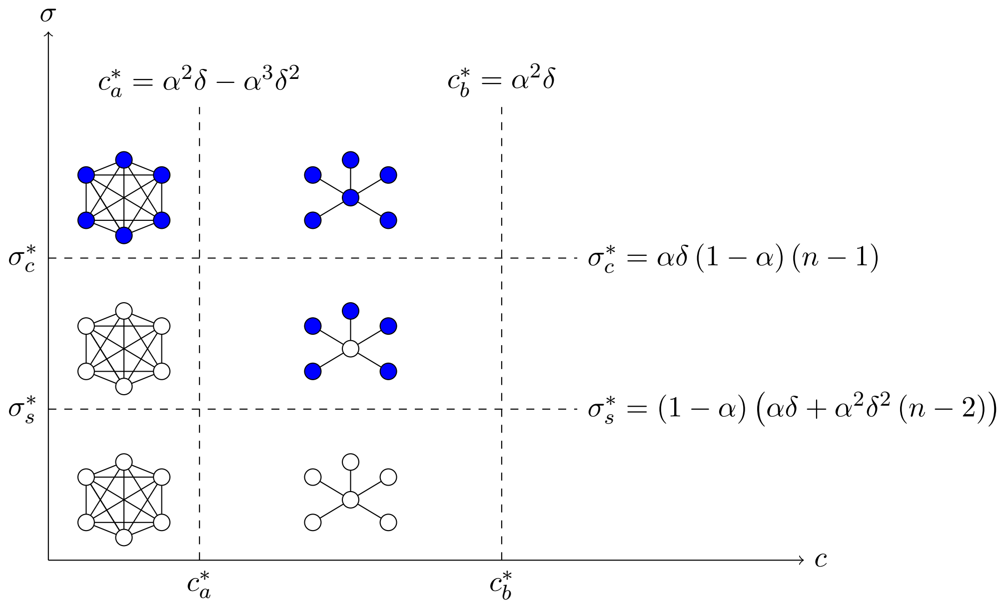
Link Cost c	Switching to *Respecter* Price σ	Network Description
Complete Networks		
$c < \alpha^2\delta - \alpha^3\delta^2$	$\sigma > (1-\alpha)(n-1)\alpha\delta$ (Lemma 2.ii)	Complete network of *Abuser* states.
$c < \delta - \delta^2$	$\sigma < (1-\alpha)(n-1)\delta$ (Lemma 2.i)	Complete network of *Respecter* states.
Star-Shaped Networks		
$\alpha^2\delta - \alpha^3\delta^2 < c < \alpha^2\delta$	$\sigma > (1-\alpha)(n-1)\alpha\delta$ (Lemmas 3–4, 5.ii)	A star consisting of *Abuser* states.
$\alpha^2\delta - \alpha^2\delta^2 < c < \alpha\delta$	$(1-\alpha)\left(\delta + \alpha\delta^2(n-2)\right) < \sigma < (1-\alpha)(n-1)\alpha\delta$ (Lemmas 3–4)	A star with a *Respecter* state at the center and *Abuser* spokes.
$\delta - \delta^2 < c < \delta$	$\sigma < (1-\alpha)\left(\delta + \delta^2(n-2)\right)$ (Lemma 5.i)	A star consisting of *Respecter* states.
Circle Networks		
For odd n, $n > 4$: $\alpha^2\delta - \alpha^3\delta^2 < c < \frac{\alpha\left(\alpha\delta - (\alpha\delta)^{\frac{n-1}{2}}\right)}{1-\alpha\delta}$. For even n, $n > 4$: $\alpha^2\delta - \alpha^3\delta^2 < c < \frac{\alpha\left(\alpha\delta - (\alpha\delta)^{\frac{n-2}{2}}\right)}{1-\alpha\delta} + \frac{1}{2}\alpha^{\frac{n}{2}+2}\delta^{\frac{n}{2}}$ for even n.	For odd n and $n > 4$: $\sigma > 2(1-\alpha)\left(\frac{\delta - \delta^{\frac{n-1}{2}}}{1-\delta}\right)$; for even n and $n > 3$: $\sigma > 2(1-\alpha)\left(\frac{\delta - \delta^{\frac{n-2}{2}}}{1-\delta} + \frac{1}{2}\delta^{\frac{n}{2}}\right)$. (Lemma 6)	Circle network of *Abuser* states.
$\delta - \delta^2 < c < \left(\frac{\delta - \delta^{\frac{n-1}{2}}}{1-\delta}\right)$ for odd n, or $\delta - \delta^2 < c < \left(\frac{\delta - \delta^{\frac{n-2}{2}}}{1-\delta}\right) + \frac{1}{2}\delta^{\frac{n}{2}}$ for even n.	When n is odd and $n > 4$: $\sigma < 2(1-\alpha)\left(\frac{\delta - \delta^{\frac{n-1}{2}}}{1-\delta}\right)$; when n is even and $n > 3$: $\sigma < 2(1-\alpha)\left(\frac{\delta - \delta^{\frac{n-2}{2}}}{1-\delta} + \frac{1}{2}\delta^{\frac{n}{2}}\right)$. (Lemma 6)	Circle network of *Respecter* states.

Figure 5. Network Shapes



(a) Empty Network (b) Circle Network (c) Star Network (d) Complete Network

Figure 6. Complete and Star-Shaped Equilibria



Note: Blue nodes represent *Abuser* and white nodes represent *Respecter* states.

Figure 7. Scenario 1. The Two Nodes are Not Connected

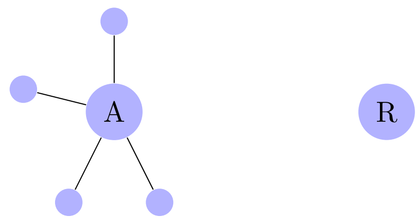


Figure 8. Scenario 2. The Two Nodes are Connected