Shaping the Truth: History Distortion Post-Conflict

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Abstract

How should information be transmitted to the next generation in the aftermath of a conflict? We propose a dynamic model where two groups engage in an infinite sequence of conflict games with evolving costs, observed only when there are conflicts. Without communication, conflict persists endlessly. Optimal communication by informed leaders generates peace cycles and balances the important trade-off between *how likely* peace will be versus *how long* it will last. This balance depends crucially on the baseline environment's stability. In highly unstable environments, optimal communication mimics static Bayesian persuasion games. Conversely, in stable environments, optimal communication implies only slight distortions in conveying history.

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1 Introduction

On April 6, 1994, Rwanda's President Juvenal Habyarimana died when the aircraft carrying him and Burundian President Cyprien Ntaryamira was shot down by missiles near Kigali, Rwanda. This event sparked a door-to-door campaign by the Army and Hutu military organizations targeting Tutsi Rwandans and moderate Hutus, resulting in a hundred days of bloodshed until July 1994. Approximately 800,000 people were killed. A new Tutsi government took power and began rebuilding the country. Among the many daunting challenges faced by the new government, one was how to teach this history to the young generation. The solution found by the post-1994 Rwandan government was to impose a moratorium on history teaching in Rwanda's schools.[1] This moratorium lasted at least until 2006. Other countries that have recently experienced conflicts, such as Afghanistan, Bosnia and Herzegovina, Cambodia, Croatia, Guatemala, Lebanon, Libya, and South Africa, have also temporarily suspended history education.[2]

History textbooks are often viewed as an instrument for peace, as they can potentially deliver a new narrative that strengthens inner cohesion. UNESCO recognized the importance of textbooks as aids to peace as early as the beginning of the twentieth century and exerted considerably more effort in thinking about how these materials should be written after 1949. Local governments, international organizations, and bilateral/multilateral commissions often debate how to write history textbooks that aim to accurately portray the events of the conflict without exacerbating tensions or inflaming future conflicts.[3] The way in which history is taught after a conflict may significantly impact peace and stability, as it shapes the beliefs, attitudes, and values of future generations. Indeed, the dynamic nature of information transmission implies that current information affects current incentives and future beliefs.

Our overarching research goal is to comprehend the consequences of how the history of a conflict is conveyed to younger generations. History is often taught in ways that distort the facts in many directions. There are notable examples in the form of selective omission, where some events may be deliberately excluded from the textbooks. In other cases, history may be rewritten, leading to an exaggeration, fabrication, or sanitization of the events that occurred. Our general research goal is admittedly broad and multifaceted. Instead, we narrow our question to the following: If the objective is to maximize long-run peace, then in the aftermath of a conflict, should history be told truthfully?

[1] Hodgkin (2006).

[2] See Bentrovato et al. (2016) and de Baets (2015).

[3] The Council of Europe in its Parliamentary Assembly of June 2009 emphasizes that "(...) history teaching can be a tool to support peace and reconciliation in conflict and post-conflict areas (...)"). Available online: https://t.ly/L9vTQ

In our model, a conflict game is played repeatedly between two short-lived players belonging to rival groups. Players do not know the cost of a conflict unless they engage in one. This cost determines if the mutual play of peace is a Nash equilibrium of the complete information game and is not permanent, changing over time following a hidden Markov Chain. After the conflict game is played, if players choose conflict, they observe the state of the world. Conversely, if peace happens, then the cost is not observed. This captures the idea that if there has been no conflict in the span of a generation, the costs of future potential conflicts become harder to assess. We make the simplifying assumption that players can observe past actions and can only be informed by an information designer. This reflects the observation that leaders tend to be better informed than the general population.

Within this framework, we study how intergenerational communication affects the likelihood and duration of peace. Our model helps discipline the fundamental question of finding the optimal communication after a conflict and sheds light on the intricate interplay between peace and truth. While truth-telling is often perceived as a crucial step towards reconciliation and peace, it can also exacerbate the existing conflictual environment. A related and larger debate centers around the tension between peace agreements and the accountability of the main actors responsible for the conflicts, the "Peacemaker's Paradox" (Hayner (2018)).[4]

Our theoretical model points to a difficult and interesting trade-off. Truth-telling, or minor distortions of the truth, result in a prolonged *duration* of peace. Conversely, larger distortions of history, in the form of communication that induces interior beliefs, increase the *likelihood* of peace, but it will be short-lasting. The optimal communication protocol will ultimately depend on the underlying parameters of the environment. If the persistence in the state of the world is sufficiently low, then distorting history to maximize the likelihood of it happening in the subsequent period is the optimal policy. If, instead, the persistence is high, then this protocol is sub-optimal, and less distortion of the truth will be optimal by inducing longer periods of peace. In general, our framework allows for comparative statics to tackle how communication across generations influences cycles of peace and conflict (short-run and long-run).

We developed a dynamic information design framework to analyze our question. In a dynamic world, information changes current incentives, but importantly, it also shapes future beliefs. Thus, from a theoretical point of view, we contribute to the recent literature on dynamic information design by showing this trade-off of how long versus how likely in a world with partial learning about an ever-changing underlying state.

The importance of dynamic information transmission extends beyond our environment. When policymakers deliberate on how to convey information regarding a fundamental economic

[4]See also Mendeloff (2004) and Barberis (2019).

parameter, they encounter a similar trade-off to that faced by our designer. Likewise, firms face a comparable trade-off in determining the most effective way to communicate with their employees. This trade-off also applies to political leaders as they disseminate information to their followers.

In the section below, we discuss how some countries handled history telling with explicit pacification or reunification purposes but do not explicitly model the literal communication process in the remainder of this paper. Instead, we take an information design approach and model the belief dynamics directly. Similarly, we do not explicitly discuss who this designer might be. In reality, many actors are responsible for communication in a post-conflict society. Our theoretical framework allows us to be flexible regarding the objective of the designer. Still, our analysis focuses on the case where communication has a purpose: maximize long-term peace. Therefore, we relate to the goals of well-informed leaders who seek peace and make use of the information design framework to gauge the limits that communication can achieve to this end. Our designer encompasses the role of truth commissions and multilateral commissions assigned to design and guide textbook writing and history education in schools.

1.1 History Distortion Post-Conflict

Public beliefs about anticipated conflict outcomes are often shaped by historical narratives.[5] These narratives, however, are frequently subject to distortion, which manifests in two primary forms: history omission and history rewriting. Below, we briefly explore these phenomena, accompanied by historical and contemporary illustrations of each.

History Omission

"(In Athens) ... there is also an altar dedicated to Lethe (oblivion)."[6]

History omission consists of the deliberate suppression or evasion of historical narratives. This temporary suspension of historical facts has been a common strategy in post-conflict societies. In late 403 BCE, Athens saw the overthrow of the oppressive oligarchy known as

[5]Blouin and Mukand (2019) show that government propaganda was an important tool of nation-building in post-genocide Rwanda. The ability to control information and "shape the truth" is arguably more crucial today than ever. Guriev and Treisman (2019) show how modern authoritarian regimes, rather than relying on fear and violence, use information manipulation to stay in power. Szeidl and Szucs (2024) explore how modern politicians use information to "shape the truth" and persuade voters of alternative realities. For surveys of the literature on the impact of traditional media on political outcomes, see DellaVigna and Gentzkow (2010), DellaVigna and La Ferrara (2015), and Enikolopov and Petrova (2015). See also Zhuravskaya et al. (2020) for the impacts of the new media (internet and social media) on political outcomes. See Egorov and Sonin (2024) for a recent survey of information manipulation and political persuasion models.

[6]Plutarch, "Moralia", cited by Loraux (2002).

The Thirty Tyrants. Thrasybulus led the democratic victory that marked the flight of the Thirty and the return of exiles. To prevent further conflict, Athenians swore an oath not to recall wrongdoings of the past—a pledge of reconciliation, vowing to abstain from vengeance rooted in previous grievances (*mē mnēsikakein*).[7]

In recent times, Rwanda has provided a prominent example of promoting narrative silence, with which we started our introduction. However, many post-conflict societies have officially implemented some form of history moratoria. For instance, Afghanistan, Bosnia and Herzegovina, Cambodia, Croatia, Guatemala, Lebanon, Libya, and South Africa.[8] The *Pacto del Olvido* (Pact of Forgetting), including an Amnesty Law of 1977, was a tacit agreement by Spanish politicians to avoid a direct confrontation with its Civil War past and the Franco years. Another example of how societies decide to communicate about their recent divisive past is the case of emergency textbook revisions, in which international commissions implement immediate exclusions of materials that they may consider to be conflict-inciting. Examples include post-WWII Europe, Bosnia, Afghanistan, and Iraq.[9]

Such measures are often aimed at addressing legitimate concerns but risk perpetuating conflict-inciting issues and dissatisfaction from community members. Efforts to reintroduce history to classrooms often involve the deliberation of truth commissions and other bodies tasked with charting a conciliatory path forward.

Latin American countries provide recent examples of concealing the past to achieve peaceful political transitions from their military dictatorships. Transitioning back to democracy, Argentina, Chile, and Brazil enacted amnesty laws protecting the perpetrators of political crimes during the dictatorship. Each country took different paths in effectively sidestepping public debates on their dictatorial past. The amnesty laws in Argentina were initially repealed, and prominent figures of this period were trialed.[10] Shortly after, in 1986, the congress passed the *Ley de Punto Final* (Full Stop Law), which ended the investigation and prosecution of political crimes during the dictatorship. The Chilean courts sometimes nullified the amnesty laws passed during the dictatorship of Augusto Pinochet. Still, subsequent governments lacked the political support to repeal the laws.[11] Brazil's 1979 amnesty Law was never repealed, shielding military officers from prosecutions.[12] In 2011, then President Dilma Rousseff created

[7]Loraux (2002).

[8]See Bentrovato (2017) and references therein. Moreover, de Baets (2015) documents a long list of recent cases of history moratoria. The examples can be categorized in moratoria after the defeat in WWII, after the implosion of communist regimes, after genocides, and after racial, ethnic, and religious conflicts.

[9]Pingel (2009) and Torsti (2007).

[10]The trials, *Juicio a las Juntas* (Trial of the Juntas), were depicted in the 2022 Oscar-nominated movie "Argentina, 1985."

[11]Pinochet was later arrested in 1998 in Great Britain for violating international law.

[12]More generally, Abreu Silva (2021) argues that there was an institutionalized silencing strategy throughout the democratic period that followed the dictatorship.

the National Commission of Truth to finally convey the truth by clarifying and investigating the political crimes committed during the military dictatorship. The explicit aim of the newly created commission was to "enforce the right to memory and to the historical truth and promote the national reconciliation."[13] After more than two years of extensive work, the commission produced a detailed report documenting the political crimes committed during the military dictatorship. Despite this effort, the amnesty law remained unchanged, and no convictions resulted from the commission's findings.[14]

History Rewriting

"Exu killed a bird yesterday with the stone that he only threw today."[15]

Narrative reconstructions offer opportunities for easing tensions and de-escalating potential conflictual situations. They are particularly evident in the reshaping of textbooks. Textbooks are powerful cultural artifacts and serve as official communicators. Today, there is a longstanding tradition that textbooks should play a conciliatory role (Foster (2011)). The creation of commissions and specialized bodies dedicated to re-examining textbooks with conciliatory purposes highlights this effort, as exemplified by Pingel (2008, 2010).

History teaching has sometimes been explicitly integrated into peace agreements, such as the Taif Agreement of 1989, which ended the civil war in Lebanon and advocated for history education to strengthen national identity.[16] The importance of textbook writing is also underscored in the United Nations's "duty to preserve memory" explicit in their impunity and reparation principles, which emphasize the accurate depiction of historical violations as a symbolic gesture of reparation.[17]

Historical negationism, the denial or deliberate fabrication of historical facts, is ubiquitous and often government-backed, part of official policies. The Armenian genocide of 1915 is mostly ignored in history textbooks in Turkey, which the Ministry of Education must approve.[18] Japan has longstanding controversies concerning the government-approved history textbooks utilized in secondary education.[19] Cantoni et al. (2017) show that a recent curriculum reform in China changed students' beliefs and political attitudes in a direction the Chinese government deliberately aimed. In Germany, large official operations designed to conceal

[13] Law 12.528, November 18, 2011. https://t.ly/l2MiD

[14] Schneider (2019).

[15] This is a well-known sentence in Afro-Brazilian Yoruba religion. Exu is a divinity often associated with communication.

[16] Taif Agreement (1989). Retrieved from http://peacemaker.un.org/lebanon-taifaccords89

[17] Principle 3 of the UN set of principles for protecting human rights and combating impunity (E/CN.4/2005/102/Add.1), 2005.

[18] Göcek (2015).

[19] These controversies predominantly revolve around the actions of the Empire of Japan during WWII.

historical records were underway during the Nazi regime, the most well-known being *Aktion 1005*. Moreover, Adena et al. (2015) show that controlling the radio and propaganda had an important effect in the rise of the Nazis in Germany in the period pre WWII. Some forms of negationism persist to this day, including the enduring Myth of the Clean Wehrmacht, which falsely denies the involvement of the German armed forces in the Holocaust. Rousso et al. (2006) document and discuss the spread of Holocaust denial in French universities, especially after 1968, as well as a denial of the level of involvement of the collaborationist Vichy government in WWII, which was coined as the Vichy Syndrome (*Le syndrome de Vichy*).[20]

The act of rewriting history unfolds in many ways, and examples abound. A recent paper by Esposito et al. (2023) shows that the screenings of the blockbuster movie "The Birth of a Nation" in 1915 contributed to a North and South reconciliation by popularizing the "Lost Cause" narrative of the US Civil War. Conversely, the "1619" Project is a recent revisionist historical project focused on retelling the role of slavery in the founding of the United States, with the goal of revising the educational curriculum.[21] There are many recent examples of leaders who attempt to rewrite history.[22] Another example of recent revisionism with deliberate political purpose was in 2010 by Hugo Chávez in Venezuela, who appointed a special commission to exhume the revolutionary leader Simón Bolívar, dead in 1830, with the purpose of investigating whether he was poisoned by Colombian oligarchs.[23]

Creating reconciliation narratives is so important that it may be one of the primary reasons behind the early expansion of primary schooling. Indeed, Paglayan (2022) argues that education is a pivotal tool in state-building and is particularly evident following periods of mass violence in Europe and Latin America. According to her, this expansion was aimed to indoctrinate the masses into accepting the prevailing social and political order, thus promoting long-term stability.

1.2 Literature

Acemoglu and Wolitzky (2014) present a model of endogenous cycles of conflicts. Our paper complements their analysis by discussing the role of communication in the cycles of conflict and peace. Another related paper is by Dessi (2008). She discusses the optimal collective memory that a Principal would like to choose for a community and how these collective

[20]Rousso (1995).

[21]Hannah-Jones (2019), which can also be retrieved at pulitzercenter.org/1619.

[22]Prominently in India (The Economist, April 13, 2023) and the recent resolutions of the Communist Party in China (The Economist, November 6, 2021).

[23]Bolivar is widely believed to have died of tuberculosis, and the results of the investigation were inconclusive.

memories influence agents' investments in their efforts to integrate into the community.[24]

More broadly, our paper brings together two different literatures. The literature on the economics of conflicts and the literature on dynamic information design.

Information and Conflicts: Our stage conflict game will resemble those from Baliga and Sjöström (2004, 2008, 2012), where uncertainty in the costs of going to war may shift, enabling different static Nash equilibrium, for different values of the parameter. Those models focused on cross-group communication, understanding when mediated or unmediated talks between parties can avoid or propel conflict. Chassang and Padró i Miquel (2009, 2010) investigate the determinants of cooperation and conflict in a dynamic environment under strategic risk. Hörner et al. (2015) uses a mechanism design approach to study when parties may truthfully disclose information to a mediator, who seeks to design a mechanism that screens types in conflict. In a dynamic environment but with complete information Anderlini and Lagunoff (2005) and Anderlini et al. (2010) construct *dynastic* games, with inter-generational information transmission. Differently, Acemoglu and Wolitzky (2014) propose a dynamic model in which bounded information about the game's history may fuel cycles of conflict, even when both groups would benefit from peace. See, also, Kimbrough et al. (2020) and Acemoglu and Wolitzky (2023) for comprehensive reviews on the topic. Also related is Ray and Esteban (2017).

Dynamic Information Design: A recent body of literature addresses information design in a dynamic environment. Some recent papers include Au (2015), Ball (2022), Bizzotto et al. (2021), Honryo (2018), Mathevet et al. (2022), Lehrer and Shaiderman (2021), Lorecchio and Monte (2023a,b), Lorecchio (2023), Orlov et al. (2020), and Smolin (2021). In Ashkenazi-Golan et al. (2023) and Ely (2017), an informed sender knows how a state variable evolves and wants to optimally persuade a receiver. Particularly related is Renault et al. (2017). Our two-period version is similar to theirs, but with an important difference: in our paper, in the absence of conflict, nothing is learned. This significantly changes both the learning process and the designer's incentives. Ely and Szydlowski (2020) develop a model of dynamic effort, where an informed designer optimally discloses information through time regarding the difficulty of a task to induce optimal effort by an uninformed receiver. An analogy can be drawn between our model and one in which a recommender system communicates to agents in an environment with experimentation since only one action profile reveals the state of the world. However, in our setting, it is as if the designer wants to discourage experimentation (conflicts). Kremer et al. (2014) analyses a long-lived social planner that wants to optimally disclose information to short-lived agents. The planner wants

[24] In the sense that our paper deals with intergenerational transmission of information, it is also broadly related to Bisin and Verdier (2000, 2001) who study the transmission of cultural traits across generations.

agents to experiment and produce new information that could be useful to future players. Che and Hörner (2017) show that a recommendation system optimally induces spamming in equilibrium for players to experiment.

2 Model

We propose a model where two groups, A and B, interact every period in an infinite horizon game. At each time $t \geq 1$ a generation is born in each group and lives for one period. We denote by i_t a player from the generation born at t. Each generation has two players, one for each group $\{A, B\}$, who play a conflict stage game at the time t that they are born, choosing either a peaceful action P or to engage in conflict C. The payoffs are perfectly aligned within groups and across generations. The stage game is depicted in Table 1.

		Player B_t	
		C	P
Player A_t	C	$(-c^t, -c^t)$	$(b - c^t, -d)$
	P	$(-d, b - c^t)$	$(0, 0)$

Table 1: Conflict Game

In the model, $c^t > 0$ stands for the cost of conflict (resources, institutional costs) at time t, $b > 0$ is a "first"-mover advantage of unilaterally initiating a conflict, and $d > 0$ is the loss of being attacked without being prepared to the conflict. The value of c^t will pin down the stage Nash Equilibria (NE), determining the incentives to engage in conflict for different costs.

If $c^t < d$ and $b < c^t$ then both (C, C) and (P, P) are (pure strategy) NE, and we are in a *Stag Hunt* game. We let c_h be a cost that satisfies both conditions. Conversely, if $c^t < d$ and $b > c^t$, the unique stage-game NE is (C, C), and we are in a *Prisoner's Dilemma* game in which conflict is a dominant strategy. We let c_ℓ be the cost of conflict satisfying these conditions, being easy to check that $c_h > c_\ell$. Here, the intuition is the following: when the costs of war are low enough the temptation to gain the first-move advantage and the fear that the other player is doing the same prevents any coordination on the Pareto Superior outcome of peace, (P, P). When the costs of conflict are higher, the attacker's advantage is reduced, allowing for coordination on peace. However, the fear of being the conflict's sole loser and losing d remains, so that conflict C is also a mutual best-response.

We denote by $\Omega = \{c_h, c_\ell\}$ and let $c^t \in \Omega$ be the unknown state of the world at time t. Also, we assume the state evolves in time following a hidden Markov chain with a "persistence" parameter $q \in (\frac{1}{2}, 1)$, that is:

$$Prob(c^{t+1} = c | c^t = c) = q, \quad \forall c \in \{c_h, c_\ell\}, \forall t \geq 1.$$

The state is unknown prior to playing the stage game, but we assume that if any player chooses C at t, then the state is revealed to the current generation. However, if both players choose P in the stage game, then c^t is not revealed, and players do not get any other information. We say that the observed state is $\tilde{c} \in \Omega \cup \{\emptyset\} := \hat{\Omega}$, where $\emptyset$ denotes the case when players do not observe the state. The rationale behind this assumption is that when a generation faces a conflict, they bear the direct costs of it, learning about the state of the world when the conflict occurred. Conversely, if a generation experiences peace, they won't know precisely how costly the conflict would have been at that point. Therefore, without communication from a leader, a generation living in peace will lack information about the current costs of conflict and will rely solely on past history to assess the probabilities of the different states of the world. This aspect of only observing the state during conflict is crucial for the dynamics of our model.

2.1 Information Policy

We now define information policy and how it affects the game's play. An information policy specifies a public message following every conflict and given the current public belief. If there is *conflict* (at least one player chooses C), the state of the world is publicly observed by the current generation (but not by future generations). Instead, if *peace* occurs, nothing is learned. After *conflict*: a public message will be sent according to a chosen information policy and will inform the next generation. The information policy is chosen by a designer at period 0, before the first stage game is played between A and B. The information policy π defines a mapping for each given belief μ_t.[25]

The set of such information policies for belief μ_t is:[26]

$$\Pi(\mu_t) = \left\{ \pi \in \Delta(\Delta(\Omega)) : \int_{\mu \in \Delta(\Omega)} \mu d\pi(\mu) = \mu_t \right\} \tag{1}$$

[25]It will be convenient to define information policy directly as a splitting, but we could, instead, define the information policy π as a map from the observed state of the world and the given public belief to a compact set of messages S. Players form a posterior after observing the public message $\mu : S \to \Delta(\{c_h, c_\ell\})$ and they play according to their posterior.

[26]The designer commits to an information policy. This form of commitment can be seen as a metaphorical interpretation of the designer: the solution to our problem will give us the upper bound of peaceful periods that can be achieved as we vary across information structures. See Bergemann and Morris (2019).

Note that we have imposed that the message can be conditioned on the state of the world, but the state is only revealed when there is a conflict. We assume that the information policy is activated exclusively following periods of conflict. In the absence of conflict, no messages are transmitted. Therefore, we consider that no message is sent at period $t = 1$.

Before being explicit about the designer's payoff function, note that regardless of it, a minimal feasibility restriction holds for any version of a designer, provided that players are Bayesian: that the information policy must be Bayes-plausible, which is the constraint in (1). This means that in equilibrium, beliefs are martingales.

This feasibility restriction provides us with a framework for analyzing conflict cycles given *any* information policy.[27]

Our designer's objective function will be to maximize long-run peace. Her period t payoff is

$$U_t = \begin{cases} 1 & \text{if both players choose } P \text{ at conflict game in t.} \\ 0 & \text{if at least one player choose } C \text{ at conflict game in t.} \end{cases}$$

We also assume that the designer has commitment power in the information policy.

At the beginning of time t each group sees the history of past actions from both players. A history of actions of length $t-1$, is a list $\alpha^{t-1} = \{a^\tau\}_{\tau=1}^{t-1}$, where $a^\tau = (a_A^\tau, a_B^\tau) \in \{C, P\}^2$ is the pair of actions that both players chose at time τ. We let $\mathcal{A}^{t-1}$ be the set of all possible action histories of length $t-1$, and $\mathcal{A}$, the set of all possible action histories of any length. Also, at each t both players see the history of public messages, with $s^{t-1} \in S^{t-1}$ being a sequence of the $t-1$ past messages.

We denote each history of the game at t as $h^{t-1} = (\alpha^{t-1}, s^{t-1})$, that is, a sequence of past messages and actions. We denote by $\mathcal{H}^{t-1}$ the set of all histories of length $t-1$, and by $\mathcal{H}$ the set of all histories of any length.

2.2 Strategies

To define the strategies of each player i_t we must specify what they choose to *play* at the stage game at the beginning of t for any given chosen information policy. Therefore, we define a *strategy* for player i as a mapping from all possible histories into the set of actions:

$$a_i : \mathcal{H} \to \{C, P\}$$

[27] A feasible information policy could be the result of a game in which one leader observes the state of nature and communicates through cheap talk (public or private); a game in which two leaders engage in public communication; or, as we do in this paper, the outcome of a game in which the leader has designed an information policy and is committed to it.

That is, for every possible past history of actions at t and every possible history of messages, each player's strategy specifies an action to be taken. We say that a profile of strategies at t is some $a^t = (a^t_A, a^t_B)$; a strategy for each group at t. Similarly, a *profile of strategies* $a = (a^t)_{t\geq 1}$ specifies an action strategy for each i_t, $i \in \{A, B\}$ and $t \geq 1$.

2.3 Beliefs and Timing

We now define the beliefs and describe their dynamics. Since, in our model, the state of the world is binary, a single probability measure will define our beliefs. We normalize it with respect to the probability of $c^t = c_\ell$, for every time t. That is, we will say that players hold a (common) belief $\mu_t \in [0, 1]$ that the state of the world is c_ℓ. Thus, the higher the belief, the more likely players believe that they are in a world in which conflict is a dominant strategy for the stage game.

A player i's indifference condition, if the other player is playing P is obtained by solving:

$$\mu(b - c_\ell) + (1 - \mu)(b - c_h) = 0,$$

which gives us

$$\mu^* := \frac{c_h - b}{c_h - c_\ell} \in (0, 1). \tag{2}$$

Note that (C, C) is a Bayesian Nash equilibrium of the stage game for $\forall\, \mu \in [0, 1]$. The interesting case for us will be to focus on equilibria in which whenever $\mu \geq \mu^*$, both players choose P.

In other words, we will focus on equilibria with cutoff strategies around μ^*. We will also restrict attention to symmetric PBE. Further, it will be more interesting to focus on the case in which $\mu^* < 1/2$.[28]

Recall that in this dynamic model, an infinite sequence of conflict games is played by short-lived agents belonging to two groups: A and B. The current costs of conflict are not observable and change over time following a hidden Markov model with persistence $q \in (\frac{1}{2}, 1)$. Therefore, given these parameters, there will be endless conflicts in the absence of intergenerational information transmission.

We will first analyze the 2-period information design problem and then study the case of a long-run designer. Finally, we provide some simulations for an infinitely patient designer that maximizes the long-run fraction of peace.

The timing of the game is the following: at $t = 0$ the designer chooses (and commits to) an information policy. Then, nature draws a state of the world ω_0, according to a distribution

[28] The case of $\mu^* \geq 1/2$ is relatively straightforward, so we omit it.

$\Pr(\omega_0 = c_\ell) = \mu_0$, but nobody is informed about it.

At period $t = 1$ players initiate the period with the belief being the prior μ_0. During the period and before they play the incomplete information game, the state of the world that will determine the game to be played in this period is drawn such that with probability q it remains the same state as in $t = 0$. That is, $\Pr(\omega_1 = \omega_0) = q$. Players are not informed about the state and play the incomplete information game.

Players initiate each period $t \geq 1$ with a given belief μ_t. Then, an information policy will follow depending on whether there was conflict of peace in the previous period. That is, if at least one player chose C at period $t-1$, a message is sent according to the chosen information policy π. Otherwise, no message is sent. Then, Nature draws the state of the world of period t. Players play the incomplete information game.

The evolution of beliefs within each period can be seen in the following figure:

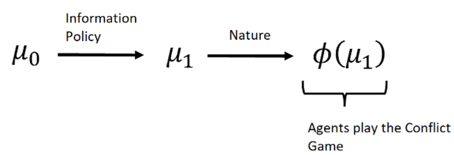

Figure 1: Belief Updating: Period One

where the last term corresponds to the belief updating that happens in the absence of information (since Nature is drawing a different state of the world with probability (1-q)). It will be convenient to define an operator $\phi(\mu)$ that gives us the belief updated to account for Nature's move at a given period:

$$\phi(\mu_1) = \mu_1 q + (1 - \mu_1)(1 - q).$$

3 Two Periods

We will start our analysis by solving a two-period version of this game. Suppose that $\mu_0 > \mu^*$. For this version, the information policy will be defined as a tuple: (π_1, π_2), where $\pi_1 : \{c_l, c_h\} \to \Delta(S)$ and $\pi_2 : \{c_l, c_h\} \times [0, 1] \to \Delta(S)$, where π_2 only operates if there was a conflict in period 1.

We can summarize the timing of the game as follows. At $t = 0$ an information policy is chosen. At the start of period $t = 1$ agents hold belief μ_0, then the designer communicates according to π_1, generating belief μ_1. Before the agents play their first conflict game, Nature moves according to $Pr(\omega_{t+1} = \omega_t) = q$, which implies that agents update their beliefs. The new public belief is given by: $\phi(\mu_1) = \mu_1(2q-1) + (1-q)$. Finally, agents play the conflict game of period $t = 1$.

If any of the two players choose C, the designer will observe the state of the world in $t = 1$ and will be able to communicate it in $t = 2$. Otherwise, there will be no communication in the next period. In period $t = 2$ agents start with belief $\phi(\mu_1) = \mu_1(2q-1) + (1-q)$. Then, the designer communicates (provided that one of the players chose C). The new belief is denoted by μ_2. If both players chose P in period $t = 1$, then $\mu_2 = \phi(\mu_1)$. The timing and the belief updating process is best seen in the following figure:

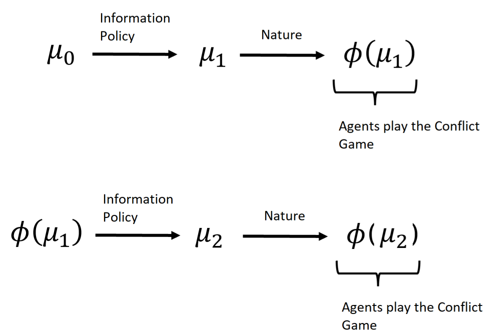

Figure 2: Two periods: beliefs

To better understand the optimal information policy in a two-period game, it will be convenient first to understand how it would look like in a two-period game without communication. The figure below presents this simplification:

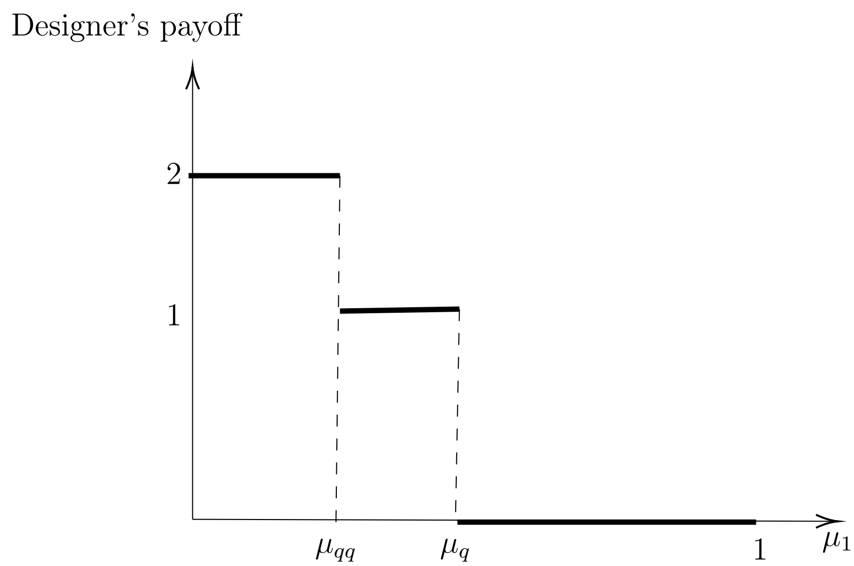

Figure 3: Two periods: No communication

Where: $\mu_q \equiv \frac{\mu^* - (1-q)}{2q-1}$ and recursively, $\mu_{qq} \equiv \frac{\mu_q - (1-q)}{2q-1}$.[29] Also, for the purpose of illustration, we assume in the figures that $\mu^* > (1-q)$ and $\frac{\mu^* - (1-q)}{2q-1} > 1-q$. In Figure 3 the belief space is partitioned in three intervals: $\mu \leq \mu_{qq}$, $\mu \in (\mu_{qq}, \mu_q]$, and $\mu > \mu_q$. In the first interval, the initial belief is so low that there will be two periods of peace: at the end of period 1 it will be $\phi(\mu) \leq \mu_q$, and at the end of period 2 it will be $\phi(\phi(\mu)) \leq \mu^*$.

Instead, suppose there is communication but only in period $t = 2$. Then, the initial belief will determine whether there will be peace or conflict in period 1, and, following a conflict, the designer will use an information policy in period 2. Since this is the last period, the information policy will be a simple Bayesian persuasion policy where the belief $\phi(\mu_1)$ is the outcome of an appropriately chosen randomization between beliefs 1 and μ_q. The reason that we have the solid line instead of the dashed line connecting the payoffs of these two beliefs is the following. Suppose the initial belief is $\mu_1 > \mu_q$ and that there is no information policy in this period. Then, there will be conflict in the first period and the second period will start with a belief $\phi(\mu_1)$. In other words, the information design problem will be to choose the optimal randomization given belief $\phi(\mu_1)$ (and not μ_1).

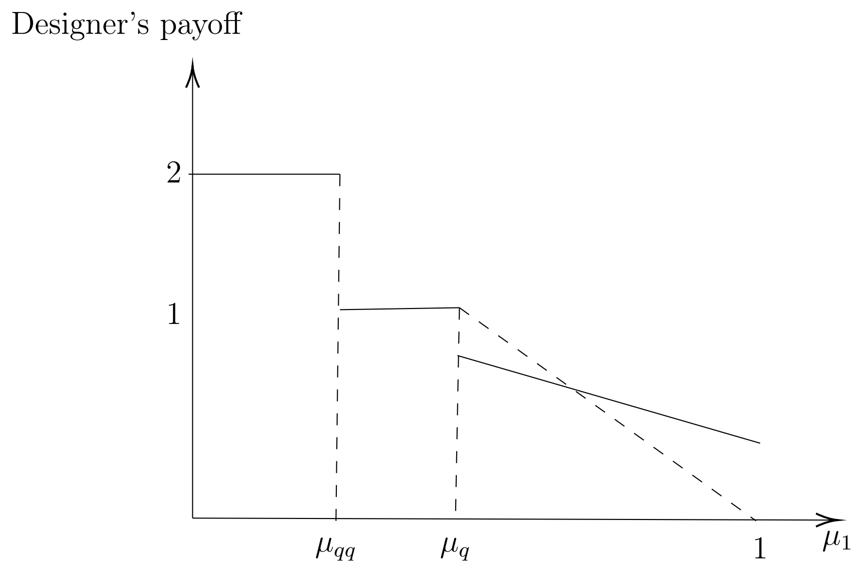

Figure 4: Two Periods: Communication only in 2nd Period

We now turn to the solution of this two-period problem. Relatedly, we can ask the following question: Can a short-run designer policy (which we will denote by a greedy policy) be optimal in this two-period game? The answer depends on the relation between the belief threshold μ^* and the persistency parameter q. If q is high, then states (therefore, beliefs) are very persistent. That is, a high belief today implies a high belief tomorrow. Under a low q, a

[29] Thus, $\phi(\mu_q) = \mu^*$ and $\phi(\mu_{qq}) = \mu_q$.

high belief today will be closer to 1/2 tomorrow.

Our main result for this section is stated below.

Proposition 1 (Two-Period Optimality)**.** *Consider the two period case, with $\mu_0 > \mu^*$ and $\mu^* \in (2q(1-q), \frac{1}{2})$. Denote by $\pi_t(\mu)$ the probability of a posterior μ given information policy π at period t. Then, the optimal information policy is $\pi_1(1) = \frac{\mu_0 - \mu_{qq}}{1-\mu_{qq}}$ and $\pi_1(\mu_{qq}) = \frac{1-\mu_0}{1-\mu_{qq}}$. For the second period, $\pi_2(\cdot)$ is the standard Bayesian persuasion policy for a static problem, that is, for a given belief $\mu > \mu_q$ we have that $\pi_2(1) = \frac{\mu - \mu_q}{1-\mu_q}$ and $\pi_2(\mu_q) = \frac{1-\mu}{1-\mu_q}$.*

Proof. The condition that $\mu^* > 2q(1-q)$ ensures that $\mu_q > 0$ and $\mu_{qq} > 0$. Since we are able to fully analyze the problem using the designer's two-period payoffs, we can use the well-known Bayesian persuasion techniques to prove this proposition. We will show that the concave closure induced by the information policy that randomizes between beliefs 1 and μ_{qq} lies above the concave closure of the split between beliefs 1 and μ_q. First, let us calculate V(1), where $V(\mu)$ is the designer's two-period payoff for a given belief μ. Note that V(1) is equivalent to a static Bayesian persuasion payoff given belief q. This is because, given an initial belief $\mu = 1$, there is conflict in the first period, and the resulting posterior at the end of period 1 is q. This payoff is seen at the point in the dashed line that crosses the belief q. From the similarity of triangles, we have $\frac{1}{1-\mu_q} = \frac{1-V(1)}{q-\mu_q}$. Thus, we obtain that:

$$V(1) = \frac{1-q}{1-\mu_q}.$$

Now, we will show that:

$$\frac{2-V(1)}{1-\mu_{qq}} > \frac{1-V(1)}{1-\mu_q}.$$

Suppose that $\frac{2-V(1)}{1-\mu_{qq}} \leq \frac{1-V(1)}{1-\mu_q}$

$$\begin{aligned} 2\,(1-\mu_q) - V(1)\,(1-\mu_q) &\leq 1 - \mu_{qq} - V(1)\,(1-\mu_{qq}) \\ V(1)\,(1-\mu_{qq} - (1-\mu_q)) &\leq 1 - \mu_{qq} - 2\,(1-\mu_q) \\ V(1)\,(\mu_q - \mu_{qq}) &\leq \mu_q - \mu_{qq} - 1 + \mu_q \\ 1 &\leq (\mu_q - \mu_{qq})\,(1 - V(1)) + \mu_q \end{aligned}$$

but: $\mu_q - \mu_{qq} < \frac{1}{2}, 1 - V(1) < 1,$ and $\mu_q < \frac{1}{2}$. Thus, we have a contradiction.

□

The figure below shows the optimal policy for this two-period game.

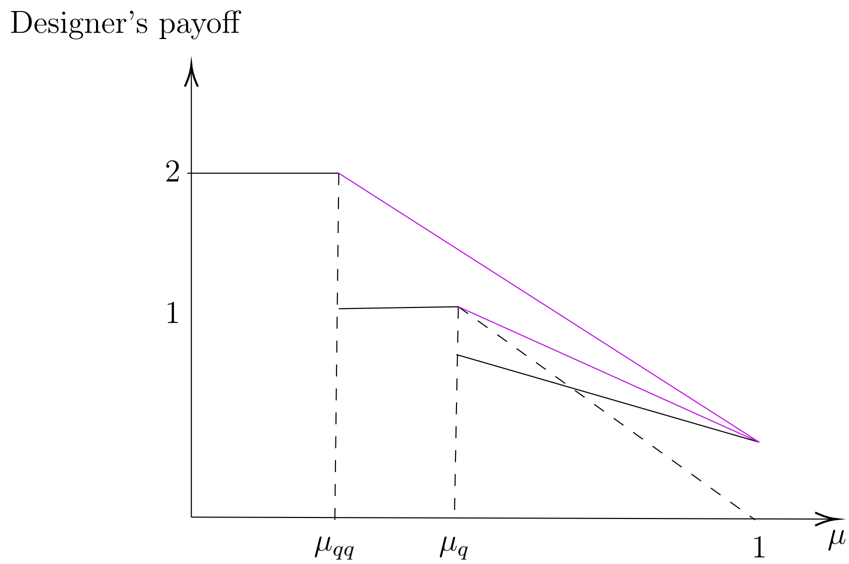

Figure 5: Two Periods: Optimal Policy

The intuition is that the loss in the likelihood of peace from aiming to induce a lower belief (μ_{qq} instead of μ_q) is more than compensated for the fact that *if* induced, peace will last for both periods. In this two-period example, under these parameters, the optimal policy is to aim for two peaceful periods.

Importantly, we emphasize that this result does not generalize and only illustrates a designer's main trade-off in a dynamic communication environment. The result in Proposition 1 depends on the parameters that we have chosen. For example, we have assumed that the designer does not discount between the two periods. If, instead there is a discount rate, as we will assume in the subsequent section, then the result of the previous proposition can be overturned (think of a short-run designer, for example). Also, a very low persistence parameter q (so that $\mu_q < 1 - q$) could also change the result in the proposition. Despite the simplifying features of this example, it is nevertheless a useful one, since it helps us understand some aspects of our more general model that we will describe in detail in the next section. Another important distinction between this finite period example and our general infinite horizon game of the next section is the fact when the second period is the last one, the designer behaves like a static designer in that period, and that is the reason for choosing a policy in that period that splits between the threshold for peace (μ_q) and the extreme belief of 1. Conversely, in the infinite horizon case, beliefs serve the dual purpose of inducing current period actions, in the spirit of a static information design problem, and having a direct effect on the information design problem of future periods.

4 Infinite Horizon

We will now consider the more general model with infinite periods $t = 0, 1, 2, \ldots$. The prior probability of state c_ℓ is $\mu_0 > \mu^*$. The first generation is born in period $t = 1$.

Without communication, beliefs evolve according to the hidden Markov model with persistency parameter q. That is, for $t = 1$, $\mu_1 = \mu_0 q + (1 - \mu_0)(1 - q)$. In general, at any t, in the absence of information transmission across generations, the public belief at time t would be:

$$\mu_t = \frac{1}{2} - \frac{1 - 2\mu_0}{2}(2q - 1)^t. \tag{3}$$

This evolution of beliefs in the absence of communication can be seen in figure 6.

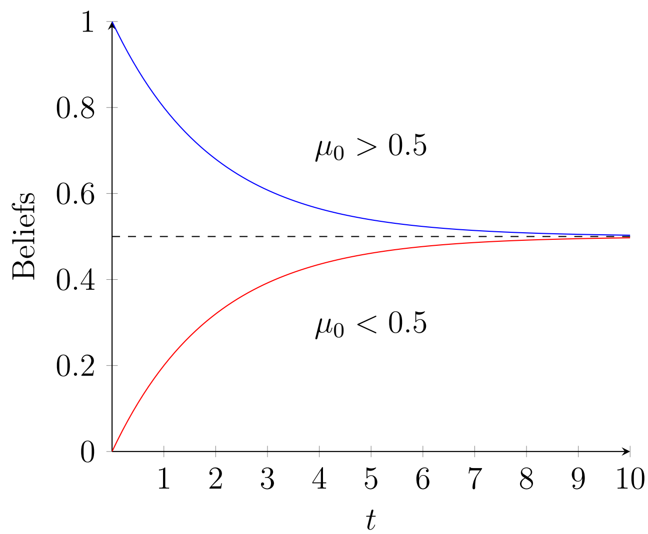

Figure 6: Evolution of Beliefs

Assume that $\mu^* < \frac{1}{2} < \mu_0$. Under these assumptions, there would be an endless sequence of conflicts in the absence of communication.

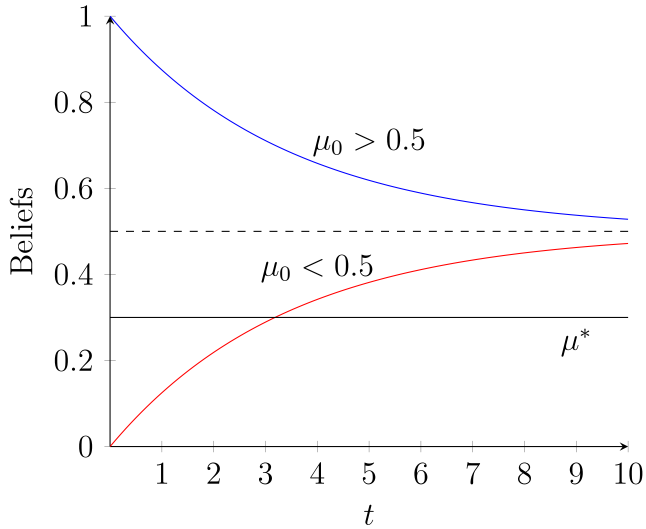

Figure 7: No communication: endless conflicts

Looking at the figure above, we can deduce the following. For any belief below the conflict threshold, $\mu \leq \mu^*$, there will be a given number of peaceful periods before the belief crosses the threshold μ^*.

In particular, we can compute the highest possible number of consecutive peaceful periods. This happens when the first such period is at a belief zero. To compute this number, we need first to compute how the belief evolves following a history of the form (under an information policy that truthfully reveals the state of the world):

$$h_{\tau-1} = (\cdots, c_h, \underbrace{\emptyset, \cdots, \emptyset}_{\tau-1 \quad times})$$

This belief can be computed as:

$$\mu_t(h_{\tau-1}) = \frac{1}{2} - \frac{1}{2}(2q-1)^{\tau}, \forall \quad \tau \in \mathbb{N}^* \tag{4}$$

To find the exact number of periods that a cycle of peace will have before an unavoidable conflict, we need to find the number that equals the belief in (4) to the threshold μ^*, and *round down* since time is discrete.

$$\tau^* = \lfloor n \rfloor = \left\lfloor \frac{\ln(1-2\mu^*)}{\ln(2q-1)} \right\rfloor \tag{5}$$

Therefore, a cycle of peace will last for at most τ^* consecutive periods.

Using a similar logic, define μ_i^* to be the belief in the peace region (i.e., $\mu_i^* < \mu^*$) such that in the i^{th} period of peace, the updated belief will be exactly equal to μ^*. That is

$$\mu_i^* = \frac{1}{2} - \frac{1-2\mu^*}{2(2q-1)^i} \tag{6}$$

We are now ready to state our main result. The proof is in the Appendix.

Proposition 2 (Optimal Information Policy)**.** *There exists a belief* $\bar{\mu} \in (\frac{1}{2}, 1)$ *such that the optimal information policy at any belief* $\mu_t \in [\mu^*, \bar{\mu}]$ *is such that* $\pi^*(\mu_{t+1} = \bar{\mu}|\mu_t) = \frac{\mu_t - \mu_i^*}{\bar{\mu} - \mu_i^*}$ *and* $\pi^*(\mu_{t+1} = \mu_i^*|\mu_t) = \frac{\bar{\mu} - \mu}{\bar{\mu} - \mu_i^*}$ *for some* $i \in \{1, 2, ..., \tau^*\}$.

The optimal policy will be such that the designer (i) commits always to induce peace at the good state, and *just sometimes* at the bad state; and (ii) induces a belief at the peace region that exactly reaches the indifference threshold, μ^*, after a certain number of periods. Figure 8 illustrates a possible optimal information policy at belief μ.

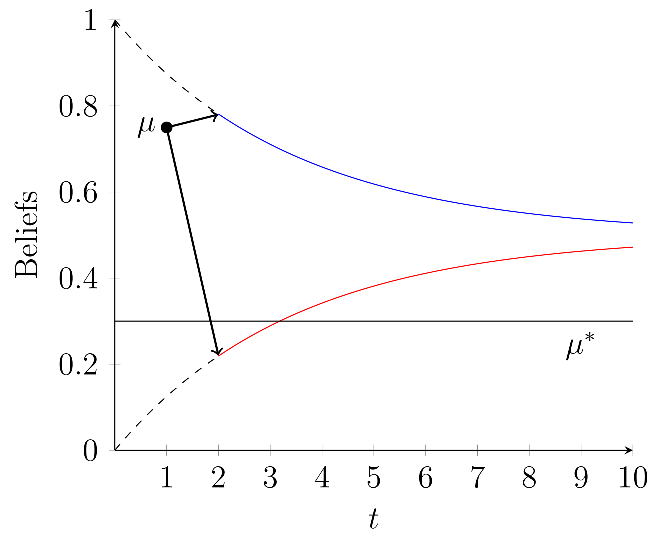

Figure 8: Optimal information policy

The intuition for why the information policy assigns positive probability only to beliefs that exactly reach the threshold μ^* after a given number of periods is that there would be a "waste" of probability if it induced a belief between μ_i^* and μ_{i+1}^*.

We can compute the optimal information policy using proposition 2 by applying the following algorithm. First, compute τ^*. This is the maximum number of periods of stasis. Then, we know we can have a policy with i consecutive periods of peace, where $i \in \{1, 2, 3, ..., \tau^*\}$. The second step in finding the optimal policy is to compute each corresponding μ_i. For each such μ_i, compute the payoff of the information policy according to proposition 2. Compare the expected payoff from each of the τ^* different policies.

Two particularly interesting policies are the greedy policy and the truth-telling policy since they are extreme in terms of the size of the peace cycles that these policies induce. A short-run designer will adopt a greedy policy by inducing beliefs at the threshold level, μ^*. Players play P, but then, in the following period, the posterior increases to $\tilde{\mu} = \mu^* q + (1-q)(1-\mu^*) > \mu^*$. Therefore, under the greedy policy, peace will be unstable, lasting for just one period.

Thus, there is a clear trade-off between the two extreme communication protocols: truth-telling and greedy policy. Truth-telling induces peace less often in the stage game, but the peace cycle may last for several periods. On the other hand, the Greedy policy will induce peace with a higher probability in the subsequent stage game, but it will last for only one period.

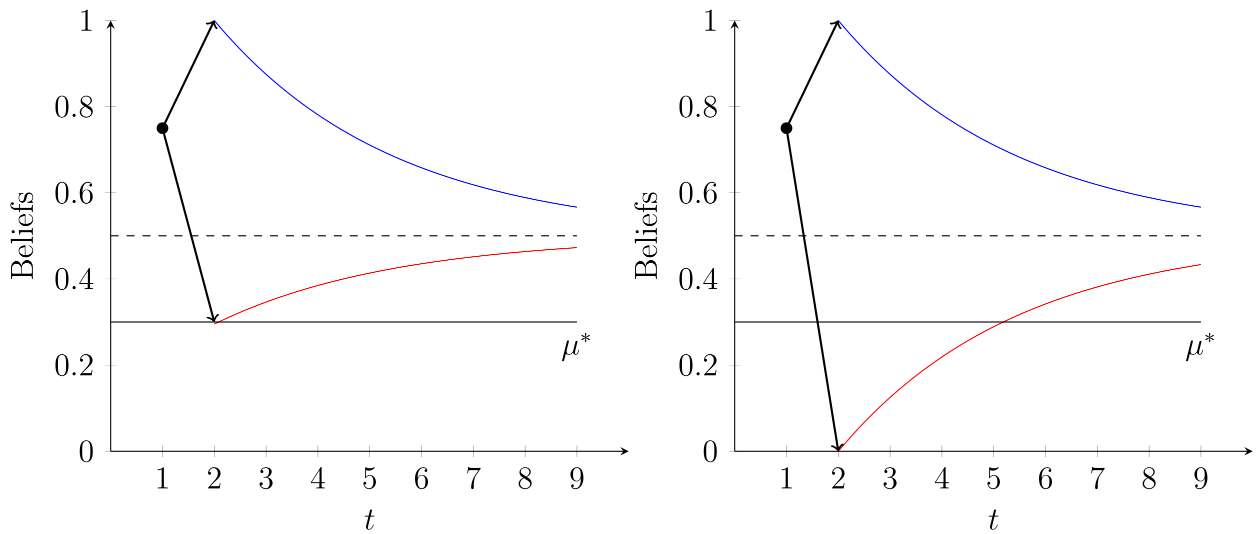

Figure 9: Comparison of Greedy Policy (left) and Truth Telling (right)

In the long run, which one will induce peace more frequently? When will the *how long* effect dominates the *how likely* effect? In the following section, we show that greedy policies dominate truth-telling in unstable environments, but the opposite happens in stable environments.

4.1 Stable and Unstable Worlds

We start this section by stating a result about optimality in highly unstable environments. The proof is a direct application of proposition 2.

Proposition 3 (Unstable Worlds: Greedy Policy is Optimal)**.** *Suppose that $\tau^* = 1$, that is, at belief 0, the parameters q and μ^* are such that it takes only one period of peace before the* *game moves back to conflict. Then, the greedy policy (static Bayesian Persuasion) is the optimal policy.*

We now turn to the other extreme case, That is, imagine a very stable world, which means a large persistence q. Then, the peaceful cycles will be long since τ^* is increasing in q, as is evident from (5).

Proposition 4 (Stable Worlds: Truth-Telling is Superior to Greedy Policy)**.** *There exists $\bar{q} < 1$ and a threshold prior in the conflict area, $\mu_0 > \mu^*$, such that for any prior belief below this threshold and any $q > \bar{q}$ truth-telling is better than the greedy policy for a sufficiently patient designer.*

Proof. The greedy policy is bounded above by a repeating one-period cycle of peace:

$$U^{BP} \leq 1 + \sum_{k=1}^{\infty} \delta^{2k} = \frac{1}{1-\delta^2}.$$

The truth-telling policy, on the other hand, is bounded below by:

$$U^{TT} \geq \mu_0 0 + (1-\mu_0) \sum_{k=1}^{\tau^*} \delta^k = (1-\mu_0) \frac{1-\delta^{\tau^*}}{1-\delta},$$

where the first term is a lower bound on a conflict cycle, whereas the second term is the payoff of a single peace cycle. Note that $U^{TT} > U^{BP}$ if:

$$\begin{aligned}
(1-\mu_0)\frac{1-\delta^{\tau^*}}{1-\delta} &> \frac{1}{1-\delta^2} \\
(1-\mu_0)(1-\delta^{\tau^*}) &> \frac{1}{(1+\delta)} \\
\mu_0 &< 1 - \frac{1}{(1-\delta^{\tau^*})(1+\delta)}
\end{aligned}$$

For high enough q, τ^* will be sufficiently high that $1 - \frac{1}{(1-\delta^{\tau^*})(1+\delta)} > 0$. Moreover, since this limit is increasing in δ, for a sufficiently patient designer and a sufficiently high q, such a threshold prior (not tight) exists. That is,

$$\lim_{\delta \to 1} \lim_{q \to 1} 1 - \frac{1}{(1-\delta^{\tau^*})(1+\delta)} = \lim_{\delta \to 1} \frac{\delta}{1+\delta} = \frac{1}{2}$$

$\square$

5 Numerical Simulations: Long-run Share of Peace

In this section, we provide numerical simulations to compare different information policies under different parameters. Here, we assume that the designer maximizes long-run peace. That is, her payoff is the limit of means of the number of peaceful periods:

$$U = \lim_{T \to \infty} \frac{1}{T} \sum_{t=1}^{T} u(a_t^A, a_t^B),$$

where $u(a_t^A, a_t^B) = 1$ if and only if the actions of both agents A and B at time t are peace; otherwise, $u(a_t^A, a_t^B) = 0$. In the figures below, we contrast the long-run fraction of peace in two extreme policies: truth-telling versus the greedy policy. As we have argued before, the greedy policy can, at most, induce peace in half of the periods. As the persistency parameter approaches 1, that is, the world becomes very stable, this upper bound is reached. This can be seen in figure 10 below.

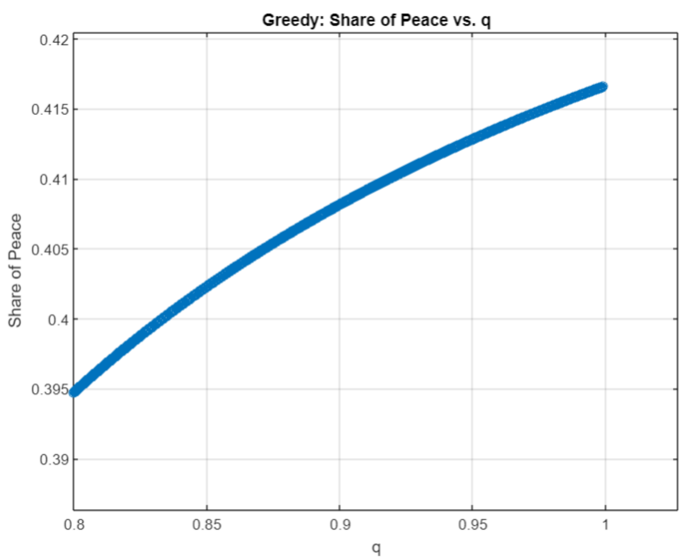

Figure 10: Greedy Policy: Share of Peace. Parameter $\mu^* = 0.4$

On the other hand, as $q \to 1$, the truth-telling policy guarantees a larger fraction of peace since the cycles of peace become arbitrarily large. Figure 11 depicts the share of peace under the truth-telling policy for varying levels of the persistence parameter, q. There are two main opposing effects in increasing q: it implies longer cycles of peace but also makes it less likely to switch from a conflict-prone world to one in which peace is possible in equilibrium. These two effects can be seen in the figure: for a range of q's such that the length of stasis, τ, remains constant, the long-run share of peace decreases as persistence increases. However, there will be a discontinuous increase in the share of peace as q increases to the point that the cycle τ increases by one period.

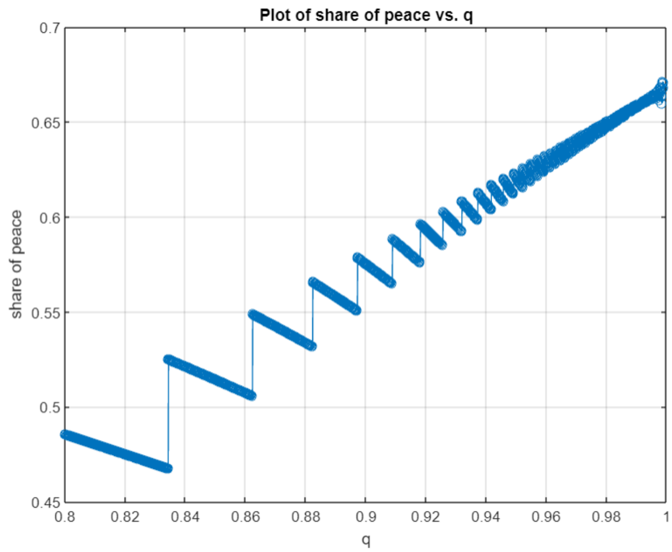

Figure 11: Truth-Telling Policy: Share of Peace. Parameter $\mu^* = 0.4$

This long-run fraction of peace strengthens the result of Proposition 4. There, we used the fact that for high persistency q, an initial peace cycle might be too long to compensate for a possible long-run sequence of conflicts. Here, instead, we show that if the cycles of peace are large enough, they will ensure that the system is more often in peace than in conflict, even though as q increases, conflict also becomes more likely to happen in a sequence (since the world is persistent).

Note that we have looked only at large values of q for the figures above. Indeed, for $q = 0.8$ and $\mu^* = 0.4$, the cycle of peace in a truth-telling policy is $\tau^* = 3$. Thus, we cannot use the results of proposition 3 in this particular example.

6 Conclusion

We propose a model of intergenerational information transmission in the aftermath of conflicts. In our model, two groups play a conflict game every period, representing societies that are often on the verge of a new conflict. When conflict emerges, an informed leader can communicate the underlying state of the world to the new generation of the two groups. Communication affects the likelihood and durability of peace.

We end with a simple message: communication is important for cycles of conflict and peace. It involves solving the trade-off of a *how long effect* versus the *how likely* one; that is, communication might aim to make conflict less likely in the short-run at the expense of having shorter cycles of peace. Instead, if communication aims at telling the truth about the consequences of a conflict, then peace, whenever achieved, will be more long-lasting. However, telling the truth also implies it will be less likely to have peace in the short run.

The optimal communication depends on the stability of the underlying environment. A stable environment is one in which peace may be long-lasting. In such environment, truth-telling outperforms a short-run strategy that maximizes the likelihood of peace in the subsequent period. Conversely, maximizing the likelihood of peace is the optimal strategy in highly unstable environments.

There are several ways in which this research question might be extended. History can be distorted in many forms and through many different instruments. We have provided a minimal framework with which different questions might be studied. These include problems in which designers have objective functions different from the one we have dealt with here, or the interaction of multiple competing leaders, or leader(s) dealings with partially informed agents.

The importance of post-conflict narrative cannot be overstated, yet it remains relatively understudied within the realm of economics. While many authors in political science, international relations, history, and psychology have looked into this question, economic theory and subsequent empirical work can enrich our understanding of this problem. By shedding light on the underlying strategic features involved in post-conflict communication, we can contribute to the debate on how to inform leaders and institutions in fostering lasting peace.

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A Appendix

We now proceed to prove the optimal information policy for the designer. The difficulty here is that in the dynamic problem, the *revelation principle does not hold.* Two beliefs that induce the same action are not the same from the designer's point of view. The reason is that beliefs determine not only actions but also future beliefs. Therefore, to use the tools from information design literature, we need to understand the shape of our value functions.[30]

Recall that within each period there are two instances in which the agents update their beliefs: after the information policy and right before they play the conflict game, accounting for Nature's move. In the figure below, we again present the timing within each period.

Figure 12: Timing

Every period can be subdivided into three parts: (i) the initial belief prior to the information policy, (ii) the posterior formed after the information policy takes place, and (iii) the updated posterior ($\phi(\mu)$, that accounts for Nature's move) with which the conflict game is played. The information policy of the subsequent period will be under the updated posterior belief of the previous period $\phi(\mu)$. Below, when we write the expected continuation payoff given a belief μ, we will refer to the expected continuation payoff as evaluated in subperiod 2, before Nature's move and the conflict game of that period is played. Thus, for a belief $\pi > \mu_q$, the expected continuation payoff at π can be written as:

$$V(\pi) = u_c + \delta \int_0^{\mu_q} p_\mu V(\mu) d\mu, \quad \text{with} \int_0^{\mu_q} p_\mu \mu d\mu = \phi(\pi), \tag{7}$$

where u_c is the stage game payoff of a conflict, which in this paper is assumed to be $u_c = 0$ (table 1).

We will refer to any belief $\mu \leq \mu_q$ as a belief in the *peace region*, and any belief $\mu > \mu_q$ as a belief in the *conflict region*.

Lemma 1 (Concavity of Value Function)**.** *V is concave for any belief $\pi > \mu_q$. That is:*

$$V(\alpha\pi + (1-\alpha)\pi') \geq \alpha V(\pi) + (1-\alpha)V(\pi'), \;\; \forall \pi, \pi' > \mu_q, \;\; \forall \alpha \in (0,1).$$

[30]See, for example, Kamenica and Gentzkow (2011) and Bergemann and Morris (2019) for the static problem and Ely (2017) and Renault et al. (2017) for dynamic problems.

Proof. Suppose, by contradiction, that there exists $\pi, \pi' > \mu_q$ such that for some α:

$$\alpha V(\pi) + (1-\alpha)V(\pi') > V(\alpha\pi + (1-\alpha)\pi'). \tag{8}$$

Then, we can write the left side as:

$$\alpha V(\pi) + (1-\alpha)V(\pi') = u_c + \delta(\alpha \int_0^1 \varphi(\mu)V(\mu)d\mu + (1-\alpha)\int_0^1 \tilde{\varphi}(\mu)V(\mu)d\mu),$$

in which $\int_0^1 \varphi(\mu)\mu d\mu = \phi(\pi)$ and $\int_0^1 \tilde{\varphi}(\mu)\mu d\mu = \phi(\pi')$. The right side can be written as:

$$V(\alpha\pi + (1-\alpha)\pi') = u_c + \delta \int_0^1 \varrho(\mu)V(\mu)d\mu,$$

in which $\int_0^1 \varrho(\mu)\mu d\mu = \phi(\alpha\pi + (1-\alpha)\pi'$. Given (8), we can write:

$$\alpha \int_0^1 \varphi(\mu)V(\mu)d\mu + (1-\alpha)\int_0^1 \tilde{\varphi}(\mu)V(\mu)d\mu > \int_0^1 \varrho(\mu)V(\mu)d\mu. \tag{9}$$

Note first that

$$\phi(\beta\pi + (1-\beta)\pi') = (\beta\pi + (1-\beta)\pi')(2q-1) + (1-q), \forall \beta \in (0,1).$$

Therefore,

$$\beta(\pi(2q-1) + (1-q)) + (1-\beta)(\pi'(2q-1) + (1-q)).$$

Thus,

$$\phi(\beta\pi + (1-\beta)\pi') = \beta\phi(\pi) + (1-\beta)(\pi'). \tag{10}$$

We can rewrite the left-hand side of (9) as

$$\alpha \int_0^1 \varphi(\mu)V(\mu)d\mu + (1-\alpha)\int_0^1 \tilde{\varphi}(\mu)V(\mu)d\mu = \int_0^1 (\alpha\varphi(\mu) + (1-\alpha)\tilde{\varphi}(\mu))V(\mu)d\mu. \tag{11}$$

Note that $\alpha \int_0^1 \varphi(\mu)\mu d\mu = \alpha\phi(\pi)$ and $(1-\alpha)\int_0^1 \tilde{\varphi}(\mu)\mu d\mu = (1-\alpha)\phi(\pi')$, thus, from (10) we obtain

$$\int_0^1 (\alpha\varphi(\mu) + (1-\alpha)\tilde{\varphi}(\mu))\mu d\mu = \phi(\alpha\pi + (1-\alpha)\pi')$$

Finally, we use this to note that

$$V(\alpha\pi + (1-\alpha)\pi') \geq u_c + \delta \int_0^1 (\alpha\varphi(\mu) + (1-\alpha)\tilde{\varphi}(\mu))V(\mu)d\mu.$$

This contradicts (9). $\square$

The intuition for the concavity lemma implies that an average belief is better than its split. This is true since, in both cases, the designer gets the same stage game payoff (conflict), and she can do better with a split using the average belief than with two splits using the combination of beliefs.

A direct implication of this result is that if an information policy involves randomization between beliefs only exclusively in the conflict zone, then it must involve a unique belief.

Lemma 2 (Superior Belief in Peace Region)**.** *Consider any belief $\pi > \mu_q$; then there exists at least one belief in the peace region, $\mu_\pi < \mu_q$, such that $V(\mu_\pi) > V(\pi)$.*

Proof. Suppose not. That is, there exists a belief $\pi^* > \mu_q$ such that

$$V(\pi^*) > V(\pi), \forall \pi < \mu_q. \tag{12}$$

Then, consider any belief $\bar{\mu} > \mu_q$ and its associated continuation value following the optimal policy:

$$V(\bar{\mu}) = u_c + \delta \left(\int_0^1 \varphi(\mu)V(\mu)d\mu \right), \quad \text{with} \int_0^1 \varphi(\mu)\mu d\mu = \phi(\bar{\mu})$$

It will be convenient to rewrite this as:

$$V(\bar{\mu}) = u_c + \delta \left(\int_0^{\mu_q} \varphi(\mu)V(\mu)d\mu + \int_{\mu_q}^1 \varphi(\mu)V(\mu)d\mu \right).$$

Using (12) we can rewrite this expression as:

$$V(\mu) \leq u_c + \delta \left(\int_0^{\mu_q} \mu V(\mu)d\mu + \int_{\mu_q}^1 \mu V(\pi^*)d\mu \right).$$

$$V(\bar{\mu}) \leq u_c + \delta \left(\int_0^{\mu_q} \varphi(\mu)V(\pi^*)d\mu + \int_{\mu_q}^1 \varphi(\mu)V(\mu)d\mu \right).$$

From the concavity result, this implies that

$$V(\bar{\mu}) \leq u_c + \delta V(E(\mu^C + \pi^*)).$$

Keep doing this iteratively and we find that $V(\bar{\mu}) \leq \frac{u_c}{1-\delta}$. But this implies a contradiction since $V(\mu) > \frac{u_c}{1-\delta}$, $\forall \mu < \mu_q$. $\square$

Thus, lemma 2 implies that for any belief in the conflict region, there is at least one belief in the peace region with a higher continuation payoff.

Lemma 3 (Decreasing Value function)**.** *$V(\pi)$ is weakly decreasing in π.*

Proof. Consider $\pi > \pi' > \mu_q$. Suppose that $V(\pi) > V(\pi')$. Then, there are two cases to consider. First, if the optimal information policy at π does not include beliefs in the peace region, and second, if it does. Let us start with the case in which it doesn't. Then, given concavity, we can write

$$V(\pi) = u_c + \delta V(\phi(\pi)).$$

However, the continuation payoff under π' can be written as:

$$V(\pi') \geq u_c + \delta \int_0^1 \varphi(\mu) V(\mu) d\mu,$$

where $\int_0^1 \varphi(\mu)\mu d\mu = \phi(\pi')$. In particular, using lemma 2 and since $\phi(\pi) > \phi(\pi')$ we can write:

$$V(\pi') \geq u_c + \delta \left(\alpha V(\mu_{\phi(\pi)}) + (1-\alpha) V(\phi(\pi))\right),$$

where we use lemma 2 to choose $\mu_{\phi(\pi)} < \mu_q$ such that $V(\mu_{\phi(\pi)}) > V(\phi(\pi)$. Choose $\alpha \in (0,1)$ such that $\alpha\mu_{\phi(\pi)} + (1-\alpha)\phi(\pi) = \phi(\pi')$. Thus

$$V(\pi') \geq u_c + \delta V(\phi(\pi)).$$

The second case is when there is a split between beliefs in the peace region and the conflict region. The logic, however, is the same as above. That is, let

$$V(\pi) = u_c + \delta \left\{ \int_0^{\mu_q} \varphi(\mu) V(\mu) d\mu + \int_{\mu_q}^1 \varphi(\mu) V(\mu) d\mu \right\},$$

with $\int_0^{\mu_q} \varphi(\mu)\mu d\mu + \int_{\mu_q}^1 \varphi(\mu)\mu d\mu = \phi(\pi)$. Since $\phi(\pi) > \phi(\pi')$, we can again use lemma 2 and construct a lower bound for the Value function evaluated at belief π'. Choose a distribution function $\tilde{\varphi}(\mu)$ such that (i) it coincides with $\varphi(\mu)$ for $\mu \in [0, \mu_q]$ (ii) for a positive mass of beliefs in the interval $(\mu_q, 1)$ we use lemma 2 and substitute for beliefs in the peace region that dominate the original beliefs (iii) for the remaining beliefs, maintain the original distribution. This new distribution $\tilde{\varphi}(\mu)$ is such that

$$\int_0^{\mu_q} \varphi(\mu)\mu d\mu + \int_0^{\mu_q} \tilde{\varphi}(\mu)\mu d\mu + \int_{\mu_q}^1 \tilde{\varphi}(\mu)\mu d\mu = \phi(\pi')$$

Therefore, we have:

$$V(\pi') \geq u_c + \delta \left\{ \int_0^{\mu_q} \varphi(\mu)V(\mu)d\mu + \int_0^{\mu_q} \tilde{\varphi}(\mu)V(\mu)d\mu + \int_{\mu_q}^1 \tilde{\varphi}(\mu)V(\mu)d\mu \right\},$$

This lower bound is clearly above the value function $V(\pi)$.

□

Lemma 4 (Split Optimality)**.** *If the optimal information policy at a belief μ_A in the conflict region induces probabilities of belief both in the conflict region and in the peace region, then for any belief μ_B such that $\mu_q < \mu_B < \mu_A$, the optimal information policy at μ_B also assigns positive probabilities to beliefs in both the conflict and peace regions. Moreover, $\mu_A \geq \frac{1}{2}$.*

Proof. By assumption, we have that $V(\mu_A) = u_c + \delta\{p_A V(x_0) + (1 - p_A)V(x_1)\}$, with x_0 in the peace region and x_1 in the conflict region. Moreover, $p_A x_0 + (1 - p_A)x_1 = \phi(\mu_A)$. Then, write:

$$V(\phi(\mu_A)) \leq p_A V(x_0) + (1 - p_A)V(x_1). \tag{13}$$

Suppose, by contradiction, that for a belief $\mu_B < \mu_A$ in the conflict region we have that

$$V(\phi(\mu_B)) > p_B V(x_0) + (1 - p_B)V(x_1), \tag{14}$$

with p_B given by $\phi(\mu_B) = p_B x_0 + (1 - p_B)x_1$. By concavity, we have that $V(\phi(\mu_A)) \geq \tilde{p}V(\phi(\mu_B)) + (1 - \tilde{p})V(x_1)$, with $\tilde{p}$ given by $\phi(\mu_A) = \tilde{p}\phi(\mu_B) + (1 - \tilde{p})x_1$. We can rewrite this as:

$$\begin{aligned} V(\phi(\mu_A)) &\geq \tilde{p}V(\phi(\mu_B)) + (1 - \tilde{p})V(x_1) \\ &> \tilde{p}\{p_B V(x_0) + (1 - p_B)V(x_1)\} + (1 - \tilde{p})V(x_1) \\ &= V(x_0)\tilde{p}p_B + V(x_1)\{\tilde{p}(1 - p_B) + (1 - \tilde{p})\}. \end{aligned}$$

Thus, $V(\phi(\mu_A)) > V(x_0)\tilde{p}p_B + V(x_1)\{\tilde{p}(1-p_B) + (1-\tilde{p})\}$. But note that

$$\phi(\mu_A) = \tilde{p}(p_B x_0 + (1-p_B)x_1) + (1-\tilde{p})x_1,$$

and thus, $\tilde{p}p_B = p_A$ and $\tilde{p}(1-p_B) + (1-\tilde{p}) = (1-p_A)$. Therefore:

$$V(\phi(\mu_A)) > V(x_0)p_A + V(x_1)(1-p_A), \tag{15}$$

but (13) contradicts (15). Note also that the information policy that assigns probability p_B to belief x_0 and probability $1-p_B$ to belief x_1 is feasible at belief $\phi(\mu_B)$.

Finally, let us also show that such belief μ_A exists. Consider belief $\mu = \frac{1}{2}$, then, $\phi(\frac{1}{2}) = \frac{1}{2}$ so if there is no split at this belief: $V(\frac{1}{2}) = u_c + \delta V(\frac{1}{2})$, thus $V(\frac{1}{2}) = \frac{u_c}{1-\delta}$, which is lower than an information policy that induces positive probability of a belief in the peace region, and, by feasibility, also a belief in the conflict region.

$\square$

The results of lemmas 2, and 4 can be illustrated in Figure 13.

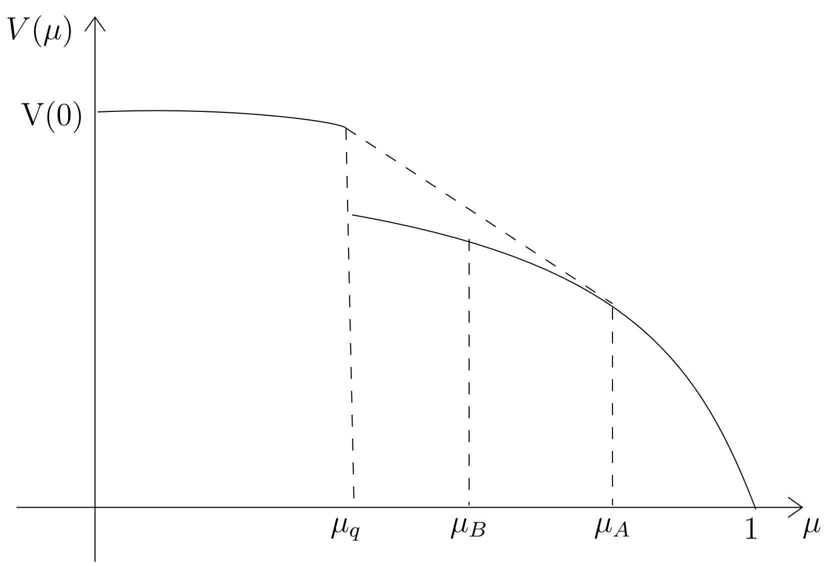

Figure 13: Concavity and Split Optimality

Before we conclude the proof of Proposition 2 we need to define $W(\mu)$, which is the concave closure of $V(\mu)$, that is

$$W(\mu) \equiv \sup\{z \mid (\mu, z) \in \mathrm{co}(V)\}.$$

Moreover, let us focus on the part of the concave closure that is above the belief μ_q:

$$W_q(\mu) \equiv \sup\{z \,|\, (\mu, z) \in \text{co}(V), \forall \mu > \mu_q\}.$$

Figure 14 represents the optimal information policy at any belief in the conflict region. Moreover, in the peace region, the value function is given by $V(\mu|\mu \in (\mu_{qq}, \mu_q)) = 1 + \delta V(\phi(\mu)$.[31]

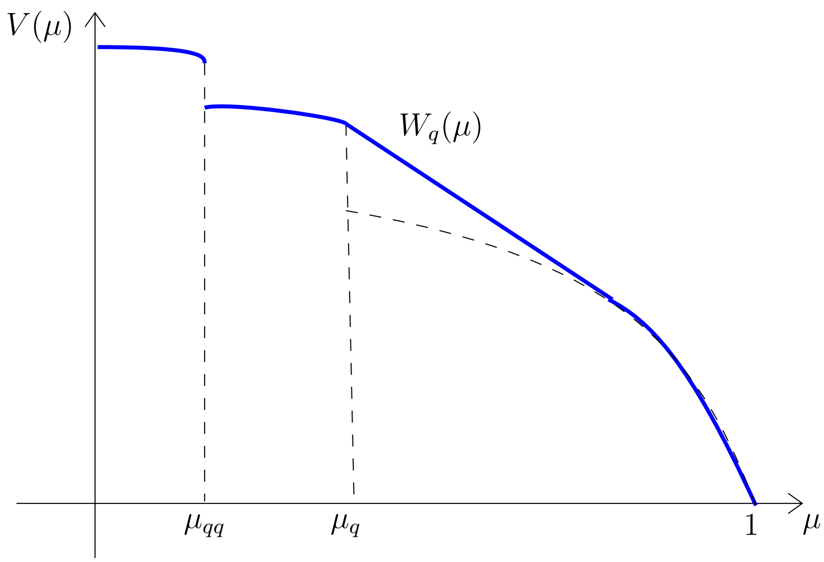

Figure 14: Optimal Information Policy

The following lemma concludes the proof of proposition 2.

Lemma 5. *The optimal information policy at any belief $\mu > \mu_q$ cannot assign positive probability to a peace belief $\mu < \mu_q$ with $\mu \neq \mu_i^*, \forall i$.*

Proof. Suppose, by contradiction, that the optimal information policy at a belief $\mu > \mu_q$ assigns positive probability to a belief $\mu < \mu_q$ with $\mu \neq \mu_i^*, \forall i$. Then, it means that the concave closure W has the same gradient at a belief $\mu > \mu_q$ and at a belief $\mu < \mu_q$. The gradient at a belief $\mu < \mu_q$, denoted by $f(\mu)$, is given by

$$f(\mu) = \delta \frac{V(\phi(\mu)) - V(\phi(\mu'))}{\mu - \mu'}$$

which is smaller, in absolute value, than the gradient at belief $\phi(\mu)$, since $\delta < 1$. Finally, the gradient at $\mu > \mu_q$ is strictly decreasing. Thus, $f(\mu < \mu_q) > f(\phi(\mu)) > f(\frac{1}{2})$ and since

[31] In general, if $\mu \in (\mu_{q\cdots qq}, \mu_{q\cdots q})$ then it is $V(\mu) = \sum_{k=0}^{\tau} \delta^k + \delta^{\tau+1} V(\phi(\cdots(\phi(\mu)))))$.

$\phi(\mu) < \frac{1}{2}$, we know by lemma 4 that the optimal policy will involve a belief in the conflict region that is greater or equal to 0.5. $\square$