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Are World Leaders Loss Averse?*

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Abstract

We focus on the preferences of a salient group of highly-experienced individuals who are entrusted with making decisions that affect the lives of millions of their citizens, heads of government. We test for the presence of a fundamental behavioral bias, loss aversion, by examining heads of governments' choice of decision rules for international organizations. Loss averse leaders would choose decision rules that oversupply negative (blocking) power at the expense of positive power (to initiate affirmative action), causing potential welfare losses through harmful policy persistence and reform deadlocks. If loss aversion is muted by experience and high-stakes it may not be exhibited in this context. We find evidence of significant loss aversion implied in the Qualified Majority rule of the Treaty of Lisbon, when understood as a Nash bargaining outcome. World leaders may be more loss averse than the populous they represent.

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1 Introduction

Loss aversion is the notion that people are more sensitive to perceived losses than to commensurate gains. Since its formal introduction in Kahneman and Tversky (1979), loss aversion has been applied to a great variety of otherwise puzzling phenomena including the equity premium puzzle (Benartzi and Thaler, 1995), asymmetric price elasticities (Hardie *et al.*, 1993), downward-sloping labor supply (Dunn, 1996; Camerer *et al.*, 1997; Goette *et al.*, 2004), inefficient renegotiation (Herweg and Schmidt, 2015), contract design (de Meza and Webb, 2007; Dittmann *et al.*, 2010; Herweg *et al.*, 2010), taxpayer filing behavior (Engström *et al.*, 2015; Rees-Jones, 2018), the play of game-show contestants (Post *et al.*, 2008), the putting strategy of Tiger Woods (Pope and Schweitzer, 2011) and the buying strategies of hog farmers (Pennings and Smidts, 2003). Chen *et al.* (2006) suggest that loss aversion is a basic evolutionary trait that extends beyond humans, while Rabin (2000, 1288) calls loss aversion the "most firmly established feature of risk preferences."[1]

This paper focuses on the preferences of a very small, but nonetheless extremely salient, group of individuals who are entrusted with making decisions that affect the lives of millions of their citizens: heads of government. If indeed loss aversion is a basic evolutionary trait then we should expect to observe it within heads of government. On the other hand, heads of government are an unrepresentative sample of the human race. They are, for instance, substantially more cognitively able than average (Dal Bó *et al.*, 2017). Perhaps unsurprisingly, therefore, there is growing evidence that these individuals (and other "elite" decision-makers) possess superior, or at least different, faculties of decision-making to a more representative sample of the population and, in particular, to the undergraduate students upon which many experimental estimates of loss aversion are based (e.g., Alevy *et al.*, 2007; Hafner-Burton *et al.*, 2013).

A growing body of evidence casts loss aversion as a potentially mutable behavioral bias, arising from the interplay of immediate emotional reactions with "deep" cognitive preferences in decision-making processes (e.g., Sokol-Hessner *et al.*, 2009, 2013; Andersson *et al.*, 2016; Cheng and He, 2017). Accordingly, some economists (e.g., List, 2003, 2011; List and Mason,

[1] For studies that take a more critical stance see, e.g., Plott and Zeiler (2005), who call into question the general interpretation of gaps between the willingness to pay and the willingness to accept as evidence for loss aversion. Gal and Rucker (2018) question other evidence traditionally interpreted as supporting loss aversion and argue that loss aversion appears to be best understood as a psychological phenomenon that is dependent on contextual factors, rather than as a stable universal trait.

2011; Levitt and List, 2008) argue that loss aversion may go away with experience and large-stakes. If so, world leaders, who make high-stakes decisions on a daily basis, should not be prone to loss aversion. Furthermore, political leaders also are known to have higher than average educational attainment (e.g., Dal Bó *et al.*, 2009; Dal Bó and Rossi, 2011), and education is frequently negatively associated with the strength of loss aversion (Booij and Kuilen, 2009; Hjorth and Fosgerau, 2011; Gächter *et al.*, 2022). Also, Inesi (2010) reports experimental findings indicating that powerful people exhibit less loss aversion.

If world leaders do exhibit loss aversion this could affect their voting behavior in potentially undesirable ways. In particular, heightened attention to potential losses might lead a head of government to oppose policies that would, in expectation, be gainful to their citizens. While important, we do not focus on voting behavior, but rather on the prior role that loss aversion plays when heads of government choose the decision rule they subsequently use to determine whether policies are implemented or not.

To investigate loss aversion among world leaders we build on the idea that leaders with different degrees of loss aversion will choose different decision rules. Participation in international organizations (IOs) forces a trade-off on world leaders: the need to coordinate on cross-border issues versus the incumbent necessity to pool national sovereignty (Hooghe and Marks, 2015). If, in particular, the national veto is conceded, a leader may experience a loss if they are required to implement a policy that is not in their interests. We therefore distinguish two distinct types of power within international institutions: the power to initiate actions that an actor supports (positive power), and the power to prevent actions that an actor opposes (negative power). From a purely objective, disinterested viewpoint – i.e., in the absence of loss aversion – the positive and negative notions of power seem of equal import. In the presence of loss aversion, however, heads of government are induced to care more strongly about preventing bad outcomes (negative power) than about initiating positive outcomes (positive power). Accordingly, when called to design decision rules for IOs, loss averse heads of government will choose rules in which the hurdle to pass a motion is higher than to defeat it. Such decision rules are biased towards maintenance of the status quo. Following studies that observe a preference for the status quo in, e.g., consumer and investment behavior (Samuelson and Zechhauser, 1988; Knetsch and Sinden, 1984; Hartman *et al.*, 1991) we term this asymmetry *status quo bias*.

Why does it matter if political leaders choose decision rules biased towards the status quo? Given heads of government represent populations that are, on averege, loss averse – the meta analysis of Brown *et al.* (2024) suggests that, on average, people are around 1.8–2.0 times more sensitive to losses than to equivalent gains – a degree of status quo bias may be socially desirable. Consistent with this notion, some degree of status quo bias is a ubiquitous feature of the decision rules used in IOs.[2] If, however, elected leaders exhibit loss aversion to a different degree than the population average, this can lead to socially undesirable consequences. In particular, if leaders are more loss averse than their electorate then the dynamic costs of excessive bias towards the status quo are likely to be substantial. As discussed in detail in Alesina and Passarelli (2019), the potential harm from excessive status quo bias manifests in at least two interrelated phenomena: (i) policy persistence, whereby policies remain long after their purpose has been served (Coate and Morris, 1999), and; (ii) reform deadlocks (e.g., Alesina and Drazen, 1991; Heinemann, 2004; Scharpf, 1988), whereby there are costly delays in policy responses to known issues.[3]

Summarizing the discussion thus far, the literature frames two related but distinct research questions. The literature on the potential mutability of loss aversion poses the question of whether world leaders are loss averse in an absolute sense ("absolute loss aversion"), i.e., whether they are more sensitive to gains than to losses. To understand the welfare implications of how world leaders treat losses, however, the relevant question is whether world leaders are loss averse in a relative sense ("relative loss aversion"), i.e., are they more loss averse than the population at large – who, evidence suggests, weigh losses approximately twice as heavily as gains. We seek to explore both of these questions.

In practice, the decision rules chosen by IOs are the outcome of a bargaining process between heads of government. We, therefore, model the formation of decision rules as the outcome of a Nash bargain, and investigate the degree of loss aversion needed to rationalize observed outcomes. Our principal analysis studies the adoption in 2007 by European leaders of a new decision rule – the so-called Lisbon Qualified Majority (QM) rule – for the European Union Council of Ministers (EUCO). The QM decision rule is a majority rule used by the EUCO as an alternative to unanimity for decision-making in a subset of policy domains. The Lisbon QM rule requires that, to pass, 55 percent of member states must vote in favor of a

[2]The idea that citizens place greater weight on negative news than on positive news when evaluating candidates for office is known as negativity bias, and is widely linked to loss aversion (Nannestad and Paldam, 1997). Summaries of the numerous empirical studies to find evidence of such a bias are given in Alesina and Passarelli (2019) and Lockwood and Rockey (2020), who each examine the implications of negativity bias for aspects of electoral competition.

[3]Consistent with these points, use in the EU of a majority rule (rather than a unanimity rule) is associated with speedier legislative responses. See, e.g., Golub (2007) and König (2007).

motion, and those in favor must also represent at least 65 percent of European Union (EU) citizens. Alternatively, a motion also passes if three or fewer countries vote against it. To rationalize this decision rule as a bargaining outcome requires estimates of loss aversion that are (well) above two, providing evidence that EU leaders are loss averse in both an absolute and relative sense. Consistent with our findings, Axel Moberg, a witness to the negotiation of the earlier Nice QM rule as a member of the Swedish delegation, documents how member states were largely preoccupied with "...the ability of groups of like-minded states to block decisions" (Moberg, 2002: 261), i.e., a negative concept of power.[4] As a robustness check, we show that our qualitative finding of absolute and relative loss aversion among world leaders also holds for the design of earlier negotiations of QM rules back to 1958, and is also robust to perturbations of the baseline methodology.

Our model predicts that, in policy domains where countries are sufficiently likely to face losses, decision by unanimity will be the bargaining outcome. By contrast, majority decision rules that do not require unanimity emerge for policy domains where gains are sufficiently likely. The threshold probability for gaining – which governs whether the bargaining solution is a majority or unanimity rule – is an increasing function of loss aversion. Accordingly, as an implication of our analysis, were – counterfactually – EU leaders to be merely as loss averse as the population average, or even loss neutral, they would potentially use the QM rule in some policy domains where they presently adopt decision by unanimity.

Our paper contributes to a relatively thin literature on elite decisionmaking. As Hafner-Burton *et al.* (2013) explain, elites are difficult to study directly because "...they are generally busy, wary of clinical poking, and skittish about revealing information about their decision-making processes and particular choices." By inferring preferences from observed choices, we seek to skirt these problems. We also connect to the literature that examines the congruence between the preferences of elected representatives and the citizens they represent. While we know of no study addressing *loss* aversion, two extant studies addressing *risk* aversion find that representatives are less risk averse than the citizens they represent (Heß *et al.*, 2018; Sheffer *et al.*, 2018). More generally, it is established empirically that the preferences of political representatives may not coincide with the majority preference of the citizens they represent. Stadelmann *et al.* (2013), for instance, estimate that individual legislators vote in accordance with the majority of their constituents only two-thirds of the time.

[4] A further inside account of these negotiations that buttresses this point is Galloway (2001, Ch. 4).

More broadly, we provide a further exploration of the role of behavioral economics in the nexus of economics and politics (see, e.g., Levy, 2003; Boettcher, 2004; Stein, 2017). Our analysis also adds to the wider formal analysis of the QM rule of the EUCO (e.g., Felsenthal and Machover, 2001, 2004, 2009). As our findings suggest that leaders exhibit relative (as well as absolute) loss aversion, our findings also have implications for the literature on the optimal selection of representatives in delegated democracies (e.g., Harstad, 2010).

The plan of the paper is as follows: Section 2 develops a theoretical framework for understanding positive and negative power under a given decision rule, and constructs a bargaining model over the choice of a decision rule. Section 3 describes our implementation of the bargaining model to the 2007 negotiation of the Lisbon QM rule, and section 4 gives the results. Section 5 extends the analysis of the Lisbon QM rule to earlier QM rules, and offers other robustness checks. A discussion of our findings is given in section 6. The Appendix details a novel approach to the computation of voting power measures, developed for this analysis. The figures appear at the very rear.

2 Model

In this section we model the adoption of a decision rule by an IO as the outcome of a grand bargain between its member states. We consider a voting body $\mathcal{N}$ comprised of $N > 1$ member states, to which motions are submitted. The set of voting possibilities is $\{for, against\}$ and the outcome space is $\{pass, fail\}$.[5] For a given motion, $F \subseteq \mathcal{N}$ denotes the set (coalition) of members voting for. The decision rule to be adopted is a mapping, w, from the set $2^{\mathcal{N}}$ (representing all subsets of $\mathcal{N}$) to the set of outcomes $\{pass, fail\}$.

Proceeding in the spirit of Laruelle and Valenciano (2010) we assume, for simplicity, that no country is indifferent between voting for or *against* on any issue, and voting is not costly. In these conditions, countries will vote for or *against* a motion according to whether the motion is gainful or harmful to them, relative to the maintenance of the status quo. Before the motion to be voted on is known, each country belongs to one of two possible types: a for-country, which stands to gain a monetized amount $W^F > 0$ if the motion passes, or an *against*-country, which stands to lose a monetized amount $W^A > 0$ if the motion

[5] We shall apply our model to the EUCO, in which abstention is a third possible voting outcome. Under the QM decision rules we study in this paper, however, abstention is formally indistinguishable from a vote against. Hence, it can be omitted without any loss of generality.

passes. Accordingly, a for-country, i, will vote for, hence $i \in F$. For an $against$-country j, $j \notin F$. If the motion fails, then the status quo position is maintained, so no country gains or loses any amount. We assume that each country is of for-type with probability $p \in (0,1)$, independently of the others, but countries only learn their type once the motion is known.

As in prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) we suppose that leaders form preferences over monetized gains relative to a reference point. Consistent with related studies (e.g., Kahneman and Tversky, 1979; Lockwood and Rockey, 2020; Alesina and Passarelli, 2019) we assume the reference point is the status quo.[6] Accordingly, the implied lottery facing country i, prior to the motion being known, can be written – in probability-payoff pairs – as

$$L_i = \left(\Pr\left(i \in F, w\left(F\right) = pass\right), W^F \ ; \ \Pr\left(i \notin F, w\left(F\right) = pass\right), -W^A \ ; \ \Pr\left(fail\right), 0\right). \quad (1)$$

Given (1), the expected utility of country i is therefore

$$\Psi\left(L_i\right) = \Pr\left(i \in F, w\left(F\right) = pass\right) U\left(W^F\right) + \Pr\left(i \notin F, w\left(F\right) = pass\right) U\left(-W^A\right) + \Pr\left(fail\right) U\left(0\right). \quad (2)$$

Letting ΔW denote payoff variation relative to the status quo, we write utility as

$$U\left(\Delta W\right) = \begin{cases} V\left(\Delta W\right) & \text{if } \Delta W \geq 0 \\ -\lambda V\left(-\Delta W\right) & \text{otherwise;} \end{cases} \quad (3)$$

where $V : \mathbb{R}_{\geq 0} \mapsto \mathbb{R}_{\geq 0}$ is continuous and everywhere increasing, and $V(0) = 0$. The shape of $U(.)$ matches the S-shaped value function proposed in Kahneman and Tversky (1979) when $V(.)$ is strictly concave. Loss aversion, in the sense of Kahneman and Tversky (1979),

[6] An alternative proposal by Kőszegi and Rabin (2006, 2007) is that the reference point is stochastic, corresponding to the decision lottery itself. A key difference between approaches is that losses are measured absolutely under the status-quo interpretation, but relative to other outcomes in the lottery under the Kőszegi-Rabin interpretation. Thus, in the latter interpretation, gain outcomes nevertheless attract loss aversion when compared to even larger gains. We do not investigate the Kőszegi-Rabin intepretation here, largely as a well-established population benchmark for this measure of loss aversion (against which to judge of relative loss aversion hypothesis) does not yet exist. In the few extant studies we know of, Campos-Mercade *et al.* (2022) report two average estimates of λ_{KR} from their experiments, both of which lie in the interval $\lambda_{KR} \in [1.3, 1.5]$, but Andersen *et al.* (2022) report $\lambda_{KR} \approx 2.5$.

is defined as $-U(-\Delta W) > U(\Delta W)$ for all $\Delta W > 0$.[7] This condition holds if and only if $\lambda > 1$. Substituting (3) in (2) we obtain

$$\Psi(L_i) = \Pr(i \in F, w(F) = pass)\, V\left(W^F\right) - \lambda \Pr(i \notin F, w(F) = pass)\, V\left(W^A\right). \tag{4}$$

From behind a veil of ignorance as to the motion to be decided, the monetary payoffs are set as $W^F = W^A = W$, so that the loss from implementing an unfavorable motion equals the gain from implementing a favorable motion. This is not to deny the existence of payoff variability across motions, but rather harks to Bernoulli's principle of insufficient reason, according to which, in the absence of a compelling a-priori reason for assigning different values, equality should be presumed. Equation (4) then reduces to

$$\Psi(L_i) = \{\Pr(i \in F, w(F) = pass) - \lambda \Pr(i \notin F, w(F) = pass)\}\, V(W). \tag{5}$$

A notable implication of (5) is that preferences over monetary outcomes, $V(W)$, enter the Nash product as a multiplicative factor, and consequently play no role in the determination of the NBS. Thus, one can estimate the coefficient of loss aversion independently of the risk preferences contained in $V(W)$.[8]

2.1 Power: Positive and Negative

To sharpen the intuition further, we now rewrite expected utility in (5) as an explicit function of formal measures of positive and negative power, extending the earlier work of Coleman (1971). Following Coleman (1971), we define positive power as the extent to which a country i can initiate action. Hence, it is intimately related to the probability that a motion will $pass$, conditional on i having voted for, $\Pr(pass|i \in F)$. Negative power – the power to prevent action – is similarly related to the probability that a motion will $fail$, conditional on i having voted $against$, $\Pr(fail|i \notin F)$. A difficulty with using these probabilities as direct measures

[7] This definition of loss aversion is the original one of Kahneman and Tversky (1979), and may be interpreted as applying to "large stakes". A related definition of loss aversion for "small stakes" is given by Köbberling and Wakker (2005), according to which $U(\cdot)$ displays loss aversion if and only if $\lim_{W\uparrow 0} \partial U(W)/\partial W > \lim_{W\downarrow 0} \partial U(W)/\partial W$. As choosing decision rules for IOs is inherently a large stakes context, we do not dwell on the small stakes case. We note, however, that these two definitions of loss aversion are complementary, and both are commonly assumed together in axiomatic models (see, e.g., Bowman *et al.*, 1999; Kőszegi and Rabin, 2007). For other related discussions of concepts of loss aversion see Wakker and Tversky (1993), Schmidt and Zank (2005) and Zank (2010).

[8] In this respect our approach contrasts with other tests of loss aversion that, to identify the effects of loss aversion, instead proceed under a maintained assumption of risk neutrality (e.g., Karle *et al.*, 2015, 2022).

of power, however, is that they mix power with luck. In particular, if the unconditional probability of a motion passing is denoted by $\Pr(pass) \equiv \omega$, then it is only the differential $\Pr(pass|i \in F) - \omega$ that reflects genuine positive power, separate from luck. Similarly, pure negative power is reflected in the differential $\Pr(fail|i \notin F) - [1-\omega]$. Netting out luck, we arrive at pure measures of positive power (β_i^+) and negative power (β_i^-):

$$\beta_i^+ = \frac{\Pr(pass|i \in F) - \omega}{1-\omega}; \qquad \beta_i^- = \frac{\Pr(fail|i \notin F) - [1-\omega]}{\omega}. \tag{6}$$

Coleman (1971) considers $\{\beta_i^+, \beta_i^-, \omega\}$ under the twin assumptions that (i) all countries vote independently; and (ii) that each country votes *for* and *against* with equal probability. We generalize the setting of Coleman (1971) by relaxing assumption (ii) to allow the probability of voting *for* to differ from that of voting *against*.[9,10]

Proposition 1 *The expected utility of country i, before the motion is known, is given by*

$$\Psi(L_i) = \left\{p\left[\omega + [1-\omega]\beta_i^+\right] - \lambda[1-p]\,\omega\left[1-\beta_i^-\right]\right\} V(W).$$

Proof. By the multiplication axiom of conditional probabilities, (5) rewrites as

$$\begin{aligned}\Psi(L_i) &= \{\Pr(i \in F)\Pr(pass|i \in F) - \lambda \Pr(i \notin F)\Pr(pass|i \notin F)\} V(W) \\ &= \{\Pr(i \in F)\Pr(pass|i \in F) - \lambda \Pr(i \notin F)[1-\Pr(fail|i \notin F)]\} V(W).\end{aligned}$$

Substituting $\Pr(i \in F) = p$, this reduces to

$$\Psi(L_i) = \{p\Pr(pass|i \in F) - \lambda[1-p][1-\Pr(fail|i \notin F)]\} V(W).$$

Finally, using (6) to replace the terms $\Pr(pass|i \in F)$ and $\Pr(fail|i \notin F)$, we obtain the proposition. ■

Proposition 1 relates the expected utility of country i to its positive power, β_i^+, and its negative power, β_i^-. Possession of positive power increases expected utility by increasing the

[9] Although we know of no previous study to relax Coleman's measures in this way, the related absolute Banzhaf index (Banzhaf, 1968) has been relaxed similarly. Our generalization of Coleman's measures corresponds to a special case of the way in which the absolute Banzhaf index is generalized in the "empirical Banzhaf indices" of Heard and Swartz (1998) and the "behavioral power index" of Kaniovski and Leech (2009).

[10] Our measures of positive and negative power are also closely related to the concept of criticality: country i is *critical* ($i \in C$) when it is able to change the outcome of a vote by switching its vote. The probability that a country is critical in a given vote, $\Pr(i \in C)$, is equivalently represented as ω-weighted average of β_i^+ and β_i^-, $\Pr(i \in C) = \omega\beta_i^- + [1-\omega]\beta_i^+$, or as the p-weighted harmonic mean of $\beta_i^+$and β_i^-: $\Pr(i \in C) = \left\{[p/\beta_i^-] + [1-p]/\beta_i^+\right\}^{-1}$.

probability that the gain utility $V(W)$ is realized. Negative power also increases expected utility, but by reducing the probability that the loss utility $-\lambda V(W) < 0$ is realized. To see how loss aversion interacts with positive and negative power note that the cross derivatives of expected utility are

$$\frac{\partial^2 \Psi(L_i)}{\partial \beta_i^+ \partial \lambda} = 0; \qquad \frac{\partial^2 \Psi(L_i)}{\partial \beta_i^- \partial \lambda} = [1-p]\,\omega V\left(W^A\right) > 0. \tag{7}$$

Importantly, λ interacts positively with negative power, but not with positive power. It follows that, as λ is increased, negative power weighs more heavily in the determination of expected utility relative to positive power.

2.2 Bargaining over Decision Rules

Owing to their central role, decision rules must be adopted as the consensual outcome of negotiations among all members of an IO. The consensual nature of the outcome not withstanding, the negotiations can commonly be intense, with countries robustly defending their interests. Accordingly, we model the observed decision rules as the solution of a (generalized) Nash bargain among the members of an IO. To view the NBS as a descriptive account of the process by which decision rules are selected, we follow a vast economic literature in interpreting the NBS as the outcome of a strategic bargaining process.[11] The NBS, however, also has desirable normative properties (Nash, 1950). In particular, the outcome of the Nash bargain we consider yields an outcome that is Pareto efficient in an ex-ante sense (i.e., from behind a veil of ignorance concerning the motion to be decided). This feature of the model connects, therefore, with a literature that advocates ex-ante utility maximization as a normative criterion for decision rule design (Barberà and Jackson, 2006; Maggi and Morelli, 2006; Rae, 1969).[12]

What would be the outcome if heads of government were unable to agree on a decision rule? Here we suppose that, in the absence of an agreement, leaders resort to the unanimity decision rule, under which a motion passes if and only if all countries vote for. Although the

[11] Binmore *et al.* (1986) show that the NBS is an approximation to the perfect equilibria in both time-preference and exogenous-risk strategic models. These results are extended to non-expected utility preferences in Rubinstein *et al.* (1992). Harsanyi (1956) shows that the NBS coincides with the predictions of some earlier strategic bargaining models, in particular that of Zeuthen (1930).

[12] See, e.g., Beisbart *et al.* (2005) and Laruelle and Valenciano (2010) for further implications of this normative criterion in decision rule design. Aghion *et al.* (2004) also consider a normative approach to setting voting quotas, but from the perspective of optimally constraining political leaders.

unanimity rule is typically Pareto dominated by majority decision rules (see, e.g., Bouton *et al.*, 2017, 2018) it is a focal choice of disagreement outcome as, uniquely among decision rules, it ensures that no country can ever experience a loss: collective action is taken only if it is a Pareto improvement (Buchanan and Tullock, 1962).

If the unanimity decision rule is adopted, each country obtains a (common) expected utility

$$\Psi(D) = p^N V(W), \tag{8}$$

where equation (8) follows from the observation that only in the event that all countries vote for, which occurs with probability p^N, is an affirmative outcome reached. In all other instances, the motion fails and the status quo is maintained.

While the unanimity rule maximizes negative power (giving full insurance against the adoption of harmful motions), it comes at the cost of minimizing positive power. A leader who is sufficiently loss averse will be willing to make this sacrifice, but a less loss averse leader will not. Comparing (2) and (8), country i prefers the bargaining outcome to the unanimity rule if

$$\lambda < \frac{p}{1-p} \frac{\omega + [1-\omega]\beta_i^+ - p^{N-1}}{\omega\left[1-\beta_i^-\right]} \equiv \tilde{\lambda}_i(p). \tag{9}$$

Let $\underline{\lambda}(p) \equiv \min_{i\in\mathcal{N}}\{\tilde{\lambda}_i(p)\}$ be the smallest $\tilde{\lambda}_i(p)$ across the membership of the IO, and $\mathcal{W}$ be the set of feasible decision rules. We then have:

Proposition 2

(i) If $\lambda < \underline{\lambda}(p)$ the bargaining outcome is described by the solution to the problem

$$\max_{\mathcal{W}} \prod_{j\in\mathcal{N}} \left[\Psi(L_i) - \Psi(D)\right]^{\tau_j}; \qquad \sum_{j\in\mathcal{N}} \tau_j = 1; \tag{10}$$

where $\tau_j > 0$ is the bargaining weight of country j.

(ii) If $\lambda \geq \underline{\lambda}(p)$ the bargaining outcome is the unanimity rule (disagreement outcome).

Proposition 2 establishes the predicted bargaining outcomes. If $\lambda < \underline{\lambda}$ there exists a decision rule that yields a Pareto improvement relative to the disagreement outcome, in which case countries are predicted to bargain to the NBS. Conversely, if $\lambda \geq \underline{\lambda}$, then there exists at least one country that is better-off under the unanimity rule than under the bargaining outcome. In this case, any such country will force implementation of the unanimity rule.

3 Estimation

The model of section 2 can be applied to a class of decision rules, widely observed empirically, that make use of one or more "quotas". Suppose each country $i \in \mathcal{N}$ possesses a set of $Q \geq 1$ characteristics $\{c_{ij}\}_{j=1}^{Q}$. The sum of characteristic j over the members of a coalition F we denote by $c_j^F = \sum_{i \in F} c_{ij}$. Quota-based decision rules are of the form

$$w(F) = pass \text{ if and only if } c_j^F \geq q_j^F \text{ for all } j,$$

where q_j^F is a quota in respect of characteristic j, satisfying

$$q_j^F \in (0, c_j^{\mathcal{N}}] \text{ for all } j, F; \tag{11}$$

$$q_j^F \in (c_j^{\mathcal{N}}/2, c_j^{\mathcal{N}}] \text{ for at least one } j \text{, given } F \text{, and for all } F. \tag{12}$$

The bounds on the quota in (11) ensure that $w(\emptyset) = fail$ and $w(\mathcal{N}) = pass$. The requirement in (12) ensures that there can only be one possible outcome, i.e., if $w(F) = pass$ then $w(\mathcal{N} \setminus F) = fail$. The simple majority decision rule, as applied in bodies such as the United Nations General Assembly for instance, is the case

$$Q = 1; \qquad c_{i1} = 1 \text{ for all } i; \qquad c_1^F = |F|; \qquad q_1^F = \left\lfloor \frac{N}{2} \right\rfloor + 1.$$

In other IOs, the c_{ij} can reflect financial contributions to the organization – as is the case for the institutions of the World Bank and for the International Monetary Fund – or may be interpreted as weighted voting rights – as is the case for the QM rules utilized in the EU between 1958 and 2004. Although not explicitly a weighted voting rule, the decision rule of the United Nations Security Council is mathematically equivalent to a quota on a set of weighted votes (e.g., Freixas, 2005).[13]

In this section we consider the adoption by EU leaders of the QM rule in the 2007 Treaty of Lisbon, which entered into force on 1st November 2014. Under the Lisbon rule, a motion passes if and only if either a coalition F meets

C1: a population threshold, t_1, and a cardinality (or size) threshold, t_2; or meets

C2: a stronger cardinality threshold $t_3 > t_2$.

[13] For systematic analyses of the decision rules of a wide range of IOs see Posner and Sykes (2014) and Blake and Payton (2015).

Implicitly, therefore, the Lisbon rule is a quota-based decision rule with $Q = 2$ quotas – a population quota q_1^F and a cardinality quota q_2^F – given by

$$q_k^F = \begin{cases} \lceil t_k \rceil & \text{if } |F| < \lceil t_3 \rceil \\ c_k^F & \text{otherwise} \end{cases} \qquad k \in \{1, 2\}, \tag{13}$$

where c_1^F is the aggregate population of the members of F and $c_2^F = |F|$. Note that if $|F| \geq \lceil t_3 \rceil$, such that condition C2 is met, then both quotas are met ($c_1^F = q_1^F$ and $c_2^F = q_2^F$). The thresholds $\{t_1, t_2, t_3\}$ chosen by EU leaders are given by

$$t_1^{Lisbon} = 0.65 c_1^{EU}; \qquad t_2^{Lisbon} = 0.55N; \qquad t_3^{Lisbon} = N - 3. \tag{14}$$

As of 2007 – when the negotiation of the Lisbon rule took place – EU membership stood at $N = 27$, with an aggregate population of approximately $c_1^{EU} = 493$ million people.[14] Thus, the thresholds in (14) took the values

$$t_1^{Lisbon} \approx 320.4\text{m.}; \qquad t_2^{Lisbon} = 14.85; \qquad t_3^{Lisbon} = 24. \tag{15}$$

The set of winning coalitions under Lisbon QM rule (for the EU as of 2007) is depicted graphically as the light-shaded space in Figure 1 (the dark-shaded areas are infeasible and the unshaded areas are feasible outcomes in which a motion fails). As is apparent in the Figure, although both conditions C1 and C2 actively shape the set of winning coalitions, condition C2 does so only marginally: it contributes only the small rectangular area below the dashed $c_1^F = \lceil t_1 \rceil$ locus in the bottom-right of the figure.

Figure 1 – see p. 30

The underlying approach to the identification of the coefficient of loss aversion implied by the Lisbon rule is to look for the value of λ which rationalizes the choices of EU leaders in (15) as a NBS.[15] To reduce the dimensionality of the problem we fix the ratios t_2/t_1 and t_3/t_1 to correspond to the ratios chosen by EU leaders. Thus, from (14) and (15),

$$t_k := t_k(t_1) = \frac{t_k^{Lisbon}}{t_1^{Lisbon}} t_1; \qquad k \in \{2, 3\}. \tag{16}$$

[14] Our population estimates as of 2007 are those of Eurostat, the statistical office of the European Commission.

[15] Thus, we take the two-quota structure of the Lisbon rule as given. This is consistent with the observation in Cameron's (2004) account of the preparatory negotiations that countries first agreed on the "double-majority" structure of the Lisbon rule, before then proceeding to negotiate over the setting of the thresholds.

Let $t_1^*(\lambda)$ be the NBS for t_1 at each coefficient of loss aversion λ. The NBS for $\{t_2, t_3\}$ will then be determined by (16). We look for $\lambda \in \lambda^*$ such that

$$\lambda \in \lambda^* \Leftrightarrow t_1^*(\lambda^*) = t_1^{Lisbon}.$$

The set λ^* may be either an interval or a singleton, as $t_1^*(\lambda)$ is a step function under the determination of quotas in (13). The stepped form of t_1^* in response to changes in λ is because the quotas in (13) depend only on the integer part of the underlying thresholds. To minimize this source of stickiness between t_1^* and λ we allow for non-integer threshold values by treating them as probabilistic mixtures of integer thresholds. Thus, e.g., $t_2 = 14.5$ is treated as a probabilistic threshold $\tilde{t}_2$, taking the integers values $\tilde{t}_2 \in \{14, 15\}$ with equal probability. More generally, we define

$$\tilde{t}_k = \begin{cases} \lfloor t_k \rfloor & \text{with probability } \lceil t_k \rceil - t_k \\ \lceil t_k \rceil & \text{with probability } 1 - \lceil t_k \rceil + t_k \end{cases} \qquad k \in \{1, 2, 3\}, \tag{17}$$

which determine probabilistic quotas, defined analogous to (13), as

$$\tilde{q}_k^F = \begin{cases} \tilde{t}_k & \text{if } |F| < \tilde{t}_3 \\ c_k^F & \text{otherwise} \end{cases} \qquad k \in \{1, 2\}. \tag{18}$$

Because the mapping from the set of thresholds to expected utility in Proposition 1 is analytically complex, identification of λ^* is via numerical grid search. This requires computation of the $\{\beta_i^-, \beta_i^+\}_{i \in \mathcal{N}}$ thousands of times. As a single brute-force computation of these quantities for the then 27-member EUCO requires checking the outcome of some 2^{27} possible vote configurations, standard approaches to the computation of these quantities are infeasible. Accordingly, we utilize a novel approach to this computational problem (Appendix 2).[16]

To determine the function $t_1^*(\lambda)$ it remains to specify all other features of the Nash bargain, in particular the bargaining weights $\sum_{j \in \mathcal{N}} \tau_j$ and the probability of for-voting, $p \in [0, 1]$. We turn to these points in the remainder of the section.

Bargaining weights

The outcome of a bargaining process may be affected by a range of factors in addition to those captured by the decision rule. As Bailer (2010) discusses in the EU context, bargaining skill,

[16] The scale of the population data thwarts the efficiency of generating functions (see Bilbao *et al.*, 2000) as an alternative exact approach. Although we do not dwell on this methodological development here, we note that the approach to the computation of $\{\beta_i^-, \beta_i^+\}$ outlined in Appendix 2 has applicability to the study of a range of other large-N voting games for which existing approaches are inefficient.

economic might, domestic constraints, information, and institutional power, all plausibly play a role. Our model allows for these features to be captured within the set of bargaining weights, $\{\tau_j\}_{j\in\mathcal{N}}$. When the Nash product is differentiable in the choice variables, it is well-known that the share of the surplus acquired by each party in the NBS corresponds to their bargaining weight:

$$\tau_i = \frac{\Psi(L_i) - \Psi(D)}{\sum_{j\in\mathcal{N}}\left[\Psi(L_j) - \Psi(D)\right]}. \tag{19}$$

Differentiability does not apply to the present context, however, for $\left\{\beta_i^+, \beta_i^-, \omega\right\}$ can take values on the rational numbers only. The Nash product is, however, sufficiently dense on the set of rational numbers for the equality in (19) to hold with only negligible relative error. Accordingly, as we observe the decision rule that EU leaders actually chose, we can infer estimates of country bargaining power. Let $\Psi_{Lisbon}(L_i;\lambda)$ be the expected utility of country i under the Lisbon rule. We can therefore compute – for each level of λ – an estimate of τ_i, denoted $\hat{\tau}_i$, as

$$\hat{\tau}_i(\lambda) = \frac{\Psi_{Lisbon}(L_i;\lambda) - \Psi(D)}{\sum_{j\in EUCO}\left[\Psi_{Lisbon}(L_j;\lambda) - \Psi(D)\right]}.$$

Voting probabilities

We estimate the parameter p – the probability a member will vote for a motion – from observed for-vote frequencies in the EUCO, as of the time the negotiations were taking place. At the time of the Lisbon negotiations, the applicable QM rule was that in the Treaty of Nice, which applied between February 2003 and October 2014. We analyze the universe of motions ($N = 581$) voted on by the EUCO under the Nice QM rule beyond 7th July 2009 using the VoteWatch Europe dataset (Hix *et al.*, 2022), hosted at https://hdl.handle.net/1814/74918. Within these data, the proportion of votes cast that were votes for stands at 97.49 percent.[17] Hosli (2007) reports a similarly high rate of 97.96 percent in data on EUCO votes covering 1995-2004. Implicit in our approach is that, in negotiating the Lisbon rule, EU leaders assumed that existing rates of voting for under the old Nice rule would continue under the

[17] The majority (87.7 percent) of the uses of the QM rule in our data occur under the ordinary legislative procedure (formerly co-decision) under which the European Parliament may propose amendments to legislation passed by the EUCO at first reading, thereby requiring further rounds of voting in the EUCO. Thus, 4.2 percent of the motions we consider were voted on more than once by the EUCO. Where multiple rounds of voting occur we restrict attention to the final round of voting, for in earlier rounds of voting the vote was over legislation not in its final form. We exclude a small number of motions (53) on which not all EUCO members participated in voting (e.g., acts adopted only by Euro area or Schengen member states). The remaining motions included in the analysis number $N = 528$.

new Lisbon rule. If so, such a belief would have been ex-post rational, for (our) estimates of for-voting under the Lisbon QM rule (based on the universe of VoteWatch Europe data post 1st November 2014) put the proportion of for votes at 97.1 percent.[18]

While it is tempting to equate the parameter p with the observed frequency of for-voting, a notable feature of our data on EUCO voting that augurs against such an approach is that no vote is observed to fail under a QM rule (Nice or Lisbon). This appears indicative of a tendency within the European Commission (and the executive organs of other IOs) to bring forward only proposals that are expected to pass. By contrast, our model envisages an environment in which motions are not filtered endogenously in the shadow of the decision rule. To account for this point, we treat the empirical proportion of votes that are for as an estimate of the conditional probability $\Pr(i \in F|pass)$ rather than of the unconditional probability $\Pr(i \in F)$. Then p is the solution to the equality

$$\frac{p}{1-\omega(p)} = \Pr(i \in F|pass). \tag{20}$$

Under the Nice QM rule some 97.49 percent of votes are for votes. Equating $\Pr(i \in F|pass)$ with this statistic, we compute the solution to the equality in (20) as $p = 0.9727$. We use this estimate in what follows.

4 Results

Figure 2 plots the population threshold at the NBS, $t_1^*(\lambda)$, for $\lambda \in [1, 7]$. $t_1^*(\lambda)$ is increasing in λ, for greater focus on losses relative to gains induces a stronger concern for negative power relative to positive power. Our estimate of the coefficient of loss aversion, $\lambda \in \lambda^*$, is located in Figure 2 where $t_1^*(\lambda)$ coincides with the choice of EU leaders, t_1^{Lisbon}, on the interval $\lambda \in \lambda^* = [5.751, 6.328]$. Thus, our finding points to both absolute and relative loss aversion on the part of EU leaders.

Figure 2 – see p. 31

The critical value $\underline{\lambda}(p)$ is found as $\underline{\lambda}(p) = 18.2$; for $\lambda > 18.2$ Malta (the least populous EU member) is sufficiently loss averse that it prefers the unanimity rule to any QM rule. Accordingly, for $\lambda \geq 18.2$ the NBS is the unanimity rule.

[18] For further discussion of voting patterns in the EUCO see Hosli *et al.* (2018).

5 Extensions and Robustness

In this section we explore the generality and robustness of our findings in section 4.

5.1 Other EU Decision Rule Negotiations

Our findings in respect of the Lisbon rule might reflect circumstances unique to the negotiation of this rule, and therefore not extend to the choice of decision rules more generally. To explore this point, we repeat the methodology of section 3 for all EU QM decision rules dating back to their introduction in 1958. As detailed in Felsenthal and Machover (1997), between 1958-2004 the EU employed five different decision rules (EU1 – EU5) each of which took the form of a single quota over a set of weighted votes. The Nice QM rule (EU6), employed between 2004 and 2014, extended this structure to a 3-quota (weighted votes, cardinality, and population) rule (Felsenthal and Machover, 2001).[19] To analyze the Nice rule, therefore, we proceed in a similar spirit to the Lisbon rule by varying the population quota, holding fixed its ratio with the weighted votes and cardinality quotas.

The results of this exercise are shown in Table 1.

Decision Rule	λ^*
EU1 (1958-1973)	$\in (1.98, 2.03)$
EU2 (1973-1981)	3.15
EU3 (1981-1986)	3.48
EU4 (1986-1995)	2.91
EU5 (1995-2004)	$\in (3.21, 3.80)$
EU6 (2004-2014)	5.62

Table 1: Estimates of loss aversion for EU QM rules 1958-2008

The interval estimates for λ^* in Table 1 arise when the NBS corresponds with the empirically observed decision rule at a "plateau", while point estimates arise when correspondence with

[19] In this taxonomy, the Lisbon rule analyzed in section 3 corresponds to EU7.

the NBS occurs at a step. The results in Table 1 show evidence of absolute loss aversion among EU leaders in all QM decision rules chosen between 1958-2014. In respect of relative loss aversion, all estimates sit well above two, with the exception of the estimate for the very first QM rule. In summary, our qualitative findings are not unique to the Lisbon rule.

5.2 Analysis of Conditions $\{\mathrm{C1}, \mathrm{C2}\}$ Separately

Although, per footnote 15, we know the $\{\mathrm{C1}, \mathrm{C2}\}$ architecture of the Lisbon QM rule was agreed prior to choosing the thresholds $\{t_1, t_2, t_3\}$, exactly how leaders chose $\{t_1, t_2, t_3\}$ is unknown. The analysis of Section 3 considers $\{t_1, t_2, t_3\}$ simultaneously. If, however, leaders hypothetically agreed $\{t_1, t_2, t_3\}$ in a sequential manner, an alternative methodology might be more appropriate. We therefore assess the robustness of our findings to both sequential possibilities. Thus, we disaggregate the level of loss aversion implied by the constituent conditions $\{\mathrm{C1}, \mathrm{C2}\}$ separately, varying the thresholds in one condition holding the threshold(s) in the other condition fixed. When holding the two thresholds in C1 fixed at the EU leaders' choices and varying the higher cardinality threshold, t_3, in C2 we obtain the estimate $\lambda^* \in [5.75, 8.01]$. Alternatively, fixing $t_3 = t_3^{Lisbon}$ and then varying the population threshold in C1, fixing the t_2/t_1 ratio as previously, we obtain the estimate $\lambda^* = 5.19$. In both cases, the results are consistent with EU leaders being loss averse in both absolute and relative senses.

5.3 Qualified Majority or Unanimity?

Here we extend our baseline analysis to in order to understand its implications for what EU decisionmaking might look like in a counterfactual world where leaders accentuate losses to a lesser degree. In the EU context two distinct effects are discernible. First, at the "intensive" margin, our analysis predicts that, if EU leaders were less loss averse, they would design QM rules with less stringent quotas for motions to pass. Second, at the "extensive" margin, EU leaders would be willing to utilize the QM rule for decisionmaking over a range of policy issues that are, in actuality, subject to the unanimity rule. As a strong ceiling effect caps the scope of the intensive margin effect, given the already very high rates of for-voting in policy domains in which a QM decision rule is utilized, we focus on the extensive margin. To do this, we consider how the threshold value, $\lambda = \underline{\lambda}(p)$, at which the NBS switches from an agreed outcome (i.e., a QM rule) to the unanimity rule (disagreement outcome), behaves as a function of p.

We consider the function $\underline{p}(\lambda) = \underline{\lambda}^{-1}(\lambda)$. When $\underline{p}(\lambda)$ is an increasing function (as we shall find), the NBS in Proposition 2 is the unanimity rule (disagreement outcome) for policy domains with $p \leq \underline{p}(\lambda)$ and a QM rule for policy domains with $p > \underline{p}(\lambda)$. That is, unanimity is predicted to prevail in policy domains where countries lack sufficient common interests, whereas QM is predicted to prevail in policy domains with strong enough common interests. This is an empirically attractive feature of the model, for EUCO indeed employs the unanimity rule for policy domains such as common taxation and defence, which are widely acknowledged to be contested, while employing a QM rule in other policy domains. The usefulness of $\underline{p}(\lambda)$ is that $\underline{p}(\lambda^*)$ is an estimate of the threshold level of consensus used by EU leaders to partition policy domains into those employing the unanimity rule, and those employing a QM rule. $\underline{p}(\lambda^*)$ can then be compared with counterfactual estimates such as under loss neutrality, $\underline{p}(1)$, or under population estimates of loss aversion, $\underline{p}(2)$.

We plot $\underline{p}(\lambda)$ under the Lisbon rule in Figure 3. For the estimate $\lambda^* \in [5.75, 6.33]$ of the baseline analysis in section 3 we have $\underline{p}(\lambda^*) \in [0.85, 0.87]$. Thus, at the baseline estimate of loss aversion, the bargaining solution is the Lisbon QM rule for values of p above this interval. Consistent with this analysis, empirical rates of for-voting under the Lisbon QM rule exceed 97%, as discussed in section 3.3. In the counterfactual scenario of loss neutrality, we have $\underline{p}(1) = 0.35$, such that the bargaining solution takes the form of a QM rule for $p > 0.35$ and the unanimity rule otherwise. Accordingly, policy areas for which $p \in (0.35, 0.85]$ are predicted to utilize the unanimity rule for loss aversion λ^*, but to utilize a QM rule if, counterfactually, leaders are loss neutral. Thus, some domains which presently use the unanimity rule (e.g., taxation, social security or social protection, foreign and common defence policy and operational police cooperation) might be predicted to use a QM rule in a loss neutral world, with potentially profound implications for European cooperation. By a similar argument, policy areas for which $p \in (0.65, 0.85]$ are predicted to utilize the unanimity rule for loss aversion λ^*, but to utilize a QM rule if, counterfactually, leaders exhibit loss aversion $\lambda = 2$.

Figure 3 – see p. 31

6 Discussion and Conclusion

In this study we used the way in which world leaders choose voting systems for international organizations (IOs) to infer their coefficient of loss aversion. In particular, we consider the design of the QM rule in the Treaty of Lisbon, which was negotiated by EU leaders in 2007. Our approach models the negotiations over the Lisbon rule as a (Nash) bargain, and estimates the coefficient of loss aversion independently of risk preferences. Given that EU leaders ringfenced the use of their QM rule to policy domains known a-priori to have high levels of agreement between members, the thresholds chosen for motions to pass suggests a very strong concern for blocking power.[20] Our findings suggest that world leaders are loss averse in the absolute sense of weighing losses more heavily than equivalent gains, and also in the relative sense of exhibiting a stronger aversion of losses than characterizes the populations they represent.

Designing decision rules for IOs inherently entails high-stakes, and heads of government are highly experienced decisionmakers. These features might suggest that heads of government would not exhibit loss aversion. Our findings go contrary this suggestion, however, and are instead consistent with a literature arguing that even experts remain prone to behavioral biases (Foellmi *et al.*, 2016; Pope and Schweitzer, 2011). Professional golfers, for instance, are significantly less accurate with birdie putts than with otherwise similar putts for par. Importantly, our estimate of loss aversion for heads of government is higher than is typically found in the literature. We see two competing interpretations of this finding, each with distinct implications.

The first explanation is that electoral systems induce the selection of political representatives with systematically higher loss aversion. While we know of no direct empirical evidence on this point, it is established empirically that the preferences of political representatives do not typically coincide exactly with the majority preference of the citizens they represent. Stadelmann *et al.* (2013), for instance, estimate that individual legislators vote in accordance with the majority of their constituents only two-thirds of the time. Two recent studies we know of do examine whether representatives have the same risk aversion – alas, not loss

[20]Moreover, EU member states, as well as ringfencing use of a QM rule, also have access to a number of constitutional arrangements – notably the "Luxembourg Veto" and "Ioannina Compromise" – that aim to provide safeguards to countries who face being outvoted under a QM rule (see, e.g., Reestman and Beukers, 2017). Article 50 of the Lisbon Treaty, which provides for member states to leave the EU, can also be viewed as an ultimate form of insurance against realizing a loss (Huysmans, 2019).

aversion – as the citizens they represent (Heß *et al.*, 2018; Sheffer *et al.*, 2018). Both of these studies find evidence that representatives are less risk averse than the citizens they represent. Whether, however, risk aversion correlates at the individual level with loss aversion remains unclear.[21] As such, the findings for risk aversion, while suggestive, cannot be assumed to hold for loss aversion. To the extent that present electoral systems do select more loss averse candidates, the key to avoiding the negative consequences of excessive loss aversion may be to instead implement electoral processes that match the preferences of representatives and citizens as closely as possible. The types of electoral processes that meet this desideratum are discussed in, e.g., Martin and Hug (2018).

An alternative explanation of our findings is that heads of government are, in general, no more or less loss averse than the population at large, but that situational features specific to the high-stakes international negotiations we consider may have induced greater than normal loss aversion. In particular, there is evidence that the exhibition of behavioral biases in decision-making may be non-monotonic in the size of the stakes. Biases are observed to decrease for moderate stakes relative to small stakes, yet an emerging literature documents a tendency for even experienced decisionmakers to "choke" when faced with very high stakes (Baumeister, 1984; Dohmen, 2008; Ariely *et al.*, 2009). Such decision-makers are observed to exhibit greater behavioral bias than when making decisions over lower stakes. To the extent this explanation holds, steps might be taken that act to systematically reduce the manifestation of loss aversion. Evidence suggests that decisionmakers exhibit less loss aversion when making decisions for others (Polman, 2012; Andersson *et al.*, 2016; Füllbrunn and Luhan, 2017). This suggests a new argument for the role of bureaucrats in high-stakes decisionmaking in addition to those identified previously (see, e.g., Alesina and Tabellini,2007).[22] To test between explanations, note that this explanation suggests that loss aversion would be lower for lower-ranked national and local political representatives charged with making less consequential decisions than are heads of government. By contrast, under the former explanation, all political representatives – not just heads of government – should display heightened loss aversion.

[21] For contrasting evidence on this point see, e.g., Baek *et al.* (2017) and Charpentier *et al.* (2017).

[22] The final negotiation of the Lisbon QM rule, and other earlier EU QM rules, was between EU leaders, with minimal presence of officials. In personal correspondence, Axel Moberg, the earlier cited witness to the Nice QM rule negotiations, describes how "high-ranking officials were often indisposed to enter into discussion of the merits of various proposals since this was a matter for "higher up"." These points, and that our estimate of loss aversion is relatively high, are suggestive of a limited bureaucratic influence on such decisions at present.

From a broader perspective, given that decision rules are not only a feature of EU decisionmaking, but are pervasive in other international, national and local contexts, the wider public policy implications of our analysis are potentially significant. In an effort to prevent behavioral biases distorting the design of such decision rules we echo the call of Hosli and Machover (2004) for a dialogue between academics and practitioners in order to allow for more informed choices.

References

Aghion, P., Alesina, A. and Trebbi, F. (2004). "Endogenous political institutions", *Quarterly Journal of Economics*, 119(2), 565–612.

Alesina, A. and Drazen, A. (1991). "Why are stabilizations delayed?", *American Economic Review*, 81(5), 1170–1188.

Alesina, A. and Passarelli, F. (2019). "Loss aversion in politics", *American Journal of Political Science*, 63(4), 936–947.

Alesina, A. and Tabellini, G. (2007). "Bureaucrats or politicians? Part I: A single policy task", *American Economic Review*, 97(1), 169–179.

Alevy, J., Haigh, M. and List, J. (2007). "Information cascades: Evidence from a field experiment with financial market professionals", *Journal of Finance*, 62(1), 151–180.

Andersen, S., Badarinza, C., Liu, L., Marx, J. and Ramadorai, T. (2022). "Reference dependence in the housing market", *American Economic Review*, 112(10), 3398–3440.

Andersson, O., Holm, H., Tyran, J.R. and Wengström, E. (2016). "Deciding for others reduces loss aversion", *Management Science*, 62(1), 29–36.

Ariely, D., Gneezy, U., Loewenstein, G. and Mazar, N. (2009). "Large stakes and big mistakes", *Review of Economic Studies*, 76(2), 451–469.

Baek, K., Kwon, J., Chae, J.H., Chung, Y., Kralik, J., Min, J.A., Huh, H., Choi, K., Jang, K.I., Lee, N.B., Kim, S., Peterson, B. and Jeong, J. (2017). "Heightened aversion to risk and loss in depressed patients with a suicide attempt history", *Scientific Reports*, 7, 11228, doi:10.1038/s41598-017-10541-5.

Bailer, S. (2010). "What factors determine bargaining power and success in EU negotiations?", *Journal of European Public Policy*, 17(5), 743–757.

Banzhaf, J. (1968). "One man, 3.312 votes: A mathematical analysis of the Electoral College", *Villanova Law Review*, 13(2), 304–332.

Barberà, S. and Jackson, M. (2006). "On the weights of nations: Assigning voting power to heterogeneous voters", *Journal of Political Economy*, 114(2), 317–339.

Baumeister, R. (1984). "Choking under pressure: Self-consciousness and paradoxical effects of incentives on skillful performance", *Journal of Personality and Social Psychology*, 46(3), 610–620.

Beisbart, C., Bovens, L. and Hartmann, S. (2005). “A utilitarian assessment of alternative decision rules in the Council of Ministers”, *European Union Politics*, 6(4), 395–418.

Benartzi, S. and Thaler, R. (1995). “Myopic loss aversion and the equity premium puzzle”, *Quarterly Journal of Economics*, 110(1), 73–92.

Bilbao, J., Fernández, J., Losada, A. and López, J. (2000). “Generating functions for computing power indices efficiently”, *Top*, 8(2), 191–213.

Binmore, K., Rubinstein, A. and Wolinsky, A. (1986). “The Nash bargaining solution in economic modelling”, *RAND Journal of Economics*, 17(2), 176–188.

Blake, D. and Payton, A. (2015). “Balancing design objectives: Analyzing new data on voting rules in intergovernmental organizations”, *Review of International Organizations*, 10(3), 377–402.

Boettcher, W. (2004). “The prospects for prospect theory: An empirical evaluation of international relations applications of framing and loss aversion”, *Political Psychology*, 25(3), 331–362.

Booij, A. and Kuilen, G. (2009). “A parameter-free analysis of the utility of money for the general population under prospect theory”, *Journal of Economic Psychology*, 30(4), 651–666.

Bouton, L., Llorente-Saguer, A. and Malherbe, F. (2017). “Unanimous rules in the laboratory”, *Games and Economic Behavior*, 102(1), 179–198.

Bouton, L., Llorente-Saguer, A. and Malherbe, F. (2018). “Get rid of unanimity rule: The superiority of majority rules with veto power”, *Journal of Political Economy*, 126(1), 107–149.

Bowman, D., Minehart, D. and Rabin, M. (1999). “Loss aversion in a consumption-savings model”, *Journal of Economic Behavior and Organization*, 38(2), 155–178.

Brown, A., Imai, T., Vieider, F. and Camerer, C. (2024). “Meta-analysis of empirical estimates of loss-aversion”, *Journal of Economic Literature*, 62(2), 485Ű516.

Buchanan, J. and Tullock, G. (1962). *The Calculus of Consent: Logical Foundations of Constitutional Democracy*, Ann Arbor: University of Michigan Press.

Camerer, C., Babcock, L., Loewenstein, G. and Thaler, R. (1997). “Labor supply of New York City cabdrivers: One day at a time”, *Quarterly Journal of Economics*, 112(2), 407–441.

Cameron, D. (2004). “The stalemate in the constitutional IGC over the definition of a qualified majority”, *European Union Politics*, 5(3), 373–391.

Campos-Mercade, P., Goette, L., Graeber, T., Kellogg, A. and Sprenger, C. (2022). “Heterogeneity of loss aversion and expectations-based reference points”, DOI: 10.2139/ssrn.3170670.

Charpentier, C., Aylward, J., Roiser, J. and Robinson, O. (2017). “Enhanced risk aversion, but not loss aversion, in unmedicated pathological anxiety”, *Biological Psychiatry*, 81(12), 1014–1022.

Chen, M., Lakshminarayanan, V. and Santos, L. (2006). "How basic are behavioral biases? Evidence from Capuchin monkey trading behavior", *Journal of Political Economy*, 114(3), 517–537.

Cheng, Q. and He, G. (2017). "Deciding for future selves reduces loss aversion", *Frontiers in Psychology*, 8, 1644.

Coate, S. and Morris, S. (1999). "Policy persistence", *American Economic Review*, 89(5), 1327–1336.

Coleman, J. (1971). "Control of collectivities and the power of a collectivity to act", in (B. Lieberman, ed.), *Social Choice*, 269–300, Amsterdam: Gordon and Breach.

Dal Bó, E., Dal Bó, P. and Snyder, J. (2009). "Political dynasties", *Review of Economic Studies*, 76(1), 115–142.

Dal Bó, E., Finnan, F., Folke, O., Persson, T. and Rickne, J. (2017). "Who becomes a politician?", *Quarterly Journal of Economics*, 132(4), 1877–1914.

Dal Bó, E. and Rossi, M. (2011). "Term length and the effort of politicians", *Review of Economic Studies*, 78(4), 1237–1263.

de Meza, D. and Webb, D. (2007). "Incentive design under loss aversion", *Journal of the European Economic Association*, 5(1), 66–92.

Dittmann, I., Maug, E. and Spalt, O. (2010). "Sticks or carrots? Optimal CEO compensation when managers are loss averse", *Journal of Finance*, 65(6), 2015–2050.

Dohmen, T. (2008). "Do professionals choke under pressure?", *Journal of Economic Behavior and Organization*, 65(3-4), 636–653.

Dunn, L. (1996). "Loss aversion and adaptation in the labor market: Empirical indifference functions and labor supply", *Review of Economics and Statistics*, 78(3), 441–450.

Engström, P., Nordblom, K., Ohlsson, H. and Persson, A. (2015). "Tax compliance and loss aversion", *American Economic Journal: Economic Policy*, 7(4), 132–164.

Felsenthal, D.S. and Machover, M. (1997). "The weighted voting rule in the EU's Council of Ministers, 1958-95: Intentions and outcomes", *Electoral Studies*, 16(1), 33–47.

Felsenthal, D.S. and Machover, M. (2001). "The Treaty of Nice and qualified majority voting", *Social Choice and Welfare*, 18(3), 431–464.

Felsenthal, D.S. and Machover, M. (2004). "Analysis of QM rules in the draft constitution for europe proposed by the European Convention, 2003", *Social Choice and Welfare*, 23(1), 1–20.

Felsenthal, D.S. and Machover, M. (2009). "The QM rule in the Nice and Lisbon treaties: Future projections", *Homo Oeconomicus*, 26(3/4), 317–340.

Foellmi, R., Legge, S. and Schmid, L. (2016). "Do professionals get it right? Limited attention and risk-taking behaviour", *Economic Journal*, 126(592), 724–755.

Freixas, J. (2005). "Banzhaf measures for games with several levels of approval in the input and output", *Annals of Operations Research*, 137(1), 45–66.

Füllbrunn, S. and Luhan, W. (2017). "Decision making for others: The case of loss aversion", *Economics Letters*, 161(1), 154–156.

Gächter, S., Johnson, E. and Herrmann, A. (2022). "Individual-level loss aversion in riskless and risky choices", *Theory and Decision*, 92(1), 599–624.

Galloway, D. (2001). *The Treaty of Nice and Beyond: Realities and Illusions of Power in the EU*, Sheffield: Sheffield Academic Press.

Goette, L., Huffman, D. and Fehr, E. (2004). "Loss aversion and labor supply", *Journal of the European Economic Association*, 2(2-3), 216–228.

Golub, J. (2007). "Survival analysis and European Union decision-making", *European Union Politics*, 8(2), 155–179.

Hafner-Burton, E., Hughes, D. and Victor, D. (2013). "The cognitive revolution and the political psychology of elite decision making", *Perspectives on Politics*, 11(2), 368–386.

Hardie, B., Johnson, E. and Fader, P. (1993). "Modeling loss aversion and reference dependence effects on brand choice", *Marketing Science*, 12(4), 378–394.

Harsanyi, J.C. (1956). "Approaches to the bargaining problem before and after the theory of games: A critical discussion of Zeuthen's, Hicks', and Nash's theories", *Econometrica*, 24(2), 144–157.

Harstad, B. (2010). "Strategic delegation and voting rules", *Journal of Public Economics*, 94(1-2), 102–113.

Hartman, R., Doane, M. and Woo, C. (1991). "Consumer rationality and the status quo", *Quarterly Journal of Economics*, 106(1), 141–162.

Heard, A. and Swartz, T. (1998). "Empirical Banzhaf indices", *Public Choice*, 97(4), 701–707.

Heinemann, F. (2004). "Explaining reform deadlocks", *Applied Economics Quarterly*, 55(S), 9–26.

Herweg, F., Müller, D. and Weinschenk, P. (2010). "Binary payment schemes: Moral hazard and loss aversion", *American Economic Review*, 100(5), 2451–2477.

Herweg, F. and Schmidt, K. (2015). "Loss aversion and inefficient renegotiation", *Review of Economic Studies*, 82(1), 297–332.

Heß, M., Scheve, C., Schupp, J., Wagner, A. and Wagner, G. (2018). "Are political representatives more risk-loving than the electorate? Evidence from German federal and state parliaments", *Palgrave Communications*, 4, 60.

Hix, S., Frantescu, D. and Hagemann, S. (2022). *VoteWatch Europe European Parliament and EU Council Voting Data*.

Hjorth, K. and Fosgerau, M. (2011). "Loss aversion and individual characteristics", *Environmental and Resource Economics*, 49(4), 573–596.

Hooghe, L. and Marks, G. (2015). "Delegation and pooling in international organizations", *Review of International Organizations*, 10(3), 305–328.

Hosli, M. (2007). "Explaining voting behavior in the Council of the European Union", Paper presented at the First World Meeting of the Public Choice Societies, Amsterdam.

Hosli, M. and Machover, M. (2004). "The Nice Treaty and voting rules in the Council: A reply to Moberg (2002)", *Journal of Common Market Studies*, 42(3), 497–521.

Hosli, M., Plechanovová, B. and Kaniovski, S. (2018). "Vote probabilities, thresholds and actor preferences: Decision capacity and the Council of the European Union", *Homo Oeconomicus*, 35(1-2), 31–52.

Huysmans, M. (2019). "Enlargement and exit: The origins of Article 50", *European Union Politics*, 20(2), 155–175.

Inesi, M. (2010). "Power and loss aversion", *Organizational Behavior and Human Decision Processes*, 112(1), 58–69.

Kahneman, D. and Tversky, A. (1979). "Prospect theory: An analysis of decision under risk", *Econometrica*, 47(2), 263–291.

Kaniovski, S. and Leech, D. (2009). "A behavioral power index", *Public Choice*, 141(1), 17–29.

Karle, H., Engelmann, D. and Peitz, M. (2022). "Student performance and loss aversion", *Scandinavian Journal of Economics*, 124(2), 420–456.

Karle, H., Kirchsteiger, G. and Peitz, M. (2015). "Loss aversion and consumption choice: Theory and experimental evidence", *American Economic Journal: Microeconomics*, 7(2), 101–120.

Knetsch, J. and Sinden, J. (1984). "Willingness to pay and compensation demanded: Experimental evidence of an unexpected disparity in measures of value", *Quarterly Journal of Economics*, 99(3), 507–521.

Köbberling, V. and Wakker, P. (2005). "An index of loss aversion", *Journal of Economic Theory*, 122(1), 119–131.

König, T. (2007). "Convergence or divergence? From ever-growing to ever-slowing European decision-making process", *European Journal of Political Research*, 46(3), 417–444.

Kőszegi, B. and Rabin, M. (2006). "A model of reference-dependent preferences", *Quarterly Journal of Economics*, 121(4), 1133–1165.

Kőszegi, B. and Rabin, M. (2007). "Reference-dependent risk attitudes", *American Economic Review*, 97(4), 1047–1073.

Laruelle, A. and Valenciano, F. (2010). "Egalitarianism and utilitarianism in committees of representatives", *Social Choice and Welfare*, 35(2), 221–243.

Levitt, S. and List, J. (2008). "Homo economicus evolves", *Science*, 319(5865), 909–910.

Levy, J. (2003). "Applications of prospect theory to political science", *Synthese*, 135(2), 215–241.

List, J. (2003). "Does market experience eliminate market anomalies?", *Quarterly Journal of Economics*, 118(1), 41–71.

List, J. (2011). "Does market experience eliminate market anomalies? The case of exogenous market experience", *American Economic Review*, 101(3), 313–317.

List, J. and Mason, C. (2011). "Are CEOs expected utility maximizers?", *Journal of Economics*, 162(1), 114–123.

Lockwood, B. and Rockey, J. (2020). "Negative voters? Electoral competition with loss-aversion", *Economic Journal*, 130(632), 2619–2648.

Maggi, G. and Morelli, M. (2006). "Self-enforcing voting in international organizations", *American Economic Review*, 96(4), 1137–1158.

Martin, D. and Hug, S. (2018). "Constituency preferences and MP preferences: The electoral connection", *Party Politics*, doi:10.1177/1354068818798861.

Moberg, A. (2002). "The Nice Treaty and voting rules in the Council", *Journal of Common Market Studies*, 40(2), 259–282.

Nannestad, P. and Paldam, M. (1997). "The grievance asymmetry revisited: A micro study of economic voting in Denmark, 1986–1992", *European Journal of Political Economy*, 13(1), 81–99.

Nash, J. (1950). "The bargaining problem", *Econometrica*, 18(2), 155–162.

Pennings, J. and Smidts, A. (2003). "The shape of utility functions and organizational behavior", *Management Science*, 49(9), 1251–1263.

Polman, E. (2012). "Self-other decision making and loss aversion", *Organizational Behavior and Human Decision Processes*, 119(2), 141–150.

Pope, D. and Schweitzer, M. (2011). "Is Tiger Woods loss averse? Persistent bias in the face of experience, competition, and high stakes", *American Economic Review*, 101(1), 129–157.

Posner, E. and Sykes, A. (2014). "Voting rules in international organizations", *Chicago Journal of International Law*, 15(1), 195–228.

Post, T., Assem, M., Baltussen, G. and Thaler, R. (2008). "Deal or no deal? Decision making under risk in a large-payoff game show", *American Economic Review*, 98(1), 38–71.

Rabin, M. (2000). "Risk aversion and expected-utility theory: A calibration theorem", *Econometrica*, 68(5), 1281–1291.

Rae, D. (1969). "Decision-rules and individual values in constitutional choice", *American Political Science Review*, 63(1), 40–56.

Rees-Jones, A. (2018). “Quantifying loss-averse tax manipulation”, *Review of Economic Studies*, 85(2), 1251–1278.

Reestman, J.H. and Beukers, T. (2017). “Not dead yet: Revisiting the ‘Luxembourg Veto’ and its foundations”, *European Constitutional Law Review*, 13(1), 1–12.

Rubinstein, A., Safra, Z. and Thomson, W. (1992). “On the interpretation of the Nash bargaining solution and its extension to non-expected utility preferences”, *Econometrica*, 60(5), 1171–1186.

Samuelson, W. and Zechhauser, R. (1988). “Status quo bias in decision making”, *Journal of Risk and Uncertainty*, 1(1), 7–59.

Scharpf, F. (1988). “The joint-decision trap: Lessons from German federalism and European integration”, *Public Administration*, 66(3), 239–278.

Schmidt, U. and Zank, H. (2005). “What is loss aversion?”, *Journal of Risk and Uncertainty*, 30(2), 157–167.

Sheffer, L., Lowen, P., Soroka, S., Walgrave, S. and Sheafer, T. (2018). “Non-representative representatives: An experimental study of the decision making of elected politicians”, *American Political Science Review*, 112(2), 302–321.

Sokol-Hessner, P., Camerer, C. and Phelps, E. (2013). “Emotion regulation reduces loss aversion and decreases amygdala responses to losses”, *Social Cognitive and Affective Neuroscience*, 8(3), 341–350.

Sokol-Hessner, P., Hsu, M., Curley, N., Delgado, M., Camerer, C. and Phelps, E. (2009). “Thinking like a trader selectively reduces individuals’ loss aversion”, *PNAS*, 106(13), 5035–5040.

Stadelmann, D., Portmann, M. and Eichenberger, R. (2013). “Quantifying parliamentary representation of constituents’ preferences with quasi-experimental data”, *Journal of Comparative Economics*, 41(1), 170–180.

Stein, J.G. (2017). “The micro-foundations of international relations theory: Psychology and behavioral economics”, *International Organization*, 71(S1), 249–263.

Tversky, A. and Kahneman, D. (1992). “Advances in prospect theory: Cumulative representation of uncertainty”, *Journal of Risk and Uncertainty*, 5(4), 297–323.

Wakker, P. and Tversky, A. (1993). “An axiomatization of cumulative prospect theory”, *Journal of Risk and Uncertainty*, 7(2), 147–176.

Zank, H. (2010). “On probabilities and loss aversion”, *Theory and Decision*, 68(3), 243–261.

Zeuthen, F. (1930). *Problems of Monopoly and Economic Warfare*, Routledge: London.

Appendix: Computing Positive and Negative Power

We describe here an efficient approach to the computation of the measures $\left\{\beta_i^-, \beta_i^+\right\}_{i\in\mathcal{N}}$ for the Lisbon QM rule. Whereas the brute force approach to the computation of these measures is of order 2^N complexity, our approach reduces this to a complexity of order $2^{N/2}$. The method computes exact (machine precision) values with a large proportion of the computation occurring only once at the start. We compute $\left\{\beta_i^-, \beta_i^+\right\}_{i\in\mathcal{N}}$ via the relations

$$\beta_i^+ = \left[\frac{1-p}{1-\omega}\right]\beta_i; \qquad \beta_i^- = \left[\frac{p}{\omega}\right]\beta_i;$$

where β_i is the a-priori probability that country i is critical (in the sense of footnote 10), which therefore requires us to compute the set of measures $\{\beta_i\}_{i\in\mathcal{N}}$. The crux of the problem is to count (in a weighted fashion) how often a given country is critical.

Let $\{\rho_i\}_{i\in\mathcal{N}}$ denote the set of population proportions, and $\widetilde{\rho}$ denote its median. Let $P_F = \sum_{i\in F}\rho_i$ denote the population share of the members of F. We bifurcate $\mathcal{N}$ into two subsets: $\mathcal{N}^- = \{i\colon \rho_i \leqslant \widetilde{\rho}\}_{i\in\mathcal{N}}$ and $\mathcal{N}^+ = \{i\colon \rho_i > \widetilde{\rho}\}_{i\in\mathcal{N}}$. That is, $\mathcal{N}^-$ is the least populous half of EU member states and $\mathcal{N}^+$ the most populous half. For a given set $\mathcal{M}\subseteq\mathcal{N}$ and $P\in[0,1]$, define

$$\mathcal{S}^k(P,\mathcal{M}) \equiv \{F\colon F\subseteq\mathcal{M}, |F| = k, P_F \leqslant P\}.$$

Note that each element of $\mathcal{S}^k(P,\mathcal{M})$ is equally likely; each occurs with probability $p^k(1-p)^{|\mathcal{M}|-k}$. Now let

$$s(k,P,\mathcal{M}) \equiv \left|\mathcal{S}^k(P,\mathcal{M})\right| p^k(1-p)^{|\mathcal{M}|-k}; \tag{A.21}$$

$$t(k,P,\mathcal{M}) \equiv \sum_{j\geqslant k} s(j,P,\mathcal{M}). \tag{A.22}$$

The function s in (A.21) gives the probability that a coalition of $\mathcal{M}$ with k members voting *for* and the sum of the population proportions of those k members being no more than P. The function t in (A.22) gives the same probability as s, but for a coalition of $\mathcal{M}$ where k or more members vote *for*. As s and t do not depend on the threshold values one can, in practice, compute (for each $i\in\mathcal{N}$) the set $\{s(k,P,\mathcal{M}), t(k,P,\mathcal{M})\}_{k\in[0,|\mathcal{M}|], P\in\{P_F\colon F\subseteq\mathcal{M}\}, \mathcal{M}\in\{\mathcal{N}^-\setminus\{i\}, \mathcal{N}^+\setminus\{i\}\}}$ once at the outset. These data are then used in the remainder of the approach.

A member $i\in\mathcal{N}$ is critical in a coalition F if and only if any one of the following four conditions holds:

1. $\lceil t_1\rceil - c_{i1} \leqslant c_1^F < \lceil t_1\rceil \quad \text{AND} \quad |F| \geqslant \lceil t_2\rceil - 1 \quad \text{AND} \quad |F| \leqslant \lceil t_3\rceil - 1;$
2. $\lceil t_1\rceil \leqslant c_1^F \quad \text{AND} \quad |F| = \lceil t_2\rceil - 1 \quad \text{AND} \quad |F| \leqslant \lceil t_3\rceil - 1;$
3. $|F| < \lceil t_2\rceil - 1 \quad \text{AND} \quad |F| = \lceil t_3\rceil - 1;$
4. $c_1^F < \lceil t_1\rceil - c_{i1} \quad \text{AND} \quad |F| \geqslant \lceil t_2\rceil - 1 \quad \text{AND} \quad |F| = \lceil t_3\rceil - 1.$

We use s and t to determine the probability weight of coalitions in which a given member is critical under each condition. First, for brevity, define

$$\begin{aligned} \mathcal{N}_i^{\#} &\equiv \mathcal{N}^{\#} \setminus \{i\}; \\ s_i^{\#}(k,P) &\equiv s\left(k,P,\mathcal{N}_i^{\#}\right); \\ t_i^{\#}(k,P) &\equiv t\left(k,P,\mathcal{N}_i^{\#}\right); \end{aligned}$$

where $\# \in \{-,+\}$. We then compute the probability that member i is critical under condition j, Π_{ij}, as

$$\Pi_{ij} = \sum_{F \subseteq \mathcal{N}_i^{+}} \pi_{ij}\left(F\right);$$

where

$$\begin{aligned} \pi_{i1}\left(F\right) &= t_i^{-}\left(\lceil t_2 \rceil - |F|, \lceil t_1 \rceil - c_1^F - c_{i1}\right) - t_i^{-}\left(\lceil t_3 \rceil - |F|, \lceil t_1 \rceil - c_1^F - c_{i1}\right) \\ &\qquad - \left\{t_i^{-}\left(\lceil t_2 \rceil - |F|, \lceil t_1 \rceil - c_1^F\right) - t_i^{-}\left(\lceil t_3 \rceil - |F|, \lceil t_1 \rceil - c_1^F\right)\right\}; \\ \pi_{i2}\left(F\right) &= s_i^{-}(\lceil t_2 \rceil - 1 - |F|, 1) - \lim_{\varepsilon \downarrow 0} s_i^{-}(\lceil t_2 \rceil - 1 - |F|, \lceil t_1 \rceil - \varepsilon - c_1^F); \\ \pi_{i3}\left(F\right) &= s_i^{-}(\lceil t_3 \rceil - 1 - |F|, 1); \\ \pi_{i4}\left(F\right) &= s_i^{-}(\lceil t_3 \rceil - 1 - |F|, \lceil t_1 \rceil - c_{i1} - c_1^F). \end{aligned}$$

We may then compute

$$\beta_i = \sum_{j=1}^{4} \Pi_{ij}.$$

Figures

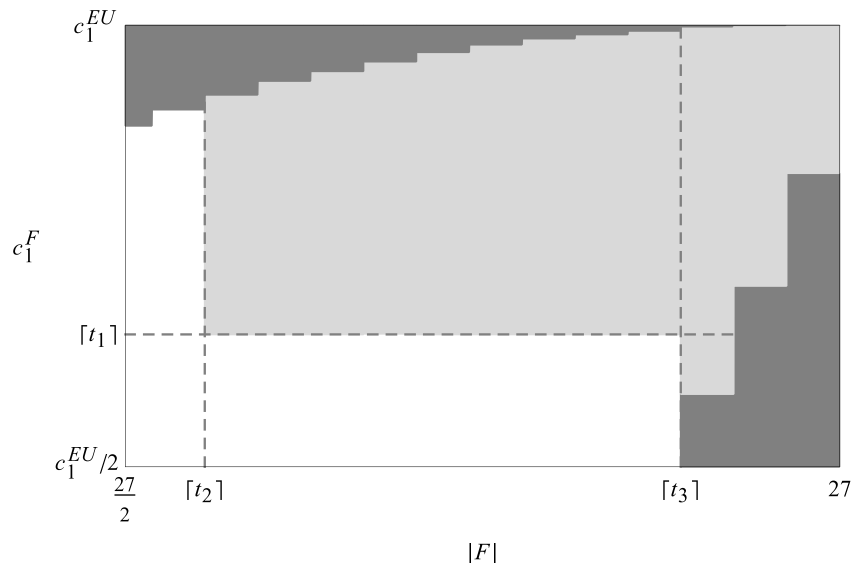

Figure 1: Visual representation of the set of winning coalitions under the Lisbon QM decision rule. The heavy-shaded region is infeasible. The light-shaded region is the set of winning coalitions.

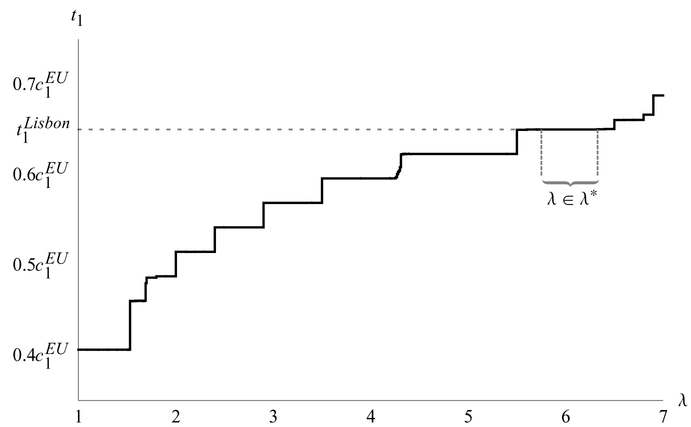

Figure 2: The bargaining outcome for different values of λ.

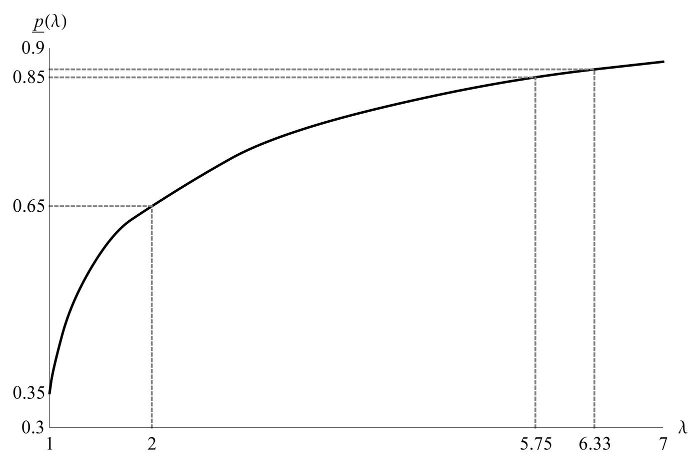

Figure 3: Threshold p above which the Lisbon qualified majority voting rule is the bargaining solution, and below which the unanimity rule is the bargaining solution.