War with Sovereign Debt*

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Abstract

This paper explores how international capital markets can reduce the frequency of interstate war that result from preventive motives. In particular, we demonstrate that, while preventive war remains possible, peace is more likely when a rising state can issue sovereign debt. The ability of the market to avert conflict between a rising state and its rival relies on a multitude of factors, including the price of debt, as well as market and state-specific conditions (e.g., the risk-free interest rate and the probability of default, respectively).

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A state that expects to experience a large shift in its military power faces a problem with its rivals. When a rising state grows stronger, it can and will demand more resources or a larger say in policy outcomes. The state in relative decline then faces a problem. Understanding that the shift in capabilities is coming, it is unclear why the rising state would honor any previous agreements with the declining state that did not reflect the rising state's newfound power. Furthermore, a rising state can only freely give all of today's resources to the declining state in an attempt to stop a preventive war. If such a sacrifice is insufficient to compensate the declining state for the series of losses they see coming, the rivals may find preventive war a better option. Here, war gives the declining state the hope of avoiding the consequences of the shifts in power and locking in their access to resources in the long run.

Such preventive wars are, at their core, wars resulting from a liquidity problem. In this situation the rising state does not have enough resources on hand to buy peace, but the state is not insolvent and it could credibly make transfers today if it could borrow against future streams of resources.[1]

To demonstrate how significant borrowing can be, consider the following example of a resource consumption problem between two states. Normalize the size of each period's resource pie to 1. Equating each period to a year, we can reasonably set the discount rate of future periods to 0.95. Assume the cost of war is 0.5 or half of all the resources available in a period. After a shift in power, assume that the rising power will win a war with the declining power with 0.5 probability. In this case, we can calculate that by going to war after the shift is complete the rising power will be able to guarantee itself the following expected value: the present value of the entire pie in every future period with probability 0.5 minus the cost of war. This value is approximately 9 pies in present value. If the rising state could borrow against this future value, then this is a source of transfers that is nine times the

[1]For instance, Baliga and Sjostrom (2013) comment that commitment problems as a cause of war arise when transfers are limited to current output. They note that transfers are limited in this manner when international bankers are unwilling to lend to states.

size of today's pie. That is, the traditional model only captures a tenth of the resources potentially available for bargaining. Of course, this is just an illustrative example, but there is nothing pathological about the parameterization. In fact, one could easily imagine realistic parameterizations with far more extreme outcomes.

If credit market access drives a great deal of the resources available for bargaining, this fundamentally alters our understanding of preventive war, bargaining, and the connections between conflict and international finance. In this paper, we derive four immediate results from this change in approach, but this just scratches the surface of what future research might find.

First, one might ask if accessing credit markets always allows states to avoid war. The answer is no. The commitment problem due to power shifts remains a vital mechanism for interstate war. In fact, the extent of its impact is broadened by allowing for sovereign borrowing. Borrowing allows states to avoid a number of wars that would occur if credit market access was entirely shut down. The bar for a shift to cause war is increased, but it is still the case that increasing the likelihood, size, rapidity, and persistence of a power shift will make war more likely. Now though, significant power shifts that do not cause war but do cause borrowing bring about a new kind of inefficiency. Namely, borrowing in order to prevent war is non-productive and inherently inefficient. The more a state is forced to borrow in order to avoid preventive war, the more inefficiency a power shift introduces. This inefficiency is increasing in the size of the power shift until, ultimately, a significant enough power shift will bring about the full inefficiency of war.

Second, if credit market access is so critical to conflict, what drives credit market access? One might imagine a number of factors, but here we take on the most obvious—price. States must, at minimum, pay the risk-free rate that the bond market could achieve through some other loan. In addition to this, states must pay an endogenously determined premium on any loans they may default on. When a state's potential shift in power occurs with less than certainty, they may default exactly when they fail to grow. It's important to note that price may constrain borrowing through two different mechanisms: (1) from the rising power's perspective, loans may be too expensive to borrow relative to war today; (2) the bond market may be unwilling to lend enough to prevent war because the rising state is not sufficiently likely to be able to pay back the loan in the future.

Third, understanding that the bond market cares deeply about risk when making lending decisions allows us to derive a novel implication about the types of power shifts that are particularly dangerous. As in standard models, shifts with large expected values are more dangerous. In our model, given the size of an expected shift, more extreme but less likely shifts are more dangerous than highly likely but only moderately sized shifts. In these cases, the bond market is unwilling to lend because of the default risk in cases where the rising power fails to grow in strength.

Fourth, by connecting conflict and sovereign borrowing in our model, we are able to immediately see some obvious ways in which international economics and conflict intertwine. In our model, economics impacts international relations in that higher real rates reduce the mitigation effect of borrowing on preventive war therefore increasing the likelihood of conflict. On the other hand, international relations impacts economics in that shift in power may increase a state's borrowing for non-economic reasons, driving higher premiums on debt and potential defaults.

To explore the effects of borrowing on war, we build a simple model of preventive war where sovereign lending is possible. A rising state may sell bonds to a profit-maximizing market generating resources that they may then transfer to a declining state. Our model considers a bond market where states are allowed to default on these loans but do not do so if they have resources to pay their debt. We also simplify away from traditional consumption smoothing motives for state borrowing and instead focus on how borrowing may help states avoid preventive war due to commitment problems arising from stochastic shifts in power.

We find that borrowing from an outside lender or market against future bargaining gains allows the rising state to avoid war in certain circumstances. However, in some cases, preventive war is still unavoidable. There are two reasons for this. First, states must pay interest on their loans and, depending on market conditions, this interest may be high enough that states cannot credibly borrow enough today to fully alleviate the threat of preventive war. Second, states only achieve gains in power with some probability. When shifts fail to occur, states may default. When this risk of default is significant enough, lenders and states may be unwilling to agree to loans that would have avoided preventive war. This means both the nature of the power-shift and market conditions can determine when commitment problems cause war.

In addition to this result, three empirical predictions arise quite naturally from our simple setup. First, for future shifts of the same expected size, less probable but more extreme shifts are especially dangerous. In this case, markets are less able to provide liquidity given the high probability of default. This indicates that preventive war should be especially likely in situations where low probability, high impact changes are expected. For example, a nuclear weapons program delivers a relatively low probability of success in any given period, but a very high impact makes it difficult to resolve through borrowing.

Second, even when states can successfully borrow against uncertain future power shifts, they will often pay a premium on their debt. Markets will demand higher rates in order to cover themselves in the event that the state fails to grow more powerful and is forced to default. This effect may address why rapidly growing states in adverse security environments, like South Korea, pay a premium on their debt versus states in more benign security situations.[2]

Third, all else equal, when the world real risk-free interest rate is high, war is more likely

[2]Several studies, including recently Coudert and Mignon (2013), demonstrate that the carry trade with South Korea can produce excess returns in normal economic times. Rare economic disasters have been put forth as an explanation for why excess returns in the carry trade persist (Farhi and Gabaix 2016). Barro (2006) explicitly links rare economic disasters with the possibility of warfare.

through the commitment problem mechanism. The higher the risk-free rate, the better the outside option for the bond market relative to loaning to a rising power in our model. This makes bondholders less willing to lend and those loans that do occur are burdensome. Under these circumstances, potential borrowers may even prefer risking war to the very high rate loans they are offered.[3] Moreover, while the risk-free rate is exogenous in our model, it allows us to draw a direct connection between events like the worldwide depression before World War II that increased the cost of capital, and the subsequently heightened dangers of war due to commitment problems. For example, Romer (1992) demonstrates that real interest rates in the United States skyrocketed in the early part of the Depression and then again in 1937. Moreover, U.S. lending to Europe dropped significantly, from 598 million dollars in 1928, to 142 million dollars in 1929 (Kindleberger 1973, pg 56). The economic implications were particularly serious for Germany, which depended on U.S. loans to make reparations payments.[4] A particularly interesting connection between financial markets and war is the implication that significant conflict in one part of the world may raise the risk-free rate and serve as a contagion channel for war in other parts of the world.

Commitment Problems and Sovereign Debt

This paper connects two distinct literatures. The first studies how dynamic changes in the international power structure lead to commitment problems that potentially cause war. The second studies how shifting economic fortunes may lead states to strategically default on their debt.

The international relations literature on commitment problems begins with Fearon (1995) and is further theoretically developed in several subsequent papers (Powell 1999, 2004, 2006,

[3] In an empirical paper, Chapman and Reinhardt (2013) find that higher costs of foreign capital increase the likelihood of civil conflict.

[4] A full discussion of this highly complex situation is beyond the scope of this paper. See Kindleberger (1973) and Tooze (2006) for in-depth analyses of this case.

2012, 2013; Fearon 1996, 2004; Leventoglu and Slantchev 2007; Chassang and Padro i Miquel 2010; Bas and Coe 2012; Debs and Monteiro 2014; Krainin and Wiseman 2016; Krainin 2017; Krainin and Slinkman 2017; Wiseman 2017). Commitment problem models have been recently utilized to understand a number of applied issues including civil wars (Paine 2016) and how domestic politics affects the potential for interstate war (Chapman, McDonald, and Moser 2015). Moreover, new techniques have been developed to empirically test commitment problem models (Bell and Johnson 2015; Bas and Schub 2017). However, thus far no paper has addressed how borrowing against the future may impact the liquidity constraint that lies at the heart of the commitment problem.

In order to address this question, we connect this international relations literature on commitment problems to the economics literature on sovereign default. The default side of this paper's model is most closely connected to the one developed in Arellano (2008). Eaton and Gersovitz (1981) provides a classic contribution to this literature while Chatterjee et al. (2007) makes important recent theoretical advances in the context of strategic consumer default. The literature on sovereign default includes a vast number of papers that make theoretical and empirical contributions. However, papers in this literature do not model lending in a strategic security context, and therefore cannot address how the specter of preventive war may lead to debt build-ups and subsequent defaults.

Some previous work has studied the militarization of sovereign debt collection. Both Finnemore (2003) and Mitchener and Weidenmier (2010) find that militarized debt collection was a common tool in the pre-World War I era. On the other hand, Tomz (2007) argues that creditor governments rarely used or threatened to use military force in the event of sovereign default. While these studies engage with the incentive to militarize debt collection, our paper focuses on how sovereign lending interacts with the incentives for preventive war.

Another recent literature has focused on debt financing war efforts. McDonald (2011) demonstrates how sovereign lending allows states to maintain arms races without having to renegotiate their society's basic social contract. Slantchev (2012) builds a model where states may borrow unlimited amounts of debt to finance mobilization efforts, and default occurs when a state is defeated in war. Slantchev establishes that the incentives states have to borrow can endogenously induce conflict. In his model, borrowing can endogenously increase the cost of preserving a peaceful status quo relative to war because war lowers the burden of debt by allowing the defeated state to default.[5] In contrast to work emphasizing war as a driver of sovereign default, Shae and Poast (2017) finds that states are unlikely to default after losing a war. The reasoning is similar to an effect present in our model—lenders will strategically limit loans to amounts that receiving states can pay back with sufficient probability. Finally, Poast (2015) notes how states that possess central banks are better able to secure debt financing, especially in times of war.

North and Weingast (1989) develops a compelling theory that constitutional limits increase the credibility of sovereign debt. Schultz and Weingast (2003) argues that therefore, democratic states have greater ability to commit to repaying sovereign debts over autocratic states. More democratic states thus have an advantage in long-run hegemonic competition with less democratic states, since the more democratic states will be better able to finance wars and arms races. While some empirical studies have failed to support the "democratic advantage" thesis (Saiegh 2005; Archer, Biglaiser, and DeRouen 2007), several subsequent studies have refined the theory and found supporting empirical evidence (Stasavage 2007, 2011; Dincecco 2009; Beaulieu, Cox, and Saiegh 2012).

Our study does not directly address the democratic advantage. However, our results suggest that in a context where strategic default is possible, more democratic states would similarly have an advantage in maintaining peace by utilizing greater debt market access to supply peaceful transfers in order to avoid the possibility of preventive war. This effect may speak to the peaceful rise of the United States vis-à-vis Great Britain in the period between the American Civil War and World War I.

[5] Powell (2006, pg. 192-194) analyzes a different context where the cost of maintaining the status quo leads to war.

Another long-running literature has argued that financial interests work to create peace. Polanyi (1944) argues that powerful, cartel-like financial interests actively pushed the international system toward peace in the 19th century. Recently, Flandreau and Flores (2012) has refined Polanyi's argument, suggesting that "prestigious" financial certification intermediaries act to avoid war in order to avoid the possibility of sovereign default and the consequent damage to their reputations. Alternatively, Kirshner (2007) proposes a preference-based argument emphasizing that financial communities are averse to war due to its deleterious impact on macroeconomic stability.

Similarly, in our model, financial interests effectively work to help states avoid preventive war. However, they do so as a direct consequence of their profit-maximizing activity. Purely through their economic self-interest of seeking the most profitable investments, financial interests may help states maintain peaceful international bargains. One advantage of our analysis is that the limits of this incentive are clear, and we are able to identify when wars will occur despite the effect of financial interests. Moreover, our argument does not preclude that the peaceful effects others have pointed to in this literature may also motivate financiers beyond our proposed mechanism.

Finally, it is worth a few words about the relationship between our model and observed state behavior. Clearly, our set up is both simple and abstract. We consider a pie, a discount bond sale, a transfer, and a repayment. In some cases, like German war reparations, the straight line between the debt instrument and the transfer is clear, but in almost all cases it clearly won't be. States are involved in many activities that require spending, and possibly issuing bonds, and countries can make different kinds of policy choices that are essentially equivalent to transfers. As a result, the major contribution of this theory is a clear understanding of the bounds on the potential effects of credit markets on wars resulting from commitment problems. The relevant empirical implications are going to be indirect, that is a relationship between central variables of our theory and key measures of conflict between countries. We don't, for example, expect to see China issuing ten year bonds and wiring the cash to the U.S. Treasury, but we would expect changes in the risk-free rate to have wide ranging effects on conflicts with preventive war incentives.

Model

To model the bargaining problem with power shifts and a financial market, we start with the canonical model of bargaining and war and then add a profit maximizing bond market. As we will see, the bond market has important effects on the probability of conflict emerging from the commitment problem.

Players and Resources

There are two states, Home (H) and Foreign (F), that interact over two periods, $t \in \{1, 2\}$. Home can borrow against the future through the bond market or lender, L, for an amount that it can use in bargaining with Foreign.[6] Namely, in period 1, H can sell one-period discount bonds, B, at a "discount price" $q < 1$. The countries must bargain over an international flow of benefits each period, normalized to size 1, plus qB if Home chooses to borrow knowing they will need to pay back B in the future. Foreign makes a take-it-or-leave-it proposal x_t, in each of two periods where Home receives x_t and Foreign receives the remainder of the benefits, as well as any amount borrowed by H from the bond market.

Future periods are discounted at the common rate $\beta \in (0, 1)$. We think of period 2 as representing the entire future, therefore payoffs in period 2 are valued at $\beta/(1-\beta)$ times the value of payoffs in period 1. Hence, H's total utility for a peaceful sequence of bargain offers is

$$V_H = x_1 + \tfrac{\beta x_2}{1-\beta},$$

[6]Alternatively, the lender may be another state. In this case, the lender may be strategic, a possibility we consider below.

and F's total peaceful utility without borrowing is

$$V_F = (1 - x_1) + \tfrac{\beta}{1-\beta}(1 - x_2).$$

With borrowing by H, F additionally gains a one-time transfer of qB.

The Bond Market

We start by considering a financial market consisting of profit-maximizing traders, collectively acting as the non-strategic lender L, who are willing to buy bonds from Home. L can alternatively lend money at an international interest rate $r > 0$. If feasible, Home commits to pay back L when Home borrows. Therefore, Home does not default strategically and only defaults when it lacks the ability to pay back its bonds. This happens with probability δ, a value that will be determined endogenously and described in a subsequent section. Other than maximizing its return, L has no further interest in outcomes for Home and Foreign. We also assume Home places a sufficient value on the future, $\beta > \frac{1}{1+r}$, so that it does not have an incentive to borrow against future wealth in order to consume more today purely due to impatience. For simplicity, we also do not allow other states, like Foreign, to buy Home's bonds.[7]

Our commitment assumption that Home does not default strategically is a stark simplification, but could be justified in two ways in a more general model. One, Home may want to borrow for a variety of reasons (such as consumption smoothing) and loses access to markets after defaulting. Two, the model could be extended to the case where shifts in power happen repeatedly and Home must preserve a good reputation with bond traders in order to preserve liquidity in case of future shifts.

[7]In this sense the financial resources are coming from outside the strategic interaction. We refer to this later as outside money. The case for inside money is considered in the extensions.

Empirically countries are borrowing for many reasons, and bond income goes into general funds that are used for many things like building roads, social welfare programs, and foreign aid. While our model considers the single war-oriented motivation for borrowing, its real world implication is an association between the price of public debt and peace.

War

In our model war is represented by a costly lottery. Each state wins the war with some probability and pays costs $\kappa > 0$. The winning state captures the value of the international flow of benefits in both periods. The losing state can still consume any domestic resources, but can no longer challenge the winning state for a portion of the international pie. We can think of the losing state as being disarmed.

In this model, states win a war with an exogenously determined probability. H's probability of winning a war, or strength, in period 1 is s, and Foreign's probability of victory at time 1 is $1 - s$. If war occurs in period 1, then the value of war to H is

$$\tfrac{1}{1-\beta}s - \kappa.$$

We assume this value is positive to avoid uninteresting cases.

In the event that H wins the war, H captures the entire international pie of size 1 today and in the future. This is multiplied by $\frac{1}{1-\beta}$ to account for period 2 representing the entire future. F's value for war in period 1 and the value of war for both states in period 2 can be similarly defined.

Exogenous Power Shifts

Now consider the impact of a potential exogenous power shift, which occurs at the end of period 1 with probability $\rho \in (0, 1)$. If no shift occurs, H's probability of victory remains the same as in period 1, at s. If a shock does occur, H's probability of victory increases to θs where $\theta \in \left(1, \frac{1}{s}\right)$. Note that for simplicity we only consider positive shocks to H's exogenous probability of victory.

Timing

Putting it all together, period 1 proceeds as follows:

1. Home and Foreign both learn the values of ρ and θ.

2. Home chooses how much to borrow, qB, this period.

3. Foreign makes a take-it-our-leave-it offer to Home of x_1, where Foreign gets the remainder of the international pie and whatever Home borrowed, or Foriegn declares war.

4. Home either accepts or rejects the offer. If Home accepts, the states peacefully consume their allocations. If Home rejects, war occurs and the states receive their war payoffs.

5. Power shifts occur with probability ρ.

Period 2 proceeds in the same way except that steps 1, 2, and 5 are skipped, and that if war has occurred, the winner receives the whole international pie. Our solution concept is Subgame Perfect Equilibrium (SPE).

Analysis

Power Shifts without Borrowing

In this portion of the analysis, we explore how Home behaves when borrowing is not a possibility. We can see how our problem relates to the classic explorations of the commitment problem in Fearon (1995; 2004) and Powell (1999; 2004; 2006). This relationship is easiest to see when $\rho = 1$, such that a power shift will occur with certainty. When this is the case, H has an initial war value in period 1 of

$$\tfrac{1}{1-\beta}s - \kappa,$$

which, in period 2, increases to

$$\tfrac{1}{1-\beta}\theta s - \kappa$$

after the power shift takes place.

Anticipating this shift in power, Foreign prefers war versus any bargain when its period 1 war value is greater than the largest bargain H can credibly commit to in the future. This amount is the entire pie today, plus the entire future bargain value, minus the discounted value of Home's period 2 war value. That is,

$$\tfrac{1}{1-\beta}(1-s) - \kappa > 1 + \tfrac{\beta}{1-\beta} - \beta\left[\tfrac{1}{1-\beta}\theta s - \kappa\right].$$

After some rearrangement, we can solve for the minimum size θ that leads to war. This result is presented as Lemma 1.

Lemma 1. *When there is no borrowing and $\rho = 1$, then war occurs if and only if $\theta > \tfrac{1-\beta}{\beta s}(1+\beta)\kappa + \tfrac{1}{\beta}$.*

This result is essentially identical in form to the conditions on war found previously in the literature for one period, exogenous shifts in power (Powell, 2006). The size of the shift necessary to cause war is increasing in the costs of war, decreasing in the discount rate, and decreasing in the initial probability of victory for the positively shifting power.

The first modification to this canonical case is that we allow for the possibility that $\rho \neq 1$. Hence, with probability ρ, a shift as above will occur, while with probability $1-\rho$, a shift will not occur. This leads to a modification of the condition in Lemma 1, which is stated in

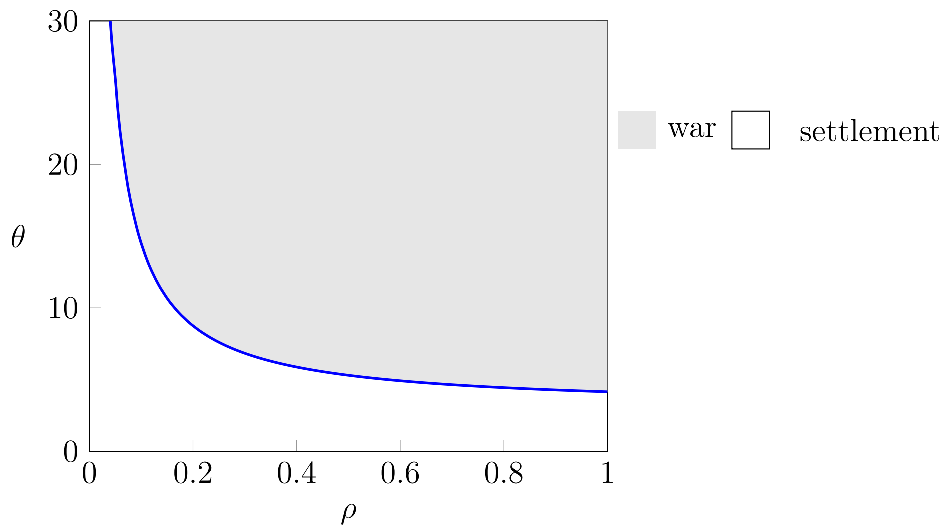

Figure 1: War with uncertain power shifts.

Lemma 2.

Lemma 2. *When there is no borrowing, then war occurs if and only if*

$$\theta > 1 + \frac{1-\beta}{\beta\rho}\left(1 + \frac{1+\beta}{s}\kappa\right). \tag{1}$$

(The proof of all results can be found in the appendix.)

As can be seen, when the probability of the shift goes to one, smaller changes in Home's military capabilities (θ) can lead to war as a result of the commitment problem. This can be seen in the graph in Figure 1. The condition for war for a probabilistic shift otherwise behaves in the same manner as when the shift is certain, with the the size of shift needing to increase in the costs of war, and decrease in the discount rate and initial probability of victory.

The Effect of Borrowing

Lemma 2, represented by the shaded region of Figure 1 defines the circumstances where Home may choose to borrow from the bond market in this model. Home only desires to borrow in order to avoid war and therefore only borrows when inequality (1) is satisfied. There are two further conditions on borrowing explored in detail below. First, the buyer of the bond must prefer to loan H a sufficient amount of money to avoid war to its outside option for that money. Here, that outside option is the exogenously given global risk-free interest rate, r. Second, H must prefer to borrow a sufficient amount of money to avoid war to the payoff from war.

Borrowing increases the possibility of peace, by transferring money from H's future income to today where it can be credibly be transferred to F. The amount of borrowing necessary to prevent war can be derived directly from inequality (1), since F's utility from fighting in period 1 must be at least as much as its utility from getting all of the pie in period 1, its portion of the pie in period 2, and any amount H borrows to appease F. Borrowing amount qB today is therefore just sufficient to prevent war when

$$\tfrac{1}{1-\beta}(1-s)-\kappa=1+\tfrac{\beta}{1-\beta}+\beta\kappa-\rho\left(\tfrac{\beta}{1-\beta}\theta s\right)-(1-\rho)\left(\tfrac{\beta}{1-\beta}s\right)+qB^{*}.$$

We can solve for the minimum loan qB^* required to prevent war, presented in Lemma 3. Note that if $qB^* < 0$, then no borrowing is required.

Lemma 3. *When there is borrowing, F requires at least $qB^* = \frac{s\beta\rho}{1-\beta}(\theta-1) - s\left(1+\frac{1+\beta}{s}\kappa\right)$ to opt for peace.*

Home has to borrow more when the probability of a power shift is higher, since Foreign will be more worried about the possibility of power transition, as well as when the size of the possible shift increases. Home borrows less when the cost of war is higher, since F is less worried about its willingness to fight wars. The effect of the discount rate and the initial probability of victory are ambiguous on the borrowed amount.

The Bond Market's Perspective

Home defaults on its loans in period 1 when it lacks the resources to pay back bondholders. Let the probability of default be δ (this will be determined endogenously later). Before calculating the probability of default for various parameters, first consider the Lender's bond purchasing decision. By borrowing from L, Home promises to pay back B to bondholders in period 2, while receiving qB today. However, Home only pays L back with endogenous probability $1-\delta$. Alternatively, market actors could lend qB on the international market and receive back $(1+r)\,qB$ for sure next period. By no arbitrage, the expected return must be equivalent under both investment schemes, so that

$$(1-\delta)\,B = (1+r)\,qB$$
$$q = \tfrac{1-\delta}{1+r}.$$

Hence, we can calculate the price of the bond q as a function of the default rate δ and the going risk-free rate of r.[8]

Now consider Home's borrowing decision. Home pays a premium on borrowed money and, therefore, only borrows when either q is low relative to future value of consumption—that is when Home would prefer to consume tomorrow's income today because interest rates are low and it is impatient. We rule out this possibility in our model with the assumption that $\beta > \frac{1}{1+r}$—or when liquidity is constrained, so transfers are needed in order to avoid war.[9] Therefore, Home does not borrow when it can buy peace without borrowing, meaning when inequality (1) does not hold.

[8]The assumption of total default is based on the idea that the inability to pay back the bond makes future borrowing for any purpose impossible so there is no point in paying back part of the debt. If instead we assumed that there was partial default, it would have the natural effect of making risky lending more attractive and risky borrowing more costly, but not fundamentally change any result.

[9]Note that in traditional macro models, H would borrow in order to smooth consumption

When inequality (1) does hold, Home prefers to borrow and avoid war so long as borrowing and avoiding war gives a higher payoff than fighting. In order to calculate this, we must first calculate the value of borrowing. If borrowing is sufficient to prevent war in the initial period, two things may happen in period 2. Either Home experiences a positive shift with probability ρ and can borrow, and pay back, up to the entire present value of future payoffs determined by H's war value in this case, i.e.

$$\beta\left(\tfrac{1}{1-\beta}\theta s-\kappa\right),$$

or a shift does not happen and it can only pay bondholders back with

$$\beta\left(\tfrac{1}{1-\beta}s-\kappa\right).$$

As determined above, B^* is the smallest bond necessary to prevent war, with bond price $qB^*=\frac{1-\delta}{1+r}B^*$. Therefore, there exists three borrowing regions. In the region where $B^*>\beta\left(\frac{1}{1-\beta}\theta s-\kappa\right)$, Home cannot commit to ever repaying and default is assured, so $\delta=1$. In the region where $B^*<\beta\left(\frac{1}{1-\beta}s-\kappa\right)$, then $\delta=0$ and default never occurs. If B^* is between these two values, then δ is equal to the probability of no shift, or $1-\rho$. These regions imply a q of 0, $\frac{1}{1+r}$, and $\frac{\rho}{1+r}$, respectively. The bond market will only lend to H in the latter two cases.

The Borrower's Perspective

Although borrowing can reduce the likelihood of war, war may still occur if Lenders will not lend as much as Home needs, or if Home does not think borrowing is a better deal than going ahead and fighting a war. First, consider solutions where $\delta=0$, which is only the case

across periods. This incentive does not come into play in this model since we have assumed linear utility in consumption.

when

$$\frac{1}{1+r}B^{*}=\frac{s\beta\rho}{1-\beta}\left(\theta-1\right)-s\left(1+\frac{1+\beta}{s}\kappa\right)$$

and

$$B^{*}<\beta\left(\frac{1}{1-\beta}s-\kappa\right).$$

The bond market will not offer such a loan when

$$s\left(1+r\right)\left[\tfrac{\beta\rho(\theta-1)}{1-\beta}-\left(1+\tfrac{1+\beta}{s}\kappa\right)\right]>\beta\left(\tfrac{1}{1-\beta}s-\kappa\right)$$

In any situation where borrowing is considered, H cannot appease F in period 1 simply with the existing international pie, so it will either go to war in the first period, or it will give up all of the pie and a borrowed amount in the first period while gaining part of the pie in the second period. Substituting the above determined value of B^{*}, this inequality indicates that war is still preferred to no-default borrowing when:

$$\tfrac{1}{1-\beta}s-\kappa>\beta\left[\rho\left(\tfrac{1}{1-\beta}\theta s-\kappa\right)+\left(1-\rho\right)\left(\tfrac{1}{1-\beta}s-\kappa\right)-s\left(1+r\right)\left[\tfrac{\beta\rho(\theta-1)}{1-\beta}-\left(1+\tfrac{1+\beta}{s}\kappa\right)\right]\right].$$

Analogously, a risky loan with $\delta=1-\rho$ gives the bond amount

$$\frac{\rho}{1+r}B^{*}=\frac{s\beta\rho}{1-\beta}\left(\theta-1\right)-s\left(1+\frac{1+\beta}{s}\kappa\right),$$

such that

$$\beta\left(\frac{1}{1-\beta}s-\kappa\right)<B^{*}<\beta\left(\frac{1}{1-\beta}\theta s-\kappa\right).$$

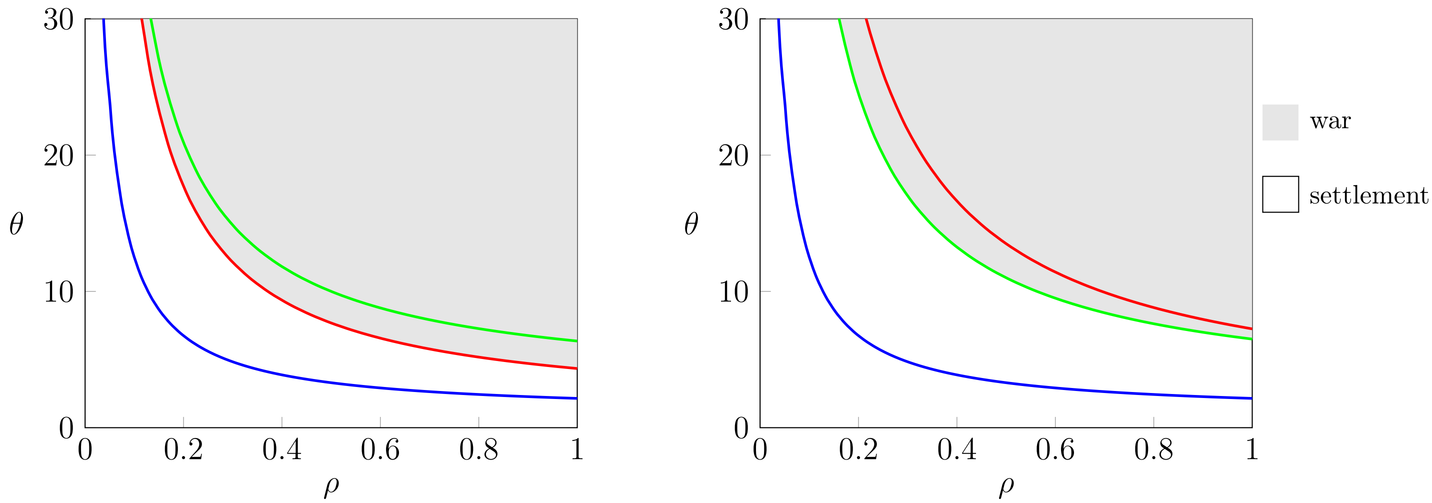

Figure 2: Peace bonds and the incentives to borrow and lend.

In other words, the bond market will still not lend if

$$\tfrac{s}{\rho}\left(1+r\right)\left[\tfrac{\beta\rho(\theta-1)}{1-\beta}-\left(1+\tfrac{1+\beta}{s}\kappa\right)\right]>\beta\left(\tfrac{1}{1-\beta}\theta s-\kappa\right).$$

Here there is a $1-\rho$ chance of default, in which case H does not have to pay off the loan, but the effect on H's finances is canceled out by the difference in pricing from $q=\frac{1}{1+r}$ to $q=\frac{\rho}{1+r}$. H therefore prefers war to either kind of borrowing when

$$\tfrac{1}{1-\beta}s-\kappa>\beta\left[\rho\left(\tfrac{1}{1-\beta}\theta s-\kappa\right)+(1-\rho)\left(\tfrac{1}{1-\beta}s-\kappa\right)-\rho\left(\tfrac{s}{\rho}\right)(1+r)\left[\tfrac{\beta\rho(\theta-1)}{1-\beta}-\left(1+\tfrac{1+\beta}{s}\kappa\right)\right]\right].$$

These conditions are summarize graphically in Figure 2, war occurs if (1) holds and Foreign prefers preventive war to peace without borrowing, and either (2) Home prefers war to the amount of borrowing that prevents war, or (3) the bond market is not willing to offer a loan for the amount Home needs to prevent war either the lender's lending constraint or Home's borrowing constraint may be violated. When they do it is a consequence of both the exogenous costs of borrowing, r, and the endogenous elements, δ and q. But clearly access to credit markets still leaves room for war. We express these latter two conditions in Lemmas 4 and 5, where the condition for Home being willing to fight rather than borrow is

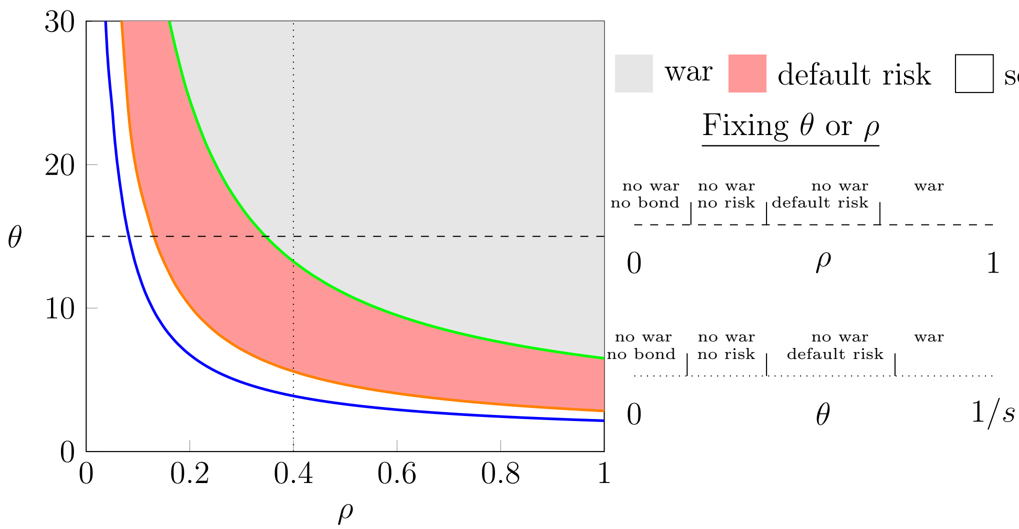

Figure 3: Borrowing, war and the risk of default.

rearranged and simplified:

Lemma 4. *H prefers fighting to borrowing when*

$$\theta\rho > \rho + \tfrac{1-\beta}{\beta} - \tfrac{\kappa}{s}\left(\beta + \tfrac{1-\beta(1-r)}{\beta[1-\beta(1+r)]}\right). \tag{2}$$

Lemma 5. *The bond market will not offer a loan if*

$$\tfrac{s}{\rho}\left(1+r\right)\left[\tfrac{\beta\rho(\theta-1)}{1-\beta} - \left(1 + \tfrac{1+\beta}{s}\kappa\right)\right] > \beta\left(\tfrac{1}{1-\beta}\theta s - \kappa\right). \tag{3}$$

In the following section, we analyze the comparative statics of inequalities (1), (2), and (3) from Lemmas 2, 4, and 5 respectively.

Figure 3 shows the different conditions one might encounter in a given crisis. In this figure the borrower or lender's constraint might bind, but we show the lender's constraint in this example. As can be seen the market is often willing to make risky loans that will avoid war, but this is not always the case.

Potential for Conflict Despite the Possibility of Borrowing

Recall inequalities (1), (2), and (3). War occurs whenever (1) is satisfied and borrowing fails to occur because either H prefers paying the cost of war to borrowing at a high premium (as in equation (2)) or L will not lend because H would default at any interest rate that L is otherwise willing to offer (as in equation (3)). Proposition 1 shows that increasing either the probability of the shift ρ or the size of the potential shift θ increases the likelihood of a power transition war.

Proposition 1. *There exist shifts that cause war even with borrowing. Increasing the expected size of a shift increases in the potential for conflict.*

The proof follows fairly directly from the inequalities. Qualitatively, this proposition suggests that borrowing does not upend our thinking about power shifts, and that the dynamics seen in the non-borrowing case still hold. As illustrated in Figure 3, borrowing does not prevent all wars as θ increases, and the argument for ρ is analogous. Another way to phrase this proposition is that if a power shift described by (θ, ρ) first-order stochastically dominates the shift (θ', ρ'), then (θ, ρ) has a higher potential for conflict. So when shifts are more likely or more extreme, war becomes more likely. Moreover, even as $\beta \to 1$, some power shifts may cause war. Increasing β makes condition (1) easier to satisfy. Both (2) and (3) are always satisfied as $\beta \to 1$: the lower bound constraint of (2) converges to ρ which is always less than the left-hand side value of $\theta\rho$ since it assumed that $\theta \in (1,\ 1/s)$ and $s < 1$; (3) is always satisfied since the left-hand side goes to positive infinity while the right-hand side is finite.

We next look at instances in which changes in the type of shift increase the potential for conflict by increasing the range of parameters for which war occurs. Two shifts, (θ, ρ) and

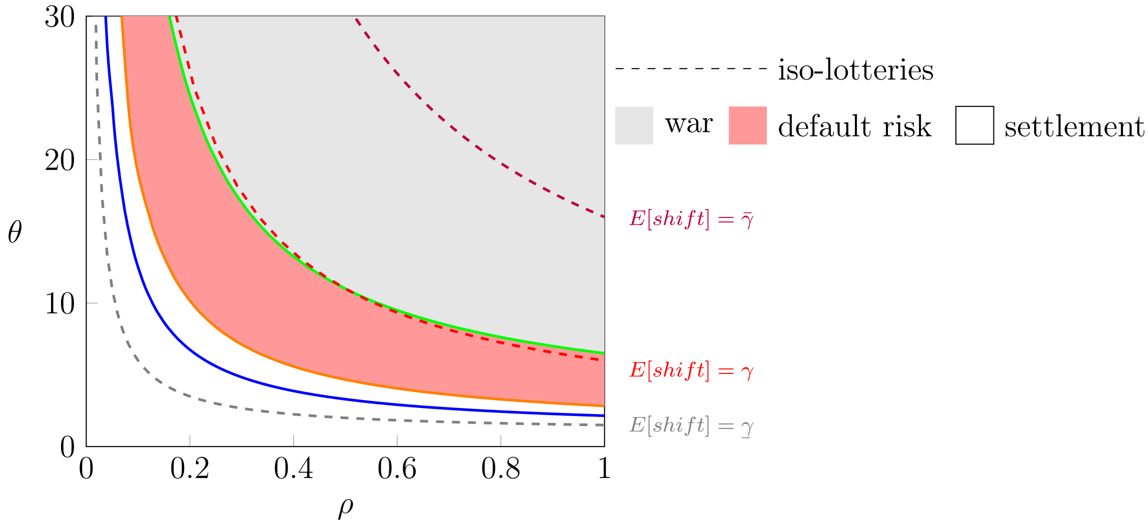

Figure 4: Mean preserving lotteries and the solving the commitment problem through debt

(θ', ρ'), have the same expected size if

$$\rho\left(\tfrac{\beta}{1-\beta}\theta s\right) + (1-\rho)\left(\tfrac{\beta}{1-\beta}s\right) = \rho'\left(\tfrac{\beta}{1-\beta}\theta' s\right) + (1-\rho')\left(\tfrac{\beta}{1-\beta}s\right)$$
$$\rho\theta s + s - \rho s = \rho'\theta' s + s - \rho' s$$
$$(\theta - 1)\,\rho s = (\theta' - 1)\,\rho' s.$$

Note that if two shocks have the same expected size, then F expects to offer H the same size pie in the second period, so it can be bought off with the same transfer amount:

$$qB^* = q'B'.$$

Because traders on the bond market care as much about the likelihood of repayment as about the rate of repayment, they may refuse to lend in situations where H's expected power shift is extreme but improbable. Even when H and F's calculations are not affected because there is no change in the expected size of the shift, L may prefer not to lend and leave H with no recourse but war.

Proposition 2. *For shifts of the same expected size, lower probability but more extreme*

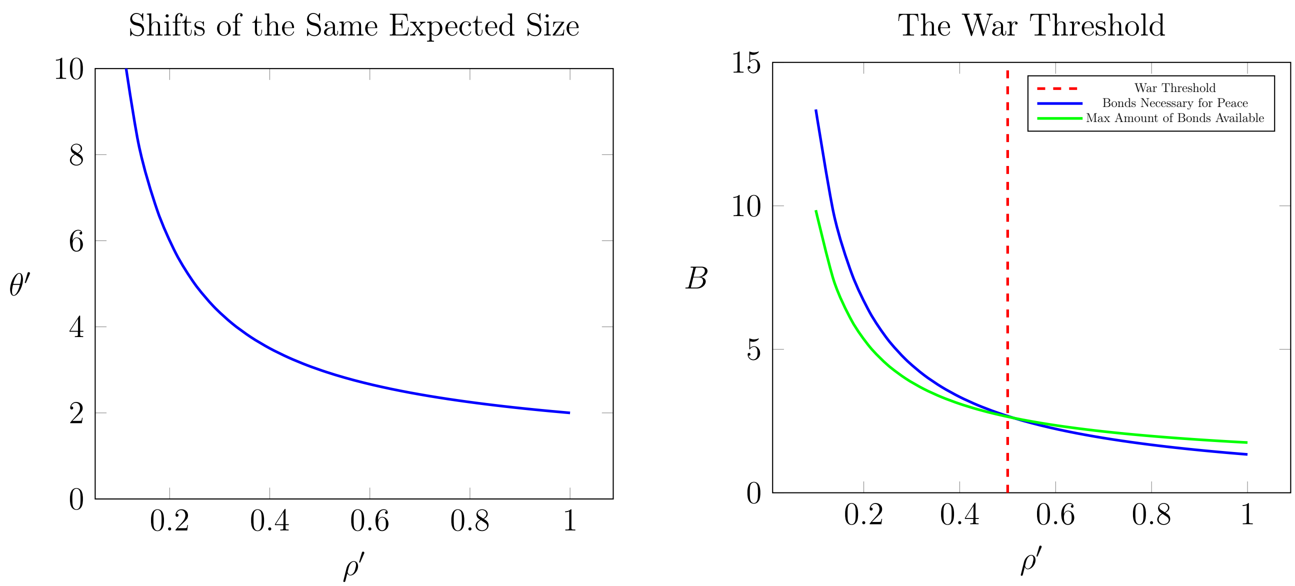

Figure 5: The Effect of Changing ρ' on Shifts of the Same Expected Size
Consider an initial shift of (θ, ρ). Proposition 2 states that if a shift (θ', ρ') is of the same expected size, then the more extreme/less likely (θ', ρ') is, the greater the potential for conflict. The left panel plots out how θ' changes in ρ'. The right panel plots how the left hand and right hand sides of inequality (3) change in ρ'. The left hand side (the blue line) indicates the necessary amount of bonds to avoid war. The right hand side (the green line) indicates the maximum amount of bonds L is willing to buy. When the blue line is above the green line, war results.

shifts increase the potential for conflict.

In other words, if a power shift (θ, ρ) second-order stochastically dominates a shift (θ', ρ'), then (θ', ρ') has a higher potential for conflict, even though the shift (θ', ρ') is a mean-preserving spread of shift (θ, ρ). This conclusion can be generalized to a continuous distribution of shifts.

Figure 4 illustrates this proposition for shifts that could induce risky borrowing. Shifts that are more extreme, but lower probability, are more dangerous for peace because it is harder for bond markets to provide the necessary liquidity. For example, to the lower right a shift of expected size γ can be compensated for by selling a risky bond, but a riskier shift of the same expected size leads to war. This has qualitative implications for interstate conflict. For instance, this may explain differences in how countries respond to purchases of conventional military equipment (low θ, high ρ), as opposed to investments in nuclear weapons technology (high θ, low ρ). Proposition 2 suggests that the latter would more frequently cause conflict. Similar effects can be seen in Figure 5 where the graph is in terms of the demand for bonds.

Finally, H may not be able to borrow at rates that it can afford if L has other, safer lending opportunities elsewhere because r is high.

Proposition 3. *Increasing the world risk-free interest rate, r, increases the potential for conflict.*

From this proposition, we conclude that exogenous shocks to the world economy that increase the cost of capital will also increase the likelihood of war. Such exogenous shocks could come in many forms. Burgeoning conflict in other parts of the world may cause increasing rates, which in turn causes bond traders to pick and choose where they lend. This could serve as a contagion channel for war to spread.

Strategic Lenders and the Existence of Preventive War

The model in this paper contains a number of simplifying assumptions. It is reasonable to ask how relaxing some of these assumptions might impact the main result of the paper—namely, Proposition 1 states that sovereign borrowing may alleviate, but not wholly eliminate the possibility of preventive war. We make three key assumptions in our model: (1) full commitment to repay loans, (2) loans are "outside money," and (3) loans are made by a "non-strategic" bond market.

To understand these assumptions clearly, first imagine that we reversed assumption (3).[10] There are two countries, H and F as in our baseline model, but no "non-strategic" bond market to provide loans. Instead, the only source of loans for H is actually F who will certainly be strategic in its loan making decisions. In this setting, F may have an added

[10]Note that all else equal, relaxing assumptions (1) or (2) just makes the result that preventive war exists in this setting easier to obtain.

incentive to provide loans to H beyond what a non-strategic bond market is willing to supply since F internalizes the costs and risks of war while the bond market only cares about the return and risk to its loan. However, having reversed (3), does it then make sense to maintain assumptions (1) and (2)?

The answer to both is clearly "no." Assumption (2) is now nonsensical due to physical constraints. The model is about two countries bargaining and fighting over the entire pie between them. If there were some outside source of money that countries have internal access to, then why can they not use this money for transfers directly? Why can this money be tapped for loans, but cannot be captured in war? In fact, if countries have access to unlimited internal funds, preventive war in the sense of Powell (2004) is immediately ruled out. If there is some limited source of internal funds, then it is unclear why these should not be included in the initial pie at issue between the two countries.

Moreover, maintaining assumption (1) in this setting would be to say that H cannot commit to making transfers after a power shift, but can fully commit to paying back a loan. When dealing with an outside bond market, commitment could make sense for the reasons presented in the base line model—maintaining access to bond market will allow for future consumption smoothing and future loans to avoid war in the event of future power shifts. H may face some of these same incentives when receiving loans from F. However, its unclear why H defaulting on promised future loan payments would be any different from defaulting on future transfers. To the extent that we assume H cannot commit to transfers to F in the future, we must also assume that H cannot commit to future loan payments to F in the future.

That is, if we reverse assumption (3), we must also reverse assumptions (1) and (2). The natural thing to ask next would be: what if there are other strategically-connected countries, countries A, B, C, ... that may want to provide H a loan for strategic reasons that is "inside money" in the sense that it is part of some country's resources within a strategically-connected system?

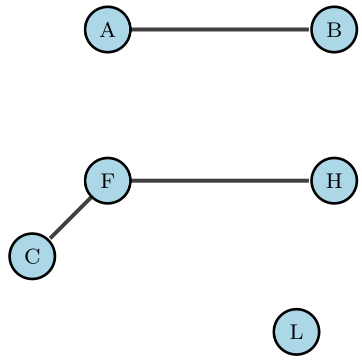

Figure 6: Inter-state system with the potential for inside money

Consider the international system depicted in Figure 6. First, we must clarify what it means for a country other than H and F to be strategically connected to H and F. One definition would be that this other country i's security is strategically impacted by a war between H and F. That is, either H or F must be capable of going to war with i either today or at some point in the future, possibly contingent on other wars occurring. That is, H, F, and i are in a connected network where there is some path by which conflict can spread from H and F to i.

In this example we see that country C is connected to both H and F on some path and therefore is strategically relevant. Countries A and B are not strategically connected, though they might be connected through market changes we discuss below. In this system we can think of the bond market L as being an isolated actor who cannot be "attacked" or invaded by any other state. In this sense, L is providing money outside of strategic military considerations and hence what we call "outside money."

So, what if a current development between F and H has the potential for a power shift and conflict where C can use its resources to lend to H to prevent a war that might bring H to C's doorstep? It is straightforward to show that there is no way for countries to transfer or loan each other "inside money" in a connected network of states in order to avoid war. This gives us Proposition 4, whose technical details can be found in the appendix.

Proposition 4. *There always exists values for power shifts, cost of war, and discount fac-*

tors in the international system game such that preventive war occurs in a subgame perfect equilibrium when strategic lenders can loan each other inside money.

However, what if there exists both a connected network of strategically interested countries *and* some outside source of money (a group of unconnected or non-strategic countries)? Clearly, by Proposition 4, some amount of outside money will be necessary to maintain peace for some power shifts. However, we have demonstrated in this paper that the amount of outside money from a non-strategic source will always be limited by a combination of the going interest rate r and endogenous default. In other words, preventive war always exists in this environment. Moreover, shifts in power will be more dangerous exactly as described in this paper—when they are greater in expected value, when r is large, and, for a fixed expected value, when they are low in probability, but potentially extreme in size.

We might imagine that countries are strategically connected to H and F in some other way that is not related to security. Perhaps there is something economically or culturally unique about H and F that war would undermine. Or for humanitarian reasons, these outside countries internalize to some degree the costs of war to the population of H and F. Our results clarify that it is only in these types of settings that outside countries would be willing to make strategic loans that potentially violate the preventive war logic of this paper. In this setting, the only limits on the terms of loans that could prevent war would be the extent of the cultural or economic interest in avoiding war or the level of internalization of harm to other countries. We consider the influence of strategic countries with outside money that are not connected with regard to security in the following section.

Finally, in an extended model with an endogenously determined risk-free rate of return and many states all acting as potential borrowers and lenders, power shifts and war have the potential to transmit economic implications throughout the system. Power shifts that do not cause war, but require borrowing to remain peaceful, act as a positive demand shock on credit, as illustrated in Figure 7, while full wars act as a negative supply shock as the warring states lose resources to loan to international markets. As mentioned before, this

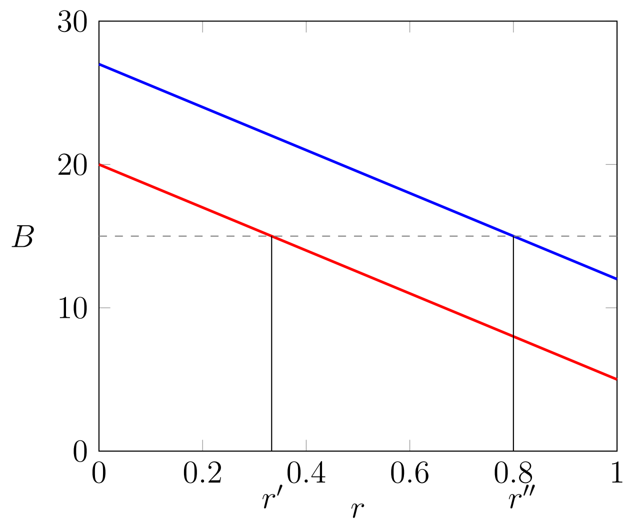

Figure 7: Endogenous demand for loans and interest rates

may lead to a contagion effect of conflict as it causes r to rise endogenously pushing other peaceful settlements out of reach. However, short of war, the increase in r would also impact the distribution of the economic pie. Suppliers of capital would benefit from the improved terms, while demanders of capital would suffer from increased rates. However, higher rates may also hurt lenders if it causes borrowers to default on their loans.

Strategic Lending with Outside Money

There are many reasons why a country that is not connected to Home or Foreign in a way that is related to security may nonetheless prefer one outcome to another. These preferences might be the result of a multitude of interests, including socio-cultural and economic interests. In this section, we consider a state that prefers a peaceful resolution when war between H and F is imminent.

Suppose there exists a country A that is outside of Home and Foreign's security network and has a preference for peace. The simplest case to imagine is a country A that is a deeply humanitarian nation and incurs costs when anyone in the world is at war. Alternatively, we can suppose country A has economic incentives that lead it to prefer peace between H and F.

For example, if country A heavily imports rubber and Home has a comparative advantage in the production of rubber, A might expect Home to channel more resources into security and less into production when war is likely. Even if A does not intend on importing rubber directly from Home, A expects that Home's increased production will nonetheless lead to an increase in the global supply, which would reduce the price at which A purchases rubber elsewhere. Country A would anticipate improved terms of trade from a peaceful resolution to the impending conflict between Home and Foreign.

In any situation like this, A can advance a peaceful resolution by lending to Home when the lender's or borrower's constraint is violated. To avoid uninteresting cases, we assume country A has the financial ability to offer such a loan. Either case will require A to agree to a higher price on H's debt than the bond market would be willing to accept, so A will necessarily incur a loss in doing so and therefore only chooses to lend if war is otherwise imminent and the gain from peace outweighs this loss. A will never incur larger losses than necessary to facilitate peace and so, if it decides to offer a loan, it will leave the weakest violated constraint binding. When peace-generating strategic lending occurs, a preference for peace can be analogous to a preference for Home. For example, this can happen if H prefers not to fight but the lender's constraint is violated. Then, A's lending makes peace possible and increases Home's expected payoff.

When either the lender's or the borrower's constraint is violated, A is faced with a decision about whether to accept a higher price on H's bond that will prevent the outbreak of war. If the losses incurred in lending to H are less than the gain A receives from the peaceful outcome, A will lend Home's the required amount qB^* at a greater price q^A. Recall that F requires a transfer of the minimum amount qB^* as defined in Lemma 3 from H, which includes the price of the bond $q = \frac{1-\delta}{1+r}$ where δ is the probability of default and r is the risk-free rate of return, as well as the bond amount B^* to be paid back in period 2. Any alternative loan to H must be at least this amount to forgo war and, since A does not incur larger losses than necessary, the new loan amount will necessarily be equal to qB^*.

Specifically, we must have $q^A B^A = qB^*$ where q^A is the new higher price and B^A is the new lower bond value to be paid back in period 2. Here, we have $q^A = \frac{1-\delta}{1+r^A}$ where r^A is the lower rate of return A would expect by lending and $B^A = (q/q^A)B^*$ or equivalently $B^A = \frac{1+r^A}{1+r}B^*$. Note that value of r^A varies depending on whether indifference between peace and war leaves the lender's or the borrower's constraint binding. If A chooses to lend, Home will only need to pay back the lower amount B^A to A in period 2.

First, suppose the lender's constraint is not violated but the borrower's constraint is. Then, inequality (3) from Lemma 5 does not hold but inequality (2) from Lemma 4 does. In words, the bond market is willing to offer a loan but Home prefers fighting a war to issuing a bond as the cost of incurring the necessary debt is too large. Since the RHS of inequality (2) is decreasing in r, a lower rate r^A is required to satisfy H. Then, to encourage Home to issue debt and avoid war, A needs to be willing to lend at price q^A, defined as a function of r^A, such that equation (4),

$$\theta\rho = \rho + \frac{1-\beta}{\beta} - \frac{\kappa}{s}\left(\beta + \frac{1-\beta(1-r^A)}{\beta[1-\beta(1+r^A)]}\right), \tag{4}$$

holds. Satisyfing equation (4) requires

$$r^A = \frac{\beta\left[\rho\left(\frac{1}{1-\beta}\theta s - \kappa\right) + (1-\rho)\left(\frac{1}{1-\beta}s - \kappa\right)\right] - \frac{1}{1-\beta}s + \kappa}{\beta s\left[\frac{\beta\rho(\theta-1)}{1-\beta} - \left(1 + \frac{1+\beta}{s}\kappa\right)\right]} - 1,$$

from which we recover q^A. Note that under this new price, while war can be avoided, neither H's nor F's expected utility has changed.

Alternatively, suppose the borrower's constraint is not violated but now the lender's constraint is. This time, inequality (2) does not hold but inequality (3) does. While Home prefers a peaceful resolution and would like to issue debt, the bond market will not offer a loan in the amount required to placate Foreign. Specifically, the bond amount to be paid back in period 2 is too large under the market price q. In order for A to lend, they need to offer a higher price q^A on a lower bond value B^A such that equation (5),

$$\frac{s}{\rho}(1+r^A)\left[\frac{\beta\rho(\theta-1)}{1-\beta}-\left(1+\frac{1+\beta}{s}\kappa\right)\right]=\beta\left(\frac{1}{1-\beta}\theta s-\kappa\right), \tag{5}$$

holds. Satisfying equation (5) requires

$$r^A=\frac{\beta\rho\left(\frac{1}{1-\beta}\theta s-\kappa\right)}{\frac{s\beta\rho(\theta-1)}{1-\beta}-s\left(1+\frac{1+\beta}{s}\kappa\right)}-1,$$

from which we recover q^A and therefore B^A. As opposed to the first case, both war is avoided and H's expected utility is improved under this new price. Therefore, a preference for peace can be analogous to a preference for Home.

If both the borrower's and the lender's constraints are violated, the minimum of these two possible values for r^A is used to recover q^A and B^A. Country A will be willing to offer this higher price q^A in order to receive the gains from peace so long as it is sufficiently likely that Home will pay them back. Here, we assume country A's gain from peace is not larger than the total amount qB^* because otherwise A would not face a lending decision—they would always prefer to simply gift Home the full amount qB^* if necessary. Then, A will be willing to purchase H's debt with the bond amount B^A at a price q^A so long as the gain from peace is greater than or equal to the losses incurred in generating peace. By assumption, the amount qB^* that A decides to lend to H could be loaned to the market instead. The expected return from lending the same amount to the market has an expected return equal to $(1+r)qB^*$ whereas the return from lending to Home is $(1-\delta)B^A$. Since $qB^*=\frac{1-\delta}{1+r^A}B^A$, the loss A incurs by facilitating a peaceful resolution is equal to $(1-\delta)\frac{r-r^A}{1+r^A}B^A$. This result is stated in the following lemma.

Lemma 6. *When preventive war is otherwise imminent—that is, when either inequality (2) or (3) is satisfied—a peace-motivated country A will use outside money to facilitate peace if and only if A's gain from peace in the second period is at least $(1-\delta)\frac{r-r^A}{1+r^A}B^A$, where r^A is* *defined using equation (4) when the borrower's constraint is violated, equation (5) when the lender's constraint is violated, or the minimum of the two when both constraints are violated.*

While this section explored the strategic use of outside money to facilitate peace, there are many other motivations that could lead to the use of outside money. Countries might consider lending due to preferences that are in varying degrees of alignment with those of Home and Foreign. This is a matter we leave to future research.

Conclusion

In this paper we built a model of commitment problems and sovereign lending. We were able to demonstrate that war due to commitment problems may still occur in this setting, and that the potential for conflict is increasing in the expected size of a shift. Moreover, significant empirical implications result from our simple model. First, we can characterize that extreme but unlikely shifts are more dangerous than moderate but likely shifts. Second, borrowing rates in growing countries facing relatively declining adversaries will be heightened. Third, exogenous increases in the real risk-free rate will increase the potential for conflict due to commitment problems.

The model we pursued here is highly simplified. A number of immediate extensions would provide further insight on the connections between international finance and conflict. Allowing for endogenous military spending may add an interesting dimension where potentially rising states avoid preventive war by actively constraining future military spending by building debt and spending it on non-military social programs. Additionally, more general approaches to modeling power shifts, fighting, and sovereign borrowing may identify a number of more nuanced results.

Particularly relevant extensions would bring a greater level of sophistication to the economic side of the model. First, in this paper, we have set the risk-free rate exogenously. However, in reality this rate will vary with the endogenous demand on capital. When states demand bonds for non-productive reasons such as avoiding war, this demand shock for capital raises the risk-free rate for all other borrowers. This means less productive economic activity will be financed and any other states needing to borrow due to shifts in power will face a higher price for capital—perhaps even causing a war that would have been avoided when the risk-free rate was lower. Second, persistent shifts in power arise naturally in this setting as the result of long-term economic growth. A full macroeconomic model of the relevant countries would provide a fuller understanding of how power shifts due to economic growth and access to credit relate. Indeed, both declining powers and potential financiers will be deeply concerned about the duration of a positive economic shock in almost directly opposing ways. Third, building in consumption smoothing and other reputational concerns over access to credit markets would allow the model to endogenously determine the credibility of paying back loans.

An historical analysis of cases on this topic would be of great interest. However, we caution that this is potentially complex. Modern states issue and carry debt all the time. Money is fungible. Tying a particular loan to a particular international crisis is often quite difficult and potentially counterproductive to the more general point of this paper. Our paper argues that access to credit markets relieves the liquidity constraint states face when bargaining. It does not say that states issue loans specifically tied to transfers. Consider the following analogy of Bob who has \$100,000 and needs to buy a home that minimally costs \$100,000 in order to shelter his family, but would also like to buy a car. Without access to credit, Bob pays \$100,000 for the house and goes without the car. With access to credit, Bob could take out a mortgage for \$80,000 and purchase the home with only \$20,000 of cash. This means that Bob has \$80,000 left over to spend on a car or other items. Not observing Bob take out a car loan is not evidence that credit did not make purchasing a car possible. Similarly, many states issue large amounts of debt while mandatory spending often makes up a majority of the state budget (for instance the United States). In this context, not observing a loan specifically earmarked for transfer to another state is not evidence against credit market access making the transfer possible. In some sense every rising power who both has debt and peace (e.g., China) is evidence, if not very convincing evidence, for our theory. Instead, a viable empirical test for our model might study the impact on conflict outcomes of the real risk-free rate of return and other factors that affect the cost of sovereign borrowing. As there are also many economic and domestic political forces driving borrowing decisions, a careful version of that empirical analysis is an article of its own.

There are few, if any, models connecting the bargaining model of war with the deep literature studying international macroeconomics and finance. Even from the simple model presented in this paper, a number of non-obvious empirical connections arise between macroeconomic indicators and the potential for conflict. Beyond the results presented here, this paper hopes to contribute to both literatures by providing a framework on which to build more sophisticated models at the intersection of these two literatures.

Appendix

Lemma 1

Proof. F prefers war to peace exactly when

$$\frac{1}{1-\beta}\left(1-s\right)-\kappa>1+\frac{\beta}{1-\beta}-\beta\left[\frac{1}{1-\beta}\theta s-\kappa\right]$$

$$\frac{1}{\beta}\left(1-s\right)-\frac{1-\beta}{\beta}\kappa>\frac{1-\beta}{\beta}\left(1+\beta\kappa\right)+\left(1-\theta s\right)$$

$$1-s-\beta+\beta\theta s>\left(1-\beta\right)\left(1+(1+\beta)\kappa\right)$$

$$\beta\theta s>\left(1-\beta\right)\left(1+\beta\right)\kappa+s$$

$$\theta>\frac{1-\beta}{\beta s}\left(1+\beta\right)\kappa+\frac{1}{\beta}$$

$\square$

Lemma 2

Proof. F prefers war to peace exactly when

$$\frac{1}{1-\beta}\left(1-s\right)-\kappa>1+\frac{\beta}{1-\beta}+\beta\kappa-\rho\left(\frac{\beta}{1-\beta}\theta s\right)-\left(1-\rho\right)\left(\frac{\beta}{1-\beta}s\right)$$

$$\frac{1}{1-\beta}\left(1-s\right)-\kappa>1+\frac{\beta}{1-\beta}+\beta\kappa-\frac{\beta}{1-\beta}\left[\rho\theta s+\left(1-\rho\right)s\right]$$

$$\frac{1}{\beta}\left(1-s\right)>1+\left(\frac{1-\beta}{\beta}\right)\left(1+\left(1+\beta\right)\kappa\right)-s\left[\rho\theta+\left(1-\rho\right)\right]$$

$$\frac{1}{\beta}\left[1-s-\beta+\beta s\left(\rho\theta+1-\rho\right)\right]>\left(\frac{1-\beta}{\beta}\right)\left(1+\left(1+\beta\right)\kappa\right)$$

$$s\left[\beta\left(\rho\theta+1-\rho\right)-1\right]>\left(1-\beta\right)\left(1+\beta\right)\kappa$$

$$\beta\rho\theta>\frac{1-\beta}{s}\left(1+\beta\right)\kappa+1-\beta+\beta\rho$$

$$\beta\rho\theta>\left(1-\beta\right)\left(\frac{1+\beta}{s}\kappa+1\right)+\beta\rho$$

$$\theta>1+\frac{1-\beta}{\beta\rho}\left(1+\frac{1+\beta}{s}\kappa\right)$$

$\square$

Lemma 3

Proof. F is indifferent between war and peace when

$$\frac{1}{1-\beta}(1-s)-\kappa = 1+\frac{\beta}{1-\beta}+\beta\kappa-\rho\left(\frac{\beta}{1-\beta}\theta s\right)-(1-\rho)\left(\frac{\beta}{1-\beta}s\right)+qB^*$$

$$\frac{1}{\beta}(1-s) = 1+\left(\frac{1-\beta}{\beta}\right)(1+(1+\beta)\kappa)-s\left[\rho\theta+(1-\rho)\right]+\frac{1-\beta}{\beta}qB^*$$

$$s\left[\beta(\rho\theta+1-\rho)-1\right] = (1-\beta)(1+\beta)\kappa+(1-\beta)qB^*$$

$$\beta\rho\theta = \frac{1-\beta}{s}(1+\beta)\kappa+1-\beta+\beta\rho+\frac{1-\beta}{s}qB^*$$

$$\theta-1-\frac{1-\beta}{\beta\rho}\left(1+\frac{1+\beta}{s}\kappa\right) = \frac{1-\beta}{s\beta\rho}qB^*$$

$$qB^* = \frac{s\beta\rho}{1-\beta}(\theta-1)-s\left(1+\frac{1+\beta}{s}\kappa\right)$$

□

Lemma 4

Proof. H prefers war to borrowing exactly when

$$\frac{1}{1-\beta}s-\kappa > \beta\left[\rho\left(\frac{1}{1-\beta}\theta s-\kappa\right)+(1-\rho)\left(\frac{1}{1-\beta}s-\kappa\right)-s(1+r)\left[\frac{\beta\rho(\theta-1)}{1-\beta}-\left(1+\frac{1+\beta}{s}\kappa\right)\right]\right]$$

$$\frac{1}{1-\beta}s-\kappa > \beta\left[\rho\left(\frac{1}{1-\beta}\theta s\right)+(1-\rho)\left(\frac{1}{1-\beta}s\right)-\kappa-\frac{s\beta\rho}{1-\beta}(\theta-1)(1+r)+s(1+r)\left(1+\frac{1+\beta}{s}\kappa\right)\right]$$

$$\frac{s}{\beta}-\frac{1-\beta}{\beta}\kappa > \rho\theta s+(1-\rho)s-(1-\beta)\kappa-s\beta\rho(\theta-1)(1+r)+(1-\beta)(1+r)(s+(1+\beta)\kappa)$$

$$\frac{s}{\beta}-\frac{1-\beta}{\beta}\kappa > \rho\theta s\left[1-\beta(1+r)\right]+(1-\rho)s+s\beta\rho(1+r)+(1-\beta)\left[s(1+r)+(1+r+\beta+r\beta)\kappa-\kappa\right]$$

$$\frac{s}{\beta}-\frac{1-\beta}{\beta}\kappa-(1-\rho)s-s\beta\rho(1+r)-(1-\beta)\left[s(1+r)+(r+\beta+r\beta)\kappa\right] > \rho\theta s\left[1-\beta(1+r)\right]$$

$$s\left(\frac{1}{\beta}-1+\rho\right)-s(1+r)(1-\beta+\beta\rho)-\kappa(1-\beta)\left[r+\beta(1+r)+\frac{1}{\beta}\right] > \rho\theta s\left[1-\beta(1+r)\right]$$

$$\theta > \frac{1}{1-\beta(1+r)}\left[1+\frac{1-\beta}{\beta\rho}-\frac{1+r}{\rho}(1-\beta+\beta\rho)-\frac{\kappa}{s\rho}(1-\beta)\left[r+\beta(1+r)+\frac{1}{\beta}\right]\right]$$

$$\theta > \frac{1}{1-\beta(1+r)}\left[1-\beta(1+r)+\frac{1-\beta}{\beta\rho}\left[1-\beta(1+r)\right]-\frac{\kappa}{s\rho}\left(r-r\beta+\beta-\beta^2+r\beta-r\beta^2+\frac{1}{\beta}-1\right)\right]$$

$$\theta > 1+\frac{1-\beta}{\beta\rho}-\frac{\kappa}{s\rho\left[1-\beta(1+r)\right]}\left[\beta(1-\beta(1+r))+\frac{1}{\beta}(1-\beta(1-r))\right]$$

$$\theta\rho > \rho+\frac{1-\beta}{\beta}-\frac{\kappa}{s}\left(\beta+\frac{1-\beta(1-r)}{\beta\left[1-\beta(1+r)\right]}\right)$$

Note that the sign changes in the middle of the solving since $\beta > \frac{1}{1+r}$. □

Proposition 1

Proof. The first statement holds since parameters exist where both (1) and either (2) or (3) is satisfied. For instance, fix a θ that satisfies (1). Then (3) holds when the bracketed value is positive (this is assured when κ is small and β is close to 1) and r is large.

For the second statement, there are three ways expected shift size can increase. Either θ increases, ρ increases, or both increase.

θ **increases:** Increasing θ directly increases the LHS of (1), while the RHS is unaffected, which directly increases the range of parameters that satisfy inequality (1). Increasing θ directly increases the LHS of (2) while the RHS is unaffected, which directly increases the range of parameters that satisfy inequality (2). Finally, increasing θ causes the LHS of (3) to increase faster than the RHS of (3), since taking the derivative with respect to θ of both sides gives

$$s\,(1+r)\,\tfrac{\beta}{1-\beta} > s\tfrac{\beta}{1-\beta},$$

since $r > 0$ by definition. Therefore, increasing θ increases the range of values that satisfy (3). For all three inequalities, increasing θ increases the potential for conflict.

ρ **increases**: Increasing ρ lowers the RHS of (1) without affecting the LHS, which increases the range of parameters that satisfy inequality (1).

For (2), subtract ρ from each side to get

$$(\theta-1)\,\rho > \tfrac{1-\beta}{\beta} - \tfrac{\kappa}{s}\left(\beta + \tfrac{1-\beta(1-r)}{\beta(1-\beta(1+r))}\right).$$

Since $\theta > 1$ by definition, the LHS is increasing in ρ while the RHS is unaffected. Hence, increasing ρ increases the range of parameters that satisfy (2).

For (3), the RHS is unaffected by ρ. Rearranging the LHS gives

$$s\,(1+r)\left[\tfrac{\beta(\theta-1)}{1-\beta}-\tfrac{1}{\rho}\left(1+\tfrac{1+\beta}{s}\kappa\right)\right].$$

Since the second term in the brackets is negative and decreasing in ρ, the LHS is increasing in ρ. Hence (3) will be satisfied for a larger range of parameters.

Finally, if expected shifts increases due to increase in both θ and ρ, the above two cases demonstrates that the range of parameters satisfying (1), (2), and (3) will all increase. □

Proposition 2

Proof. For two shifts of the same expected size, it is clear from the equation immediately above Lemma 3 that the amount borrowed to prevent war remains the same. Label the first shift (θ,ρ) and the second shift (θ',ρ') where $\rho'<\rho$ and $\theta'>\theta$, since the shifts have the same expected size. Assume that a positive amount must be borrowed to prevent war under (θ,ρ), and label the borrowed amount necessary to prevent war, qB^*. Similarly, let $q'B'$ be the amount necessary to prevent war under (θ',ρ').

Since the expected size of the shifts are the same, it must be that, if there is any risk of default at all,

$$\begin{aligned} qB^* &= q'B' \\ \tfrac{\rho}{1+r}B^* &= \tfrac{\rho'}{1+r}B' \\ B' &= \tfrac{\rho}{\rho'}B^*. \end{aligned}$$

That is, $B'>B^*$ since $\rho'<\rho$. Specifically, plugging in for B^* we get

$$B'=\tfrac{s}{\rho'}\,(1+r)\left[\tfrac{\beta\rho(\theta-1)}{1-\beta}-\left(1+\tfrac{1+\beta}{s}\kappa\right)\right].$$

Note that it cannot be the case that (θ,ρ) leads to a no-default loan, but (θ',ρ') leads to a risky loan. The bond market offers a no-default loan for (θ, ρ) when

$$s\left(1+r\right)\left[\frac{\beta\rho(\theta-1)}{1-\beta} - \left(1+\frac{1+\beta}{s}\kappa\right)\right] < \beta\left(\frac{1}{1-\beta}s - \kappa\right).$$

Since $(\theta - 1)\,\rho s = (\theta' - 1)\,\rho' s$, the market should also offer a no-default loan for (θ', ρ'). However, if these values lead to a no-default loan, then inequality (3) cannot be satisfied, so for this inequality in isolation, the potential for conflict is invariant in ρ'.

Inequality (3) is satisfied and war occurs under (θ', ρ') when

$$\frac{s}{\rho'}\left(1+r\right)\left[\frac{\beta\rho(\theta-1)}{1-\beta} - \left(1+\frac{1+\beta}{s}\kappa\right)\right] > \beta\left(\frac{1}{1-\beta}\theta' s - \kappa\right).$$

From the definition of shifts of the same expected size, we have

$$(\theta - 1)\,\rho s = (\theta' - 1)\,\rho' s$$
$$\theta' = \frac{\theta-1}{\rho'}\rho + 1.$$

Plugging this in to the RHS gives

$$\frac{s}{\rho'}\left(1+r\right)\left[\frac{\beta\rho(\theta-1)}{1-\beta} - \left(1+\frac{1+\beta}{s}\kappa\right)\right] > \beta\left(\frac{1}{1-\beta}\left[\frac{\theta-1}{\rho'}\rho + 1\right]s - \kappa\right).$$

Multiplying through by ρ' results in

$$s\left(1+r\right)\left[\frac{\beta\rho(\theta-1)}{1-\beta} - \left(1+\frac{1+\beta}{s}\kappa\right)\right] > \beta\left(\frac{1}{1-\beta}\left[\theta - 1\rho\right]s + \rho'\left(\frac{s}{1-\beta} - \kappa\right)\right).$$

Thus, since $\frac{s}{1-\beta} > \kappa$, giving a positive war value in the first period, the RHS is increasing in ρ', whereas decreasing ρ' (shift becomes more extreme, lower probability) lowers the RHS. This makes (3) easier to satisfy.

For (1), we can manipulate the inequality to get

$$(\theta - 1)\,\rho s > \tfrac{1-\beta}{\beta}\,(s + (1+\beta)\,\kappa)\,.$$

The LHS is invariant by definition of equal expected shifts, and the RHS is invariant since it does not depend on θ or ρ. Similarly for (2), we can manipulate the inequality to get

$$(\theta - 1)\,\rho s > \frac{1-\beta}{\beta}s - \kappa\left(\beta + \frac{1-\beta\,(1-r)}{\beta\,(1-\beta\,(1+r))}\right).$$

Once again, the LHS is invariant by definition of equal expected shifts, and the RHS is invariant since it does not depend on θ or ρ. Thus, only inequality (3) sees a change. □

Proposition 3

Proof. r is not present in inequality (1), so this inequality is unaffected by changes to r.

For (2), r is not present in the LHS. Take the derivative of the RHS with respect to r:

$$\begin{gathered} -\tfrac{\kappa}{s}\left(\tfrac{\beta}{\beta(1-\beta(1+r))} - \tfrac{1-\beta(1-r)}{[\beta(1-\beta(1+r))]^2}\left(-\beta^2\right)\right) \\ -\tfrac{\kappa}{s}\left(\tfrac{\beta^2(1-\beta(1+r))}{[\beta(1-\beta(1+r))]^2} + \tfrac{\beta^2(1-\beta(1-r))}{[\beta(1-\beta(1+r))]^2}\right) \\ -\tfrac{\kappa}{s}\left(\tfrac{2-2\beta}{[1-\beta(1+r)]^2}\right) \end{gathered}$$

The term in parenthesis is positive, so increasing r is negative for the RHS. So, overall, increasing r decreases H's willingness to borrow.

For (3), r is not present in the RHS, and the derivative of the LHS with respect to r is

$$s\left[\tfrac{\beta(\theta-1)}{1-\beta} - \tfrac{1}{\rho}\left(1 + \tfrac{1+\beta}{s}\kappa\right)\right],$$

which is positive so long as the bracketed amount is positive. Since this amount must be positive for (3) to be satisfied, increasing r increases the LHS and makes (3) easier to satisfy. $\square$

Strategic Lending with Inside Money

Consider the following strategic game with many states. Suppose there are $N > 1$ countries that interact at discrete times $t \in \{0, 1, 2, ...\}$. All countries discount the future at a common rate $\delta \in (0, 1)$ per period. The total amount of resources available for consumption in each period is $X > 0$, and the amount controlled by country i (which may vary over time) is denoted x_i. In addition to its resource level, each country i is characterized by its current military strength, s_i. There is a finite set $\hat{S} = S \cup \{0\}$ of possible states, where an element s of $S = \{1, ...K\}$, $K > 1$ represents an active country's strength in war, and a country in state 0 is disarmed and becomes inactive. Let $\mathbf{s} \in \hat{S}^N$ denote a vector of military strengths for all countries, let $\boldsymbol{I}(\boldsymbol{s}) \equiv \{i : \ s_i \neq 0\}$ denote the set of active countries, and let $\boldsymbol{S}(n)$ denote the set of strength vectors where $n \leq N$ countries are active.

In each period, each active country can either choose transfers of resources to each other active country or initiate a war with any or all of the countries with which it shares a (undirected) link. Each node represents a country, and two countries can go to war with each other only if they share a link. The set of links is represented by $l \subseteq N^2$, with a typical element $ij \in l$ representing a link between country i and country j. Thus, a country can fight a directed war, but the set of countries that it can fight with may be limited. We assume that the network is *connected*—that is, that there is a path of links between any two countries. (Connected actors are potential strategic lenders in the context of the current paper.) Let $\mathbf{L} \subseteq N^2$ denote the set of all possible connected networks with undirected links.

When a country starts a war with another country to which it is linked, the link has become *engaged* for that period. The term *general war* denotes the case where all active countries have an engaged link. In any period in which one or more countries choose war, consumption is 0 for all countries possessing an engaged link. In the absence of war, net transfers from i to j are labeled τ_{ij}, so that consumption in country i is

$$c_i = x_i - \sum_{j \in N \setminus i} \tau_{ij}.$$

We restrict transfers so that $c_i \geq 0$ for all i. The total payoff to a country that receives consumption stream $\{c_t\}_{t\geq 1}$ is

$$(1-\delta)\sum_{t=1}^{\infty} \delta^{t-1} c_t.$$

Being disarmed ($s = 0$) is an absorbing state, and a disarmed country receives a continuation payoff of 0. When a country i becomes disarmed, all active countries with engaged links to i receive equal shares of i's resources x_i. Additionally, all active countries that have an engaged link with i at the time of its disarmament inherit all of i's links.

Resources for each country are specified by a nonnegative vector $\mathbf{x} = (x_1, \ldots, x_n)$, where $x_i > 0$ if country i is active, $x_i = 0$ if country i is disarmed, and $\sum_{i=1}^{N} x_i = X$. Let $\mathbb{X}(n)$ denote the set of such resource vectors where $n \leq N$ countries are active. If there are two or more active countries in a period, not all of them can be disarmed. (If all active countries transition to $s = 0$ in the same period, then one is randomly selected to remain active, and the others are disarmed.) If and when a single country remains, the game ends, and the survivor receives the entire stream of available consumption $(1-\delta)\sum_{t=1}^{\infty} \delta^{t-1} X = X$.

Let $\gamma(s'; c, s)$ denote the probability that a country in state $s \in S$ that consumes c will transition to state $s' \in S$. A country in state 1, the weakest military position, may become disarmed in a period in which war occurs. Let $\gamma^W(s'; s)$ denote the probability that a country transitions from s to s' after a period of war. State transitions are independent across countries. The following assumptions on transition probabilities are maintained throughout:

Assumption (A)**.**

1. *One step at a time with full support: there exists* $\underline{\gamma} > 0$ *such that for all* $c \in [0, X]$

   (a) *for all* $1 < s \leq K$, $\gamma(s'; c, s) \geq \underline{\gamma}$ *for all* $s' \in \{s-1, s, s+1\} \cap S$ *and* $\gamma(s'; c, s) = 0$

for all other s'*, and*

(b) $\gamma(s'; c, 1) \geq \underline{\gamma}$ for $s' \in \{1, 2\}$.

2. *War is necessary for disarmament:*

   (a) $\gamma(0; c, 1) = 0$.

3. *War transitions:*

   (a) $\gamma^W(s'; s) = 0$ *unless* $s' \in \{s-1, s, s+1\}$,

   (b) $\gamma^W(0; 1) > 0$, *and*

   (c) $\gamma^W(s'; s) \geq \gamma(s'; c, s)$ *if* $s' < s$ *and* $\gamma^W(s'; s) \leq \gamma(s'; c, s)$ *if* $s' > s$.

We also make the following assumption:

Assumption (B)**.** *Either the number of military strength states* K *is at least 3 or the network is complete.*

Transfers and war decisions are publicly observed, as are military strengths and resource levels.

Proposition 4

Proof. Without "loans" Krainin and Wiseman (2016) demonstrate the following theorem:

Theorem 1. *In the baseline model, there exists* $\underline{\delta} < 1$ *such that the following holds: for any* $\delta \geq \underline{\delta}$ *and any initial military strength vector* $\boldsymbol{s} \in \hat{S}^N$*, network* $l \in \mathbf{L}$*, and resource vector* $\mathbf{x} \in \mathbb{X}(N)$*, in any SPE war occurs, and eventually only a single country remains active.*

How do loans affect this conclusion?

In the main paper we assume that countries have (1) full commitment to repay loans, (2) a source of outside money, and (3) loans are made by a nonstrategic actor. In the current extension, we are interested in the case where many strategically-connected (linked) countries might loan each other inside money in order to avoid preventive war.

The first thing to note is that there is nothing the dynamic network model of bargaining that rules out states lending each other resources to make transfers. Theorem 1 applies to this possibility. However, Theorem 1 assumes a particular notion of the commitment technology to loans: there is no way to commit to not going to war in the future, therefore there is no way to commit to repaying loans that imply a game value less than the minmax achieved through war in any given period.

To make it as hard as possible to demonstrate that preventive war still occurs with loans in the main body of the text, we made assumption (1), complete commitment to repay a loan. That is, the setup is implicitly partial equilibrium. Countries are willing to repay loans that violate their minmax within the game we study, because their is implicitly some other source of value in the game. Does this assumption still make sense in the current context? In other words, could a country be better off paying back a loan today that it received in the past, even if it violates their current minmax condition? The answer is "no." By only considering inside money made by strategically involved actors, there is no other source of value which players can lose out on if they violate the terms of their loan.

Imagine this were not the case. One can show that certain states are achieved where some country, say country 1, achieves a minmax value greater than an even split of all the resources [the probability of victory in that state times the total resources, $\alpha_i\left(\mathbf{s}^i\right)X$ is greater than X/N]. Definitionally, this value cannot be brought lower by any punishment strategy other countries may enact. Therefore, if country 1 chooses to continue to repay the loan in such a state, it must be that 1's expected return to this strategy is greater than or equal to the minmax value achieved through war. Call this value $Z_i\left(\mathbf{s}^i\right) \geq \alpha_i\left(\mathbf{s}^i\right)X$ where the inequality follows from the argument above.

Therefore, 1 achieves a value greater than the even split of all resources in this state since $Z_i\left(\mathbf{s}^i\right) \geq \alpha_i\left(\mathbf{s}^i\right)X > X/N$. For such states, replace $\alpha_i\left(\mathbf{s}^i\right)X$ with $Z_i\left(\mathbf{s}^i\right)$ in the proof of Theorem 1 and the proof goes through as before.

Since Proposition 4 is a direct corollary of Theorem 1 with loans, we have demonstrated the proposition. $\square$

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