Security in the Absence of a State: Traditional Authority, Livestock Trading, and Maritime Piracy in Northern Somalia*

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Abstract

Without a strong state, how do institutions emerge to limit the impact of one group's predation on another's economic activities? We consider this question in Northern Somalia, where piracy and the livestock trade are two important economic sectors. Piracy generates valuable income for certain groups, but produces a negative externality on livestock exports by raising shipping costs. We develop a model in which this conflict can be resolved when two key conditions make cooperation between rival groups self-enforcing — first, the ratio of economic interests favors the productive (livestock trading) sector, and second, traditional institutions promote income sharing between groups. These conditions are met in the northern Somali region of Somaliland, where the exercise of traditional clan-based authority has engendered peace; but not in the region of Puntland, where such authority is weak and conflict is rampant. Our model accounts for three empirical patterns. First, piracy is lower off the coast of Somaliland when livestock exports are high, but there is no such relationship in Puntland. Second, conflict rises in both regions after increases in pirate attacks off their respective coasts, but the relationship is noisier in Somaliland. And third, export price drops trigger conflict in Somaliland but not in Puntland.

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1 Introduction

An important function of the state is to promote cooperation among groups, limiting the inefficient externalities that one group's predation creates for the productive activities of another.[1] To provide this function, the state requires the institutional capacity to maintain law and order, enforce contracts, and engender peace.[2] In some states, the formal institutions that support cooperation are absent, and it is up to rival groups to locate and implement a *self-enforcing agreement* that finds peace between them.

In this paper, we examine one region of the modern world—northern Somalia—where traditional clan-based authorities operating locally at the level of sub-clans or lineage groups (hereon simply "clans") have been able to discover and support such self-enforcing agreements with varying degrees of success. For the past twenty years, and throughout much of Somalia's history, the provision of basic public goods, such as economic governance and security, has been the purview of clan leaders who rely on the informal institutions of traditional authority.[3] Somalia's longtime ruler, Siad Barre, tried very hard to dismantle traditional institutions and limit the authority of clan leaders, but clan structures remained strong in Somali society throughout the period of his rule and the country reverted to this form of traditional authority after his regime (and the Somali state) collapsed in 1991. Clanship to this day remains the fundamental basis of security in Somali society.[4]

As the key providers of local governance in northern Somalia, clan leaders in recent years have had to grapple with the dramatic rise in maritime piracy in the Gulf of Aden that took place after 1991. In addition to damaging international trade, this increase in piracy has affected the terms of Somalia's crucially important livestock sector. Even when pirating attacks are not directed at ships transporting Somali livestock abroad (as they typically are not) piracy hurts the livestock trade because it increases shipping and insurance costs. The income of Somalia's livestock herders is thus inversely related to the frequency and scale of pirating attacks off the Somali coast, creating the potential for conflict between clans that vary in the extents to which piracy and the livestock trade contribute to their income. Without a state to limit piracy and enforce cooperation, the clans themselves have had to find peaceful ways to resolve their differences. Clans in the two northern Somali regions of Somaliland and Puntland have shown markedly different levels of success in their ability to find peace despite the two regions sharing much in common.

[1] Hobbes (1651) in *Leviathan* argued that the state's authority derives from a social contact to maintain order and avoid a collapse to a disorderly and violent "state of nature." The idea that the state has a role in protecting property rights, and fostering development, was further developed in several literatures, most notably by Olson (2000), Evans (1995) and the literature on the "developmental state."

[2] See the work of La Porta et al. (1998), Besley and Persson (2009), and Acemoglu et al. (2005), and North et al. (2009), among many others.

[3] See, for example, LeSage (2005).

[4] See Gundel (2006) and Lewis (2004, p. 102).

We examine the different experiences of Somaliland and Puntland through the lens of a formal model. The model suggests that the different experiences of these regions are due, at least in part, to differences in both the relative economic importance of piracy versus the livestock trade, and the ability of clan elders to enforce a traditional system of cooperative income sharing in society. Clan leaders in Somaliland have been able to find a way to cooperate, building an agreement that has begun to resemble a formal state. In contrast, Puntland remains an economically fragmented, conflict-ridden society, with high levels of violence and weak state institutions.

A key feature of the model is that the livestock trading group has incentives to sanction piracy when they have evidence that piracy is on the rise. Another is that it is difficult to monitor piracy, and therefore the livestock trading groups have to rely on noisy signals of pirate activity such as their own revenues from the livestock trade and the observable income of the pirates. The assumption of imperfect monitoring renders it impossible to sustain a self-enforcing agreement in which there is perpetual cooperation. Periods of conflict take place in every equilibrium agreement; and, as a result, the structure of the most efficient of these agreements can be quite complex.[5] Therefore, instead of seeking a characterization of the most efficient self-enforcing agreements, we focus on particular modes of cooperation that help us make sense of the patterns we see in the Somali data.

One such pattern is that piracy is lower off the coast of Somaliland when livestock export levels are high, but there is no relationship between piracy and livestock exports in Puntland. (In fact, piracy is generally greater off the Puntland coast than off the Somaliland coast.) A second pattern is that increases in conflict appear to follow increases in piracy in both regions, but this relationship is subject to more noise in Somaliland. Finally, a third pattern is that export price drops appear to be followed by periods of conflict in Somaliland, but not in Puntland.

It is difficult to make sense of this set of patterns with other theories. Consider for example, the explanation that a decline in the price of livestock lowers the opportunity cost of conflict, making it a more attractive economic activity. This could explain why the relationship between prices and conflict exists in Somaliland, but it fails to explain why it does not exist in Puntland. After all, the livestock trade is a sizable share of the economy in both regions.[6] Alternatively, consider the related "labor market substitution theory" that the relationship between livestock exports and piracy in Somaliland can be explained by livestock traders shifting to piracy when exports are down, and pirates shifting to the livestock trade when exports are

[5] See, for example, Abreu et al. (1990) and more recently Hörner et al. (2011).

[6] The *New World Bank GDP and Poverty Estimates for Somaliland* reports that that approximately 30% of Somaliland's GDP in 2012 was from the livestock trade. The corresponding number for Puntland has not been estimated in recent years, but Somalia's Ministry of Planning and Statistics released estimates in 2003 that livestock exports accounted for 40% of GDP in Puntland. Since the Somali economy has been largely stagnant, it is unlikely this number has changed much over time.

up. This explanation also does not account for the absence of the relationship in Puntland. Moreover, qualitative evidence that we discuss below suggests that there is very little labor market substitution across activities either in Somaliland or Puntland.[7]

Our theory can account for the full set of empirical patterns, and it suggests a new way of looking at the problem of cooperation and conflict in Northern Somalia. It also suggests that development policy should take care to consider a wide range of possible causes of piracy and conflict beyond the ones that have been traditionally emphasized.

Related Literature Our paper relates to the theoretical literature on inter-group cooperation and order under anarchy. For example, Bates et al. (2002) develop a theory in which property rights can emerge in stateless societies, based upon the condition that "citizens must also invest in the capacity for violence" (p. 624). Exploring similar themes, Skaperdas (1992) argues that cooperation can result if one group is able to dominate the other, consistent with our argument that the dominance of the livestock trading group in Somaliland helps explain why we see greater cooperation there but not in Puntland. Fearon and Laitin (1996) study the role of in-group social sanctioning in enforcing cooperation across groups, raising the possibility that group leaders (in our case, clan elders) play an important role in encouraging such behavior.

Our paper also relates specifically to prior studies of the consequences of statelessness in Somalia beginning with the work of Laitin and Samatar (1987), and especially to recent scholarship that explains the divergent development trajectories of Somaliland and Puntland. Eubank (2012), for example, attributes the success cooperation between groups in Somaliland to the absence of a foreign aid curse. More in line with our perspective, Jean Paul Azam emphasizes the importance of income sharing in Somaliland's state-building efforts, and also suggests that ethnic heterogeneity and fiscal institutions play a key role in explaining the differences between Somaliland and Puntland (Azam, 2006, 2010). But the mechanism that he highlights differs from ours. In his model ethnic heterogeneity has made Puntlanders relatively myopic, which, combined with the weaker ability of the Puntland government to raise revenue and discipline bandits, has hindered cooperation.[8]

In a more general study of state building in Africa, Herbst (2000) suggested that geographic endowments and demographic features, rather than colonial history, determined the success or failure of state building projects. Herbst, however, emphasized population density as a key structural determinant, whereas we focus on the relative proportions of conflicting interests

[7] In addition, our empirical results are robust to the inclusion of a control for the unskilled wage rates, suggesting that the relationship between livestock exports and piracy is not driven by changes to labor market opportunities.

[8] Because of these structural differences, Azam is also skeptical that "export[ing] the solution that worked in Somaliland to the rest of Somalia would ... bring about the same benefits" (p. 162 in Chapter 9 of the World Bank report, "Transport Infrastructure and the Road to Statehood in Somaliland").

in the population. These conflicting interests are also central to the a model outlined by Shortland and Varese (2014), in which the variation in piracy off the Somali coast is explained by the decision of a "protector" that chooses whether to allow pirating activities or to protect productive trade. Their model, though different from ours, also suggests that predation can be reduced by strengthening the productive sector.

Other works that seek to explain the rise in piracy off the Somali coast include Murphy (2011), Chalk (2010) and Pham (2010), all of which focus on the weakness of formal state institutions after the state collapse of 1991. The collapse of the Somali state, however, provides only an incomplete explanation for Somali piracy. Local piracy occurred even with reasonably strong institutions in place, as was the case under European colonial rule through the 1950s. Moreover, there is a great deal of variation in when and where piracy occurs around the Somali coastline, which clearly cannot be explained solely by reference to the collapse of the central Somali state.[9] A compelling state-based explanation of this variation requires the identification of subnational "state-like" institutions with the potential to prevent or deter piracy, whose capacity or incentives to do so varies over time and space.

This is precisely the view of Hansen (2009), who suggests that local governance institutions rather than the central Somali state might be best placed to provide effective piracy prevention. Hansen (2009), however, focuses on local *formal* institutions in Somaliland and Puntland, noting that while those in Somaliland have been relatively strong and stable (and instances of piracy in the region have been limited), those in Puntland have been less effective and their collapse correlated with a surge in piracy after 2008. Such institutions are no doubt important, but the focus on formal institutions is problematic because in much of northern Somalia they lack both the relevance and capacity to effectively counter piracy. Within their respective territories the Somaliland and Puntland authorities "are not the main suppliers and enforcers of law" (Powell et al., 2008). Even in Somaliland, seen by many as a bastion of stability and order within Somalia, the formal judicial system is "mired in incompetence, corruption and political indifference" (ICG, 2005, p. 27), and its reach barely permeates through urban populations.[10] Our study differs from this work by acknowledging the importance of *informal* institutions, particularly the traditional institutions of clan authority.

Our paper also relates to work on the effects of economic shocks on conflict. Dal Bó and Dal Bó (2011) argue, for example, that if predation is more labor intensive than production, predation rises with positive shocks to capital intensive industries and declines with positive shocks to labor intensive ones. Dube and Vargas (2013) find evidence for this in Colombia by

[9] One notable exception in this literature is Percy and Shortland (2011), who highlight the impact of variation in the degree of instability and disorder within Somalia over time, arguing that there exists a "sweet spot" between conflict and a fully functional state that allows the business of piracy to operate effectively. Their argument makes sense of temporal changes to Somali piracy, but does not account for spatial variation.

[10] Even in urban areas, these institutions are unlikely to have much relevance in the fight against piracy since Somaliland only signed an anti-piracy law into effect in 2012.

comparing price shocks in the relatively capital intensive oil sector to those in the relatively labor intensive coffee sector. Bazzi and Blattman (2014), on the other hand, show that there is limited evidence that positive income shocks have any effect on conflict onset, but may reduce conflict duration even in countries with mostly capital intensive industries. In particular, they find limited evidence that fighting increases when there is more to fight over.

Our explanation for how price shocks affect conflict is different from the explanations studied by this literature. In our model, a negative price shock does not directly affect the material tradeoff between production and predation; instead, it serves only as a noisy signal of defection in a low information environment. This is essentially the same mechanism that breaks the possibility of perpetual cooperation in the Green and Porter (1984) cartel model.[11] Our paper applies the same insight to the relationship between price shocks and violent conflict, suggesting a different mechanism than the ones empirically investigated so far.

2 Background to Northern Somalia

Our model simplifies the northern Somali economy into two sectors, livestock trading and piracy, and Somali society into two groups based on clan heritage— those that rely comparatively more on the livestock trade for income and those that rely comparatively more on piracy. In this section, we justify this approach, focusing on the role that clan structure and authority play in economic organization and governance. We first provide a brief background to the two main economic sectors of our focus, the livestock trade and piracy. We then describe how clan structures and authority vary across Somaliland and Puntland with respect to the relative interests that they have in these two sectors and the forms of economic governance that they provide. The central differences we highlight are that (i) clans with relatively greater interest in livestock trading, as opposed to piracy, are more predominant in Somaliland than in Puntland, and (ii) although clan authority is important in both regions, clan leaders are a significantly stronger source of authority in Somaliland, especially when it comes to promoting cooperation through income sharing across groups.

2.1 The Livestock Trade

According to World Bank estimates, the largest economic sector in northern Somalia is the livestock trade, which accounts for 40% of GDP in Puntland, as well as 60% of its employment opportunities, and 80% of foreign exchange earnings.[12] The livestock sector is a slightly smaller share in Somaliland, but even there it constitutes 30% of GDP.[13] Majid (2010, p. 11) reports

[11] See also Yared's (2010) model of war and Fearon and Laitin's (1996) model of inter-ethnic cooperation.

[12] "Puntland Facts and Figures 2003," Ministry of Planning and Statistics, Puntland State of Somalia, released by the World Bank.

[13] See the January 29, 2014 press release "New World Bank GDP and poverty estimates for Somaliland."

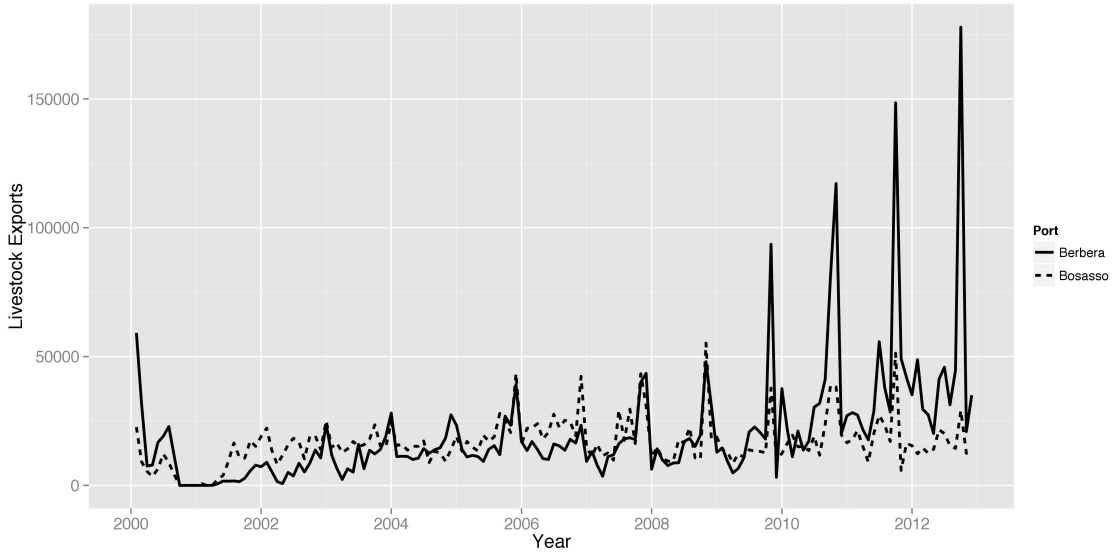

Figure 1. Monthly total livestock exports from the ports of Berbera and Bosasso, 2000-2012, collected by the Food Security and Nutrition Analysis Unit – Somalia (`http://www.fsnau.org/`).

that the northern Somali livestock trade involves the export of more than US$200 million worth of live animals across the Gulf of Aden each year. Similarly, livestock exports through the port of Bosaso in Puntland alone brought in $113 million in 2011 (Oliver et al., 2014).

The main foreign buyer of Somali livestock is Saudi Arabia, and the main export among varieties of livestock is goat, though camels and cattle are also common. Saudis prefer Somali livestock to alternatives from other major providers such as Australia, due to its provenance from a Muslim country. This is especially the case during the Hajj season when demand is high due to the sharp increase in pilgrims visiting Mecca. Somali livestock traders employ shipping companies to move livestock across the Gulf of Aden with the majority of these companies owned by businessmen from Somalia, Yemen, Saudi Arabia, and Pakistan, who typically start their shipments at the two main shipping ports of Berbera in Somaliland and Bosaso in Puntland. Local sellers at these ports are often middlemen who buy livestock from nomadic pastoralists in the hinterland and bring them to the ports, which are linked to the hinterland through a series of clan-based networks that manage the transportation and trade of livestock (Majid, 2010). These trade networks are of ancient origin, with clan-based protection for livestock caravans noted from the fourteenth century (Umar and Baulch, 2010, p. 16).

Clan authority is critical to the operation of the livestock trade. The clan-based insurance system mitigates risk for herders and traders in a context where clan arrangements provide the only form of security against issues such as infringements of grazing rights, animal theft, and reneging on loan agreements (Umar and Baulch, 2010, p. 18). For example, dispute resolution

falls under the purview of clan leaders who act as judges in an *ad hoc* court known as *guddi* in which traditional *xeer* law is expected to prevail. This is a form of customary unwritten law that is passed down orally, and which has evolved to maintain a set of principles that are applicable to any type of situation or conflict, and as such is almost never silent on any given conduct (van Notten, 2005). Modern application of the law accommodates certain aspects of *shari'a* law as well, though when the two might conflict *shari'a* law is typically subordinated to clan traditions (Gundel, 2006). This system of informal local economic governance provides strong disincentives against economic misconduct through a norm of collective liability known as the *diya* system, under which the entire clan becomes liable for a breach of contract by any one of its members.

Our main data on the livestock trade are depicted in Figure 1, which shows livestock exports over time from the two ports of Berbera and Bosasso, measured as the number of heads of livestock (summing over camels, cattle, and goats) exported monthly from each of the two ports.[14] The data reveal several patterns worth noting. First, there is a seasonality in trade with exports rising sharply during the Hajj. Second, there has been a gradual increase in exports since November 2009 after the removal of a Saudi ban on Somali livestock that started in 2000 following an outbreak of Rift Valley Fever in Yemen and Saudi Arabia. During the ban, exports to Saudi Arabia from Berbera were severely limited, though unofficial exports and indirect exports continued to hold (with livestock being first exported to Djibouti, quarantined and checked for illness before being sent to Saudi Arabia). Third, the data also appear to corroborate accounts from Majid (2010) that Bosasso may actually have benefited from the ban by becoming a channel for such unofficial exports prior to 2009. Fourth, exports from Berbera have been higher after 2009 than exports from Bosaso.

2.2 Piracy

There is a long history of predation against foreign vessels around the Somali coast, and of piracy directed against the dhow (shipping) trade that plies the Gulf of Aden (de Wijk et al., 2010). While these predatory activities were restricted under the Barre regime, maritime piracy off the Somali coast exploded after the regime collapsed in 1991. Figure 2 shows monthly counts of piracy incidents from February 2000 to December 2012 within a 250 kilometer radius of the ports of Berbera and Bosaso. The figure highlights the significant variation in rates of piracy, both spatial and temporal, across the northern Somali coast. In terms of spatial variation, the key notable pattern is the greater number of pirate attacks off the coast of Bosaso than off the coast of Berbera.

[14] The note below the figure reports the source of these data. Summary statistics for these data, and all other data used in this paper, are given in Table 4 in the appendix.

Figure 2. Monthly counts of pirate attacks within a 250 kilometer radius of the ports of Berbera in Somaliland and Bosasso in Puntland, 2000-2012. These are all attacks reported in the Anti-Shipping Activity Messages (ASAM) database compiled by the United States National Geospatial-Intelligence Agency. ASAM can be accessed at `http://msi.nga.mil/NGAPortal/MSI.portal`. Our data were accessed on July 9, 2015.

The World Bank estimates that ransom payments from piracy have brought in an annual average of $53 million to the Somali economy since 2005 while resulting in a yearly loss of $18 billion to the world economy.[15] Ransom payments in 2011 alone from pirate attacks in the Gulf of Aden generated $163 million in revenue for the Somali economy. These numbers indicate that although piracy is a smaller sector than the livestock trade, it is still a large income generator in northern Somalia. At the same time, it has the potential to produce negative spillover effects on the wider Somali economy, including the livestock trade. For example, during periods of intense piracy the number of ships willing to ply the routes between northern Somalia and the Arabian Peninsula declines, often leading to an over-supply of livestock at Somali ports, which in turn drives down the prices received by traders and herders.

Another channel by which piracy hurts the livestock trade is by increasing shipping and insurance costs. Agreements between traders and shipping agents factor in some potential losses that may occur during the sea journey, with exporters bearing up to 1% of loss of sheep and goats, and 2% of cattle. Any losses exceeding these are typically compensated by the shipping company (Umar and Baulch, 2010, p. 35). As a result, increases in piracy that make

[15]See the World Bank report titled "The Pirates of Somalia: Ending the Threat, Rebuilding the Nation." Somewhat conflicting, but similarly large figures are estimated by Besley et al. (2015), who report that Somali piracy has produced revenues for pirates of approximately $120 million, but the global welfare loss from this piracy (mainly in the form of shipping, monitoring and insurance costs) exceeds $630 million. Neither these authors nor the World Bank separately estimate the domestic costs of piracy in only Somalia.

sea journeys across the Gulf of Aden more dangerous increase the risks that shipping companies face, raise transportation costs and drive down their value from trade. Besley et al. (2015) estimate that the upsurge in Somali piracy in 2008 led to an 8% to 12% increase in international shipping costs, which they attribute mostly to higher insurance and security costs. Therefore, although the vessels attacked by pirates might not themselves always represent local victims, Somali piracy is harmful to the livelihoods of many Somalis if it negatively affects the terms of the Somali livestock trade.[16]

We lack direct quantitative evidence on the harmful effects of piracy on the terms of the livestock trade. However, the negative impact of predation on trade is borne out by local news reports. These reports highlight that piracy increases shipping costs, as trade ships charge higher transportation costs due to greater security expenses.[17] Although the international media tends only to report the most audacious attacks on international tankers and container ships, for many years Somali pirates have targeted the cargo dhows and light coastal freighters that make up the bulk of the area's maritime trade.[18] This includes vessels of different sizes transporting livestock to the Arabian peninsula out of both Berbera and Bossaso.[19] In 2011, for example, pirates captured a livestock ship in the runup to the Hajj, the most lucrative part of the year for the livestock trade, and were reportedly killed within hours by "irate traders and herders."[20]

As a result of its negative externalities for the livestock trade, piracy has the potential to invoke sanctions from different parts of Somali society. When pirate attacks are successful the pirates typically route the captured vessel to a private port, which in the face of potential sanctions requires protection and support from local accomplices. In order to function effectively, therefore, pirate groups require the complicity of groups onland, in particular local clan leaders. Interestingly, these leaders, in an attempt to allow both the livestock and pirating sectors to flourish, provide both support for *and* sanctioning against piracy. Shortland and Varese (2012) describe how clan complicity facilitates piracy, with some clans providing "protection" to pirates. At the same time, since *xeer* law forbids criminal activities such as abduction, theft, extortion, and fraud (and many clan leaders view piracy as belonging to this

[16] Oliver et al. (2014) suggest yet another by which Somali piracy hurts the Somali economy. They estimate that ransom earnings from Somali piracy had the effect of appreciating the local currency and reducing export competitiveness.

[17] See for example "The Real Costs of Piracy on Locals", *SomaliaReport*, 03/27/2011, and "Life in Bosaso", *SomaliaReport*, 03/01/2012.

[18] "Somalia Pirates' Last Stand", *African Business*, 01/03/2000.

[19] "Somalia: Puntland force prepares to rescue livestock boat from pirates", *Garowe Online*, 04/03/2010; "Pirates Hijack UAE Vessel, Says Official", *SomaliaReport*, 07/14/2011; "Weekly Piracy Report", *SomaliaReport*, 08/12/2011; "Daily Media Roundup", *SomaliaReport*, 08/15/2012.

[20] "Hope is four-legged and wooly", *The Economist*, 10/15/2011.

category, in addition to being *haraam*, i.e. forbidden, under *shari'a* law), clans leaders are able to provide a meaningful source of disincentives against piracy.[21]

The influence of clan elders over pirates is reinforced by the fact that pirate gangs tend to organize within rather than across clans, maintaining these "familial" ties by transfering "Qaaraan" ("livestock or money for the needy,") to the clan (Hansen, 2009, p. 25-26). Backhaus (2010) also notes the importance of pirate leaders being well established and connected in the local community through clan ties, and suggests that Somali pirates actively avoid attacking ships which belong to members of their own clans. Reports of clan elders pressuring pirates to release vessels in Puntland, and mediating conflicts involving pirates in both Puntland and the central region of Galmudug, suggest that clan leaders often have authority over pirates that formal authorities lack.[22]

Exactly how clan leaders manage social relationships and economic governance is complicated, but it is likely to vary across the two regions of northern Somalia in ways that, we argue, help account for the spatial variation in piracy in particular, and the divergent development paths of Somaliland and Puntland in general. In the next section we provide more details on clan authority, and discuss the differences in clan authority and structure between Somaliland and Puntland.

2.3 Clan Structure and Authority in Somaliland and Puntland

Despite the importance of clan structures and authority in both Somaliland and Puntland, clan interests and composition vary considerably across the two regions.

In Somaliland, the Isaaq clan-family makes up the vast majority of the population. The Isaaq contains a number of confederacies, themselves consisting of various sub-clans. The largest of these in Somaliland is the Habr Awal, a merchant class that has benefited from proximity to Somaliland's crucial trading port of Berbera. Despite their various tribal delineations, the Isaaq are unified by the fact that they are almost entirely nomadic pastoralists (Lewis, 1969, p. 23-24). In this regard they are very similar to the Esa and Gadabursi sub-clans in the furthest north-west part of Somaliland, who belong to the Dir clan-family. Much like their Isaaq neighbors, the Esa and Gadabursi are pastoral nomads (Lewis, 1969, p. 25).

A very small proportion of Somaliland's population come from the Dulbahante and Warsangeli sub-clans, concentrated in the north-eastern province of Sanaag (Lewis, 2008, p. 99). Both the Dulbahante and Warsangeli are primarily pastoralist groups, though the Warsengeli "are much given to seafaring and compose the bulk of the crews manning the dhows which ply between Aden and Somaliland" (Lewis, 1969, p. 21). Because of their comparative advantage

[21] For example, clan elders pressured for the release of eight pirates who had been arrested by Ahlu Sunna Waljamma'a, a paramilitary group allied to the Somali government. "Pirates Get Ready for More Attacks, Confusion Over Possible Oil Tanker Hijack", *SomaliaReport*, 02/17/2012.

[22] "Pirates Release MV LEILA", *SomaliaReport*, 04/12/2012; "Reconciliation of Clans in Rako-Raho", *SomaliaReport*, 04/03/2012; "Pirates Initiate Clan Conflict in Daba-Galo", *SomaliaReport*, 04/21/2012.

at sea, members of this group have also been known to engage in piracy, and a major pirate network operated for some time out of Las Qoray in north-eastern Somaliland (Murphy, 2011, Palmer, 2014). Thus, piracy represents a small part of the economic interests of groups in Somaliland, and "pirate clans" are very much in the minority in the region. Since the majority of clans rely on pastoralism, the ratio of economic interests in Somaliland very much favors the livestock trade.

Clan structure and authority in Puntland is considerably different. Although most clans fall under a single clan-family (the Darod), the distribution of economic preferences across these clans has made governance more difficult. As noted above, the Darod contains numerous confederacies and sub-clans, including the Dulbahante and Warsengeli, which straddle the border between Somaliland and Puntland. Far more numerous in Puntland, however, are the Mijerteen, another Darod sub-clan. As with the Warsengeli, the Mijerteen have traditionally engaged in both pastoralism and seafaring activities, and a sizable proportion of the Mijerteen (roughly 12%) are fishermen and sailors (Lewis, 1969, p. 20). As such, the vast majority of fishermen in the region come from this group, many of whom turned their seafaring skills to piracy after the collapse of the Barre regime.

Piracy, in fact, was not a new venture for the Mijerteen, who have a long history of engagement in maritime predation dating back to the early nineteenth century (Durrill, 1986). This was true for communities across the north-eastern and eastern coastlines of Puntland, with ships being lured onto the rocks to be pillaged and shipwreck survivors being taken hostage for ransom. Pirates, moreover, were linked to a broader political system of predation (de Wijk et al., 2010, 44-5). This widespread engagement in maritime predation resurfaced in the 1990s, with pirate gangs operating out of a number of locations around the Puntland coast (Murphy, 2011). This posed a challenge for others in Puntland, who suffered from the expansion of the pirate sector. As Dua and Menkhaus (2012, p. 759) note, "thanks mainly to the accident of geography, a handful of clans dominate the [piracy] business, while other clans benefit only marginally or not at all."

The piracy business is therefore much larger in Puntland than it is in Somaliland, both in absolute and in relative terms. While the various Darod sub-clans all have sizable interests in pastoralism, many of them also have an interest in piracy, much more so than any of the groups in Somaliland. As a result, the ratio of economic interests in Puntland is more balanced between piracy and the livestock trade.

The differences between Somaliland and Puntland in terms of clan influence are not just limited to the numerical composition of clans groups and interests in these regions. Clans are much more a part of the governance structure of Somaliland, and their role in society has been recognized even somewhat formally by the Somaliland state. Starting in 1991 a series of congresses and peace talks involving clan elders were held in northern Somalia, bringing together all the major clans in the region (Farah and Lewis, 1997, Huliaras, 2002, Walls,

2009). By 1993 this led to a National Charter establishing a government, rights, and basic national institutions. Key to this development was the formation of the *Guurti* assembly of clan elders as a chamber of Somaliland's bicameral legislature to facilitate cooperation across clan groups. This assembly has, to a large extent, succeeded in promoting cooperation across groups through the guarantee of national revenue-sharing, including export revenues from the port of Berbera and those from the national airport at Hargiesa, which include air taxes and landing charges (Lewis, 2008, p. 95-96). And, in general, the numerous confederacies of clans and their constituent sub-clans in Somaliland have been able to negotiate competing interests to settle both inter- and intra-clan disputes.

Groups in Puntland have attempted to form clan-based agreements akin to those in Somaliland, but with almost no success. Attempts to form a unified state have been less successful, in large part due to inter-clan conflicts and a relatively unconstrained executive after Colonel Abdilliahi Yusuf emerged as an iron leader of Puntland, who showed an interest in emulating the attempt by Somalia's longtime ruler, Siad Barre, to limit the influence of clan elders and stamp out "clannism" (Hesse, 2010). A key implication of this has been the lack of any broad-based commitment to national revenue-sharing along the lines of that seen in Somaliland.

3 Model

We consider a society that consists of two groups. One is a set of clans whose interests are predominantly in livestock trading, and another is a set whose interests in piracy are comparatively larger. While our discussion in the previous section recognizes that economic interests and occupational choices do not perfectly delineate along clan boundaries, we will for simplicity refer to these groups as "livestock traders" and "pirates."[23]

The population share of the traders is λ while the share of the pirates is $1 - \lambda$. The parameter $\Lambda = \lambda/(1-\lambda)$ denotes the ratio of these population shares. The two groups interact repeatedly over time. Time is discrete with an infinite horizon and indexed by t. Both groups discount future payoffs with a common discount factor $\delta < 1$.

3.1 Fundamentals

In each period the two groups move simultaneously, deciding whether or not to cooperate with each other.

At the start of each period t a state $s_t \in \{0, 1\}$ is drawn to determine whether trade is productive, with $s_t = 1$ indicating the realization of the high productivity state. We assume

[23] As we have noted, members of any single Somali clan are likely to be engaged in a variety of economic activities. The claim here is simply that some groups have a greater economic interest in the livestock trade, while others may have a greater interest in piracy. For simplicity, we refer simply to trading groups and pirate groups, but this should not be taken to imply that *all* members of the group are engaged in that single activity.

that s_t is independently drawn across periods and that the probability that $s_t = 1$ is a constant θ for all t. When the traders cooperate, they make peace with the pirates and each trader shares a fraction ϕ_t of his income with the pirating group, where $0 \leq \phi_t \leq \bar{\phi}$ and $\bar{\phi}$ is an exogenous parameter. When the traders do not cooperate, they do not share any of their income, and conflict takes place between the two groups. Under conflict, each member of the pirating group incurs a cost $k\Lambda > 0$ while each member of the trading group incurs a cost k/Λ.[24] The key feature of this assumption is that the cost that one group can inflict upon each member of the other group is larger the more the first group outnumbers the second.

When the pirates cooperate, they self-regulate the number of pirate attacks that they launch. By doing this, they are foregoing some of the returns from piracy, but they may be providing considerable benefits to the traders by creating a safer trading environment during periods of highly productive trade. When the pirates choose not to cooperate, they engage in unregulated piracy, creating a negative externality on productive trade in these periods.

More precisely, suppose that when productivity is low the income of each trader from productive trade is 0 regardless of what the pirates do. When productivity is high, the income of each trader is a random variable R_t which can be high or low, and whose distribution is determined by the pirating group's choice of whether or not to regulate piracy. In particular, we assume that $R_t \in \{0, R\}$ with $0 < R$, and the probability that R_t will equal 0 is $\underline{\gamma} > 0$ if the pirates self-regulate in period t, and $\overline{\gamma} > \underline{\gamma}$ if they do not. $R_t = R$ with complementary probability in either case, and R_t is realized at the end of the period.

To capture the idea that the self-regulation of piracy is costly for the pirates, we assume that the pirates have a lower chance at making a high return from piracy if they self regulate. In each period, each pirate receives a return of $d_t \in \{0, d\}$ from piracy in period t, where $0 < d$. When they do not self regulate in period t, each pirate makes the high return of $d_t = d$ with probability $\overline{\mu}$ and the low return of $d_t = 0$ with probability $1 - \overline{\mu}$. The expected return from not self regulating is thus $\overline{\mu}d$. When they do self-regulate, each pirate receives the high return $d_t = d$ with probability $\underline{\mu}$, and the normalized low return of $d_t = 0$ with probability $1 - \underline{\mu}$. The expected return from self-regulation is thus $\underline{\mu}d$. The assumption that $\underline{\mu} < \overline{\mu}$ says that self-regulation lowers the probability that the pirates will receive the high return $d_t = d$.

3.2 Monitoring Structure

We assume that the model has one-sided moral hazard: the pirates' decision to regulate piracy is not directly observed by the traders. This assumption is motivated by the fact that piracy is often, but not always, an activity that is planned and carried out in a way that may not be

[24] To motivate these costs, imagine that each individual can produce a cost k. There are λ traders, so the traders together produce λk. This cost is equally divided among all members of the pirating group, so the cost incurred by each member of the pirating group is $\lambda k/(1-\lambda) = k\Lambda$. Similarly, the pirates produce a total cost of $(1-\lambda)k$ and each trader incurs cost $(1-\lambda)k/\lambda = k/\Lambda$.

publicly observable. In particular, it is difficult for the trading group based on land to always know how much piracy is going on at sea, and where it is being targeted.

In our model, the traders have access to two noisy public signals of whether or not the pirates are self regulating: the pirates' period t income from piracy, and the traders' own period t revenue from trade, both of which are observed at the end of the period. Since the low revenue $R_t = 0$ is more likely when the pirates don't self regulate than when they do, it is evidence of unregulated piracy. Similarly, the high return $d_t = d$ is more likely when the pirates do not self-regulate than when they do, and is also evidence of unregulated piracy.

We define $\omega_t \in \{0, 1\}$ to be the period t indicator of a high income from piracy in the previous period, $d_{t-1} = d$. Thus $\omega_t = 1$ with probability $\underline{\mu}$ if the pirates self-regulated in the previous period, and with probability $\overline{\mu}$ if they did not. $\omega_t = 0$ with complementary probability in either case. Finally, we assume that if the traders learn that the pirates did not self-regulate in the previous period ($\omega_t = 1$), then by choosing conflict each trader receives an additional payoff worth g, while each pirate incurs a loss of l. If $\omega_t = 0$ then there are no additional gains or losses to either group. For example, we could set $g = h + \beta d/\Lambda$ and $l = (\alpha - \beta)d$ with the following interpretation. If a pirate earns d from piracy in the previous period, then the traders loot $\beta d \geq 0$ of this income, dividing it equally among themselves. $\alpha d > 0$ is the value of the previous period return in the current period. $h \geq 0$ represents any social motives for sanctioning unregulated piracy.[25] We set $\omega_0 = 0$.

3.3 Payoff Structure and Assumptions

The expected payoffs per individual in each group have the following structure, where the row player is the trading group and the column player is the pirate group:

	self-regulate	don't self-regulate
peace	$(1-\phi_t)(1-\underline{\gamma})s_tR$, $\underline{\mu}d + \phi_t(1-\underline{\gamma})s_tR\Lambda$	$(1-\phi_t)(1-\overline{\gamma})s_tR$, $\overline{\mu}d + \phi_t(1-\overline{\gamma})s_tR\Lambda$
conflict	$(1-\underline{\gamma})s_tR + \omega_t g - k/\Lambda$, $\underline{\mu}d - \omega_t l - k\Lambda$	$(1-\overline{\gamma})s_tR + \omega_t g - k/\Lambda$, $\overline{\mu}d - \omega_t l - k\Lambda$

These payoffs are subject to the assumptions above as well as three additional assumptions, two of which are as follows. (The third will be stated later.)

(A1) $g - k/\Lambda > 0$

(A2) $d > l + k\Lambda$

We use the first assumption to establish that the traders have short-run incentives to sanction piracy despite the costs of conflict if they expect the pirates to not self-regulate. We use the

[25] Since we allow $h = 0$ or $\alpha = 0$ we are agnostic as to whether the traders have short run incentives to choose conflict after evidence of piracy in order to obtain a share of the pirate income, or to sanction the pirates for anti-social / immoral behavior; or, for both reasons.

second one to establish that if piracy is successful, then the income that it generates is high in comparison to the potential costs of being punished for it; this gives myopic pirates a short run incentive to not self-regulate.

3.4 Social States

We have described a stochastic game with imperfect public monitoring. If the players are patient (δ is high) then the game has a large set of equilibria exhibiting varying degrees of cooperation between the two groups (Hörner et al., 2011). Our strategy for analyzing the game will be to take an approach that focuses on particular kinds of social agreements, i.e. strategy profiles. We characterize the conditions that make these agreements incentive compatible. The equilibrium concept is perfect public equilibrium (PPE).

We characterize social agreements using three categories of "automaton states" and derive conditions that are necessary and sufficient to sustain particular "path automata" in equilibrium. Informally, a path automaton specifies actions that are chosen only on the path of play.[26] As such, it is an incomplete description of a strategy profile. Our approach is to characterize conditions under which there exists a way to complete the description of the strategy profile such that it becomes an equilibrium of the game for high values of the discount factor.[27] The following describes the three categories of automaton states.

1. *Conflict* : In these states, the traders choose conflict and therefore they do not share any of their income with the pirates. Note that there are several possible automaton states in this category, depending on whether the payoff relevant signal ω_t equals 0 or 1, whether s_t equals 0 or 1, and whether the pirates self-regulate or don't.

2. *Peace and no self-regulation* : In these states, the traders make peace with the pirates but the pirates do not self-regulate. If $s_t = 1$, then this creates a negative externality on productive trade because it lowers the probability that the traders will obtain the high return ($R_t = R$) from $1-\underline{\gamma}$ to $1-\overline{\gamma}$. If $s_t = 0$ then unregulated piracy has no externality on productive trade (since $R_t = 0$ for sure). Note that there is a continuum of such states depending on the fraction ϕ of income that is shared.

3. *Peace and self-regulation* : In these states, the traders make peace with the pirates and the pirates self-regulate. The pirates are forgoing some of the expected returns from piracy by lowering their chance of obtaining the high return ($d_t = d$) from $\overline{\mu}$ to $\underline{\mu}$. During high productivity periods ($s_t = 1$) they are conferring a benefit to the traders by increasing the traders' chances of earning the high return ($R_t = R$) from $1-\overline{\gamma}$ to $1-\underline{\gamma}$.

[26] Kandori and Obara (2010) give a formal definition of path automata.

[27] We follow the literature on cooperation in repeated games by focusing on high values of the discount factor. To support the path automata that we study here for lower values of the discount factor, we typically require stronger conditions.

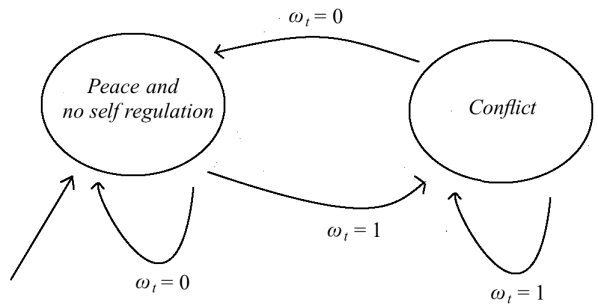

Figure 1: No Cooperation Regime (Puntland)

During low productivity periods ($s_t = 0$) they are conferring no benefit upon the traders, since $R_t = 0$ independent of what they do. Again, there is a continuum of such states depending on the fraction ϕ of income that is shared.

3.5 Cooperation and No Cooperation Regimes

We now describe two types of regimes—one that we call the "No Cooperation Regime" (NCR) in which the pirates do not self-regulate, and another that we call a "Some Cooperation Regime" (SCR) in which they do. These correspond to different classes of path automata.

NCR Suppose that the players are myopic ($\delta = 0$) and consider a situation in which no income is ever shared ($\phi_t = 0$ for all periods t in which the traders make the choice). The pirates would never self-regulate, due to the fact that $\overline{\mu} - \underline{\mu} > 0$. This results in a negative externality on productive trade during the high productivity periods. The traders would then choose peace when $\omega_t = 0$ and conflict when $\omega_t = 1$, by assumption (A1). Transitions between automaton states in this regime are depicted in Figure 1. Society begins in a *Peace and no self-regulation* state. In any period $t > 0$, if $\omega_t = 0$ then society is in a *Peace and no self-regulation* state; but if $\omega_t = 1$ then society is in a *Conflict* state in which the pirates choose not to self-regulate. This describes the NCR. In the appendix, we show that under assumption (A2) the NCR describes a path automaton that is supported by a PPE for all values of δ.

SCR Now we describe two versions of the SCR, both of which are represented in Figure 2. In both versions, the following describes which of the three categories of states society is in for any period t. (Note that these are only rules governing on-path play.)

1. Consider the following situations: (i) $t = 0$ and $s_t = 1$, (ii) $R_{t-1} = R$, $\omega_t = 0$, $s_t = 1$ and society was in a *Peace and self-regulation* state in period $t - 1$, and (iii) $\omega_t = 0$, $s_t = 1$

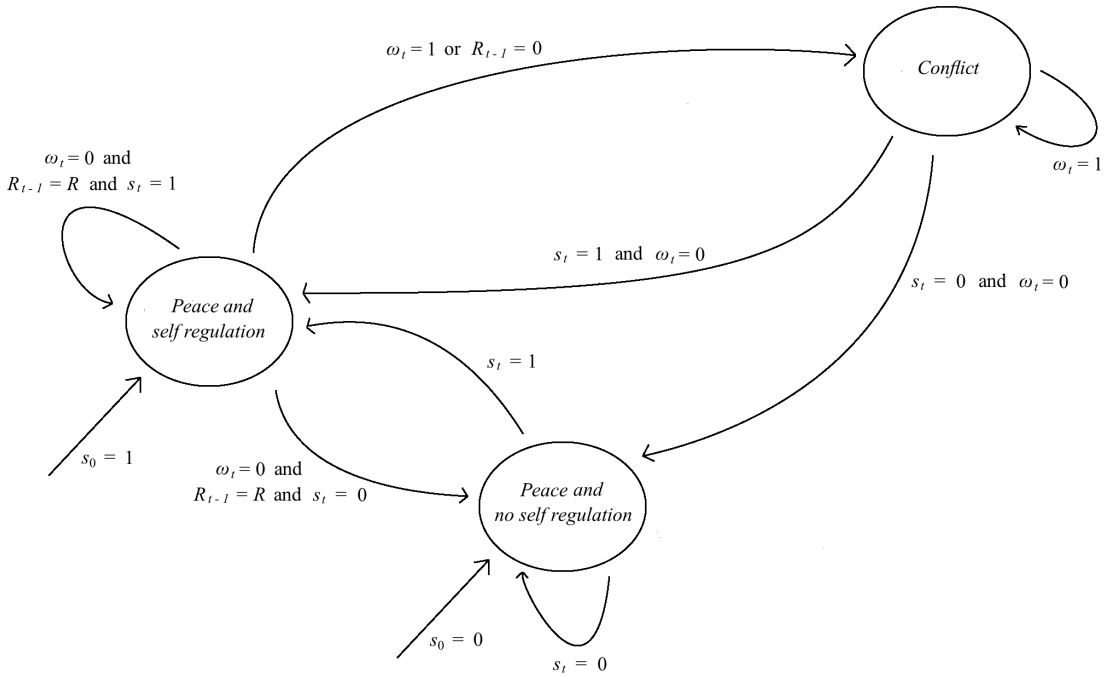

Figure 2: A Some Cooperation Regime (Somaliland)

and society was in a *Conflict* state in period $t-1$. In all of these situations, the pirates choose to self regulate and the traders make peace, sharing a fraction $\phi_t = \bar{\phi}$ of their income. Thus, society is in a *Peace and self-regulation* state in period t.

2. Consider the following situations: (i) $t = 0$ and $s_t = 0$, (ii) $R_{t-1} = R$, $\omega_t = 0$, $s_t = 0$ and society was in a *Peace and self-regulation* state in period $t-1$, and (iii) $\omega_t = 0$, $s_t = 0$ and society was in a *Conflict* state in period $t-1$. In all of these situations, the pirates choose to not self regulate and the traders make peace with the pirates. (They share any fraction of their income since they are guaranteed to have $R_t = 0$.) Thus, society is in a *Peace and no self-regulation* state in period t.

3. Consider the following situations: (i) $R_{t-1} = 0$ or $\omega_t = 1$ and society was in the *Peace and self-regulation* state in period $t-1$, and (ii) $\omega_t = 1$ and society was in a *Conflict* state in period $t-1$. In both situations, society is in a *Conflict* state in period t.

Thus in both versions of the SCR, there is maximal revenue sharing at the level $\bar{\phi}$ whenever society is in *Peace and self-regulation*. The two versions of the SCR differ only in whether the *Conflict* states that are reached involve the pirates self-regulating their pirate activities or not. In one version of the SCR, which we will call SCR[SR], the pirates self-regulate on the path of

play whenever the traders choose conflict. In the other version, which we call SCR[nSR], the pirates choose to not self-regulate on the path of play whenever the traders choose conflict.

3.6 Supporting the Regimes in Equilibrium

In an equilibrium, neither the pirates nor the livestock traders have a profitable one-time deviation from any of the automaton states that occur on the path of play. Deviations by the the livestock traders are perfectly observable, so their incentive to not deviate from the SCR can be provided by a switch to the NCR provided that the NCR gives a lower payoff to them than the SCR. To focus our attention on the monitoring problems that complicate the incentives of the pirates to not deviate, we make an assumption that guarantees that the livestock traders' payoff from either SCR exceed their payoff from the NCR for all values of δ high enough. This is our third assumption:

(A3) $\theta\left[(1-\bar{\phi})(1-\underline{\gamma})R-\left(1+\frac{1}{1-\underline{\mu}}\right)(1-\overline{\gamma})R\right]\geq[1+\underline{\gamma}(1-\underline{\mu})\theta]g+k/\Lambda$

Since the right side of (A3) is positive, this implies that the left side is positive. Therefore, the ex ante expected income to livestock traders when they share the maximum amount under *Peace and self-regulation* (i.e., the quantity $\theta(1-\bar{\phi})(1-\underline{\gamma})R$) exceeds the ex ante expected income from *Conflict* in the NCR (i.e., the quantity $\theta(1-\overline{\gamma})R$). When this is the case, assumption (A3) is more likely to hold when R is high in comparison to g and k/Λ. That is, the assumption implies that revenue from the livestock trade is important to the traders in comparison to their other payoff considerations.

The following proposition the summarizes our main result.[28]

Proposition 1. *1. There is a PPE that supports the NCR for all values of the discount factor δ.*

2. There exist three continuous real valued functions f_C, f_{nSR} and f_{SR} over the parameters of the model with the following properties: (i) there is a PPE that supports the SCR[nSR] for all high values of δ if and only if $f_{nSR}>0$ and $f_C>0$, (ii) there is a PPE that supports the SCR[SR] for all high values of δ if and only if $f_{SR}>0$ and $f_C<0$, and (iii) f_{nSR} and f_{SR} are both increasing in Λ and $\bar{\phi}$ and decreasing in d.

Proof. See Appendix A. □

We now interpret Proposition 1 and briefly remark on its implications.

Parts (i) and (ii) imply that either the SCR[nSR] or the SCR[SR] can be supported in equilibrium for high values of the discount factor, but not simultaneously both. In the proposition, $f_C>0$ represents the condition that says that the pirates have no profitable one-time

[28]The proposition refers to the parameters of the model, which are θ, $\overline{\mu}$, $\underline{\mu}$, $\overline{\gamma}$, $\underline{\gamma}$, Λ, $\bar{\phi}$, g, l, d, k and R.

deviations from any of the *Conflict* states of the SCR[nSR] that arise on the path of play. If $f_C < 0$, they have no profitable one-time deviations from any of the *Conflict* states that arise on the path of the SCR[SR].

Similarly, $f_{nSR} > 0$ represents the condition that says that the pirates have no profitable one-time deviations from the *Peace and self-regulation* state that arises on the path of play of the SCR[nSR] and $f_{SR} > 0$ is the condition that says that the pirates have no profitable one-time deviations from the *Peace and self-regulation* state that arises on the path of play of the SCR[SR]. Since part (iii) says that f_{nSR} and f_{SR} are both increasing in Λ and $\bar{\phi}$, it is easier to provide incentives to the pirates to not deviate from the *Peace and Self Regulation* state on the path of play of either SCR[nSR] or SCR[SR] when the traders significantly outnumber the pirates, and when they are able to share higher fractions $\bar{\phi}$ of their income from trade. Since these functions are also decreasing in d, as piracy becomes more lucrative, the pirates have greater incentive to deviate from self-regulating in both the SCR[nSR] and SCR[SR].

3.7 Putting the Model into Context

Our explanation for the different development trajectories of Somaliland and Puntland is that the two regions of Somaliland and Puntland differ in terms of the fundamental parameters of the model, notably $\bar{\phi}$ and Λ. The ratio of economic interests favors the livestock trade more in Somaliland, thus Λ is higher in Somaliland than in Puntland. Similarly, as we argued previously, there is a greater degree of revenue sharing among clans in Somaliland than in Puntland, making it likely that $\bar{\phi}$ is higher in Somaliland than it is in Puntland. This suggests, in light of the comparative statics of the previous section, that it is harder to provide the pirates of Puntland with the incentive to self-regulate their piracy than it is to provide the pirates of Somaliland with these incentives. Consequently, our theory is that the SCR better describes the relationship between traders and pirates in Somaliland while the NCR better describes the relationship between these two groups in Puntland. Furthermore, it may not be possible to replicate the cooperative agreement that is in place in Somaliland in Puntland since the differences in Λ and $\bar{\phi}$ across the regions suggest that the Somaliland agreement may not be *self-enforcing* in Puntland.

We now compare the two regimes in terms of their testable predictions for Somaliland and Puntland. We focus on explaining the variation in piracy and conflict.

Piracy Piracy takes place in an unregulated way under the NCR and the pirates are able to make successful attacks with probability $\overline{\mu}$ in each period. We take this to represent the frequency of piracy under the NCR. Under either SCR, on the other hand, piracy is self-regulated in the *Peace and self-regulation* state, so on average pirates make successful attacks with probability smaller than $\overline{\mu}$ in each period. Thus, the frequency of attacks is strictly lower under either of the two SCRs than under the NCR. This comports with the stylized fact

reported in Section 2.2 that there is more piracy off the coast of Bosasso in Puntland than there is off the coast of Berbera in Somaliland.

In addition, under the SCR pirating attacks are more frequent when livestock exports are low and less frequent when livestock exports are high, whereas under the NCR there is no relationship between livestock exports and the timing of pirating attacks. The reason is that the SCR represents a social agreement that is designed to mitigate the externality caused by pirating attacks on the livestock trade. When trade is low, there is almost no externality so there is no reason for the livestock traders to want the pirates to self-regulate, and for the pirates to do so. Given this, we expect to see a negative relationship between livestock exports and piracy off the coast of Berbera in Somaliland. By contrast, the relationship between livestock exports and pirate attacks off the coast of Bosasso in Puntland should be much weaker, because the distribution of interests in Puntland is such that groups are unable to reach an agreement whereby piracy will always be regulated in periods when livestock revenues are high.

Conflict What fraction of time do the two societies spend in the *Conflict* automaton states in the long run? This quantity can also be derived by finding the stationary distribution of the Markov process governing state transitions when players implement the paths associated with the NCR and either of the SCRs. The quantity is given by $\overline{\mu}$ under the NCR, by $\theta\kappa/(1-\overline{\mu}+\theta\kappa)$ under the SCR[nSR], and by $\theta\kappa/(1-\underline{\mu}+\theta\kappa)$ under the SCR[SR], where $\kappa := \underline{\mu} + \underline{\gamma}(1-\underline{\mu})$. Therefore, if $\underline{\gamma}$ is small enough, society spends less time in conflict under either of the SCRs than it does under the NCR. The assumption $\underline{\gamma}$ is small (i.e. society is relatively unlikely to enter conflict as a result of a downward income shock for the livestock traders) is natural, and comports with the evidence that we present below.[29]

As well as differing with regards to the amount of conflict that occurs, the NCR and SCR also differ in terms of when conflict starts. Under the NCR conflict takes place after pirating attacks since the pirates bring back income that creates a windfall of resources to compete over, and/or because of the social incentives to sanction piracy. Under both SCRs, there is also a relationship between conflict and pirating attacks but because attacks are less frequent, the relationship is subject to more noise. If pirating attacks occur only when piracy does not hurt the livestock trade, for example, there should be only a weak relationship between pirating attacks and conflict. Conflict does take place, however, after a sharp decline in livestock revenue since the livestock traders use conflict as a means to provide incentives to not launch too many pirate attacks. As a result, we expect that in both Puntland and Somaliland, conflict increases after pirating attacks, but the relationship is clearer in Puntland. We also expect that in Somaliland, conflict takes place after a sharp decline in livestock revenue, while in Puntland there is no relationship between livestock revenue and conflict.

[29]See, for example, Figure 3, which shows less overall conflict in Somaliland than in Puntland.

4 Empirical Patterns

In this section, we show that our model helps make sense of three empirical patterns that we see in the data from Somalia. The first is that piracy tends to be lower off the coast of Somaliland when livestock export levels are higher, but there appears to be no relationship between piracy and livestock exports off the coast of Puntland. The second is that in each region, conflict appears to rise after increases in pirate attacks off its coast but this relationship is measured with much greater noise in Somaliland than in Puntland. The third is that drops in the export price of Somali livestock trigger conflict in Somaliland but not in Puntland. We organize this section according to these three patterns.

4.1 Piracy and the Livestock Trade

To examine the relationship between piracy and the livestock trade, we estimate negative binomial regression models in which the dependent variable is a count of pirate attacks and the the main independent variable is the (logged) number of heads of livestock exported monthly from each port. Livestock export data are the same data depicted in Figure 1 and piracy data are the data depicted in Figure 2 (see the notes below these tables for more details on these data and their sources).

Because pirate attacks closer to ports are likely to have a greater impact on shipping and insurance costs, we use a spatially-smoothed version of the piracy variable, down-weighting those attacks that occur further away from the ports. We estimate separate models for pirate attacks off the two ports, Berbera and Bosasso. In addition, given the importance of the Saudi ban on Somali livestock that we noted in Section 2, and which is depicted clearly in Figure 1, we also examine the relationship prior to November 2009 separately from the relationship after this date when the ban was lifted. This takes into account the possibility of a statistical regime change taking place as a result of the removal of the ban.

In all models, we include a lag of the dependent variable, as well as year fixed effects. In an effort to control for seasonal effects, we also include a dummy variable for monsoon months to capture whether the month falls in one of Somalia's two monsoon periods.[30] Finally, we include monthly data on the average daily unskilled wage rate for each region, taken from the Food Security and Nutrition Analysis Unit - Somalia (the same source as our livestock data in Figure 1), to account for the possibility that the relationship between piracy and the livestock trade is driven by changes in local labor market opportunities (Jablonski and Oliver, 2012).

The results, which are consistent with our theory, are presented in Table 1. The table shows that in Somaliland, the coefficient for livestock exports is negative whether we look

[30] There are two monsoon seasons in the Gulf of Aden. The summer monsoon occurs from June through August, and the winter monsoon occurs during December through February. Using two separate variables for these two monsoon seasons makes no difference to any of the results in this paper.

Table 1: Negative Binomial Estimates of Pirate Attacks

DV = Pirate Attacks	*Somaliland* (*Berbera*)			*Puntland* (*Bosaso*)		
	All	During Ban	After Ban	All	During Ban	After Ban
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged Pirate Attacks	0.0536	-0.0581	0.0707	-0.0121	0.00630	-0.229
	(0.0386)	(0.0789)	(0.0446)	(0.0378)	(0.0391)	(0.156)
Exports (log)	-0.241**	-0.273**	-0.580†	-0.0769	-0.0788	0.496
	(0.0762)	(0.0935)	(0.342)	(0.122)	(0.132)	(0.490)
Unskilled Wage Rate	-0.490	0.125	-0.296	-0.285	-0.419	-0.281
	(0.312)	(0.536)	(0.416)	(0.325)	(0.479)	(0.455)
Monsoon	0.200	0.00779	0.479	-0.222	-0.306	-0.159
	(0.224)	(0.295)	(0.329)	(0.204)	(0.231)	(0.453)
Constant	4.999**	3.248*	7.467*	2.202	3.300*	-3.274
	(1.384)	(1.557)	(3.103)	(1.438)	(1.447)	(4.637)
Observations	128	90	38	143	105	38
Pseudo R^2	0.143	0.135	0.108	0.141	0.183	0.038
Log-Likelihood	-175.1	-96.72	-74.20	-201.3	-141.9	-56.51
AIC	388.2	231.4	186.4	440.7	321.8	151.0

Note: Negative binomial estimates of pirate attacks. All models include year fixed effects. Robust standard errors in parentheses. † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

at the whole time period or look separately during and after the Saudi ban. However, the coefficient is more than twice the size in the period after the ban was lifted. The implied effect of a one standard deviation increase in livestock exports is therefore a reduction in the number of pirates attacks by 0.59 per month during the period in which the ban was in place, and by 1.27 per month after the ban was lifted. The estimated coefficient for the period after the ban is only significant at the 90% confidence level, though this is likely due to the small sample size for the post-ban estimates. By contrast, in Puntland the coefficient on livestock exports is not significant in any part of the time series.[31]

Examining the direct relationship between livestock exports and piracy attacks is difficult since many unmeasured factors may affect both export volume and piracy attacks. Monthly fluctuations in livestock exports suggest that there may be seasonal factors at play, which could affect both piracy and livestock exports. One such factor is current weather conditions, which might not be sufficiently controlled for by our monsoon dummy, and which may simultaneously decrease the ability of pirates to carry out attacks while decreasing the volume of livestock offered for export. For example, in periods of plentiful rainfall and ample grazing forage,

[31]The smaller sample size for the Somaliland estimates is due to missing data on the unskilled wage rate. The positive coefficient on exports in Puntland in the period after the ban likely reflects the fact that exports and pirate attacks both increased during this period.

Table 2: Instrumental Variables Estimates of Pirate Attacks

Second Stage IV Results	*Somaliland (Berbera)*			*Puntland (Bosaso)*		
DV = Pirate Attacks	All	During Ban	After Ban	All	During Ban	After Ban
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged Pirate Attacks	0.0370	-0.0922	0.0513	-0.0121	0.00566	-0.276†
	(0.0429)	(0.0827)	(0.0393)	(0.0378)	(0.0391)	(0.161)
First Stage Residuals	0.401	0.274	1.352**	0.0821	-0.0931	0.987
	(0.246)	(0.304)	(0.485)	(0.183)	(0.197)	(1.026)
Exports (log)	-0.568*	-0.492†	-1.061*	-0.128	-0.0156	0.105
	(0.230)	(0.288)	(0.445)	(0.170)	(0.199)	(0.550)
Monsoon	0.205	0.0802	0.158	-0.215	-0.325	-0.347
	(0.227)	(0.315)	(0.357)	(0.204)	(0.228)	(0.487)
Unskilled Wage Rate	-0.261	0.375	-0.656	-0.262	-0.462	-0.219
	(0.337)	(0.546)	(0.402)	(0.331)	(0.470)	(0.475)
Constant	7.380**	4.422	14.33**	2.592	2.822	0.382
	(2.216)	(2.783)	(4.493)	(1.735)	(1.956)	(5.068)
Observations	127	89	38	143	105	38
Pseudo R^2	0.147	0.137	0.130	0.141	0.184	0.045
Log-Likelihood	-173.7	-96.02	-72.36	-201.3	-141.8	-56.09
AIC	387.3	232.0	184.7	442.5	323.6	152.2
First Stage IV Results	*Somaliland (Berbera)*			*Puntland (Bosaso)*		
DV = Exports (log)	All	During Ban	After Ban	All	During Ban	After Ban
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged Exports (log)	0.786**	0.839**	-0.107	0.682**	0.698**	-0.165
	(0.0901)	(0.0888)	(0.100)	(0.131)	(0.133)	(0.173)
Hajj	0.521*	0.227	1.797**	0.751**	0.731*	0.959**
	(0.212)	(0.209)	(0.199)	(0.225)	(0.299)	(0.102)
Constant	1.639†	1.477†	11.05**	2.585†	2.829*	11.18**
	(0.872)	(0.855)	(1.016)	(1.445)	(1.267)	(1.676)
Observations	155	117	38	155	117	38
R^2	0.778	0.787	0.733	0.676	0.678	0.590
F Statistic	16.67	21.08	19.72	6.511	8.514	26.99

Note: Two stage IV results. Second stage results, reported in the upper panel, are negative binomial estimates of pirate attacks. These models include year fixed effects, and robust standard errors are reported in parentheses. OLS estimates of livestock exports. All models, both first and second stage, include year fixed effects and robust standard errors are reported in parentheses. † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

pastoralists face less pressure to sell their animals to purchase food (Umar and Baulch, 2010). At the same time, heavy rains make it harder to undertake pirate attacks. If both livestock exports and pirate attacks are higher in periods of limited rainfall, this unobserved factor may lead us to spuriously underestimate the negative relationship between exports and piracy.

To address the possibility of such confounding, we examine how exogenous variation in demand for livestock due to the annual Hajj affects exports and, in turn, piracy. Since the Hajj is scheduled by reference to the Islamic lunar calendar, which is shorter than the Gregorian calendar, its timing is plausibly exogenous to pirate attacks as well as longer term seasonal weather that may affect piracy. Of course, the exclusion restriction for this estimation strategy – that piracy incidents are affected by the Hajj via the livestock export route alone – may be violated in other ways. For instance, one might argue that, given Somali pirates are Muslim, they may reduce the organization of piracy activities during particularly salient religious periods. However, this "pious pirate" argument does not appear to find support elsewhere in our data; in particular, pirate attacks are no less likely on Fridays.[32]

Table 2 shows the results from this instrumental variables estimation strategy. All models include lagged exports and year dummies to control for changes in export volumes across time. The first notable result is the positive coefficient of the Hajj indicator on export volumes across all first stage models in the lower panel. As expected, the Saudi livestock ban attenuated the relationship between the instrument and exports during the ban, which can be seen by comparing the coefficient estimates during and after the ban for each port. This attenuation is particularly acute for Somaliland, demonstrating the importance of the Saudi livestock market for Somaliland's Berbera port.

We report the second stage estimates in the upper panel of Table 2. Given that we use a negative binomial model for the pirate attack count data, we use the second-stage residual inclusion method for non-linear models proposed by Mullahy (2007), which provides a way to control for unmeasured confounders in the second stage. Our interest is in the coefficient of the log of exports (third row). The upper panel shows how the estimates for each region follow our expectation. There is a significant negative relationship between exports and pirate attacks in Somaliland, consistent with the argument that pirates self-regulate their piracy therein. This relationship is especially strong after the Saudi ban ended and Somaliland's export market expanded. The larger size of the estimates in Table 2 as compared to Table 1 indicate that unobserved factors do lead us to spuriously underestimate the negative relationship between exports and piracy in the first Table. In Puntland, there is no evidence of such a relationship, consistent with the lack of coordination between Puntland's diverse economic interests.

[32]One might argue that the lack of any Friday effect may be not rule out the pious pirate argument, if the Hajj is a more important religious commitment than Friday prayers. However, even if this is the case, Muslims are only expected to undertake Hajj at least once during their lifetime, and only a small number of Somalis actually perform the Hajj each year (less than 7,500 did so in 2015, "Somali Hajj pilgrims reluctant to return home", *Saudi Gazette*, 10/15/2015). Therefore it seems unlikely that any significant proportion of Somali pirates are observing Hajj each year.

4.2 Piracy and conflict

We now estimate the relationship between piracy at sea and conflict on land separately for Somaliland and Puntland. To measure conflict in these regions, we use geo-referenced conflict data from the Armed Conflict Location and Event Data Project (ACLED) and generate monthly conflict counts in Somaliland and Puntland from these geo-references (Raleigh et al., 2010). These data are depicted in Figure 3, which plots the cumulative number of violence counts in Somaliland (dotted line) and Puntland (solid line) between 2000 and 2012. During this period, Puntland saw 45% more ACLED-reported conflict incidents overall, experiencing on average eight incidents per month compared to Somaliland's five. This is consistent with our model and qualitative accounts of the on-ground situation in these two regions.

To examine the relationship of interest we take a monthly count of conflict incidents between 2000 and 2012, estimated separately for Puntland and Somaliland, as our dependent variable and a lagged monthly count of pirate attacks within a 250 kilometer radius of the ports of Berbera for Somaliland and Bosaso for Puntland as our main explanatory variable.[33] Lagging this variable enables us to evaluate whether conflict occurs as a result of pirate attacks. As a control, each model also includes a lagged version of the conflict variable to deal with the fact that conflict instances may be correlated over time. We also include the monsoon dummy and year fixed effects.

Columns (1) and (4) of Table 3 present estimates of negative binomial regression models of the relationship between pirate attacks and conflict in Somaliland and Puntland respectively.[34] Column (4) shows that there is a significant and positive relationship between pirate attacks and conflict in Puntland. Column (1) shows that there is also a positive relationship between piracy and conflict in Somaliland, but it is not significant. Although the coefficient on pirate attacks in Somaliland is smaller than that in Puntland, we cannot reject the hypothesis that the two coefficients are equivalent. We should note that our measurement of the conflict variable includes incidents that are unrelated to piracy, causing variation in the data over the intensity as well as the nature and causes of conflict incidents. As such, these data are generally very noisy, and the estimates of our standard errors should be interpreted with this in mind. Nevertheless, these results are consistent with our theoretical model, which predicts a positive relationship between conflict and piracy in both regions, but greater noise in the relationship in Somaliland.

[33] Given our mechanism linking piracy and conflict, there is no reason to down-weight attacks that are further away from the ports, as we did in the models of the previous section linking piracy to livestock exports. In particular, pirate attacks that occur closer to ports should not be any more likely to generate plentiful booty, or to result in socially undesirable behavior on land, than pirate attacks elsewhere, especially given that the pirate bases tend to be located in remote areas rather than close to the major ports.

[34] The results presented in Table 3 are substantively similar to results from Poisson specifications, though the negative binomial offers a substantially better fit.

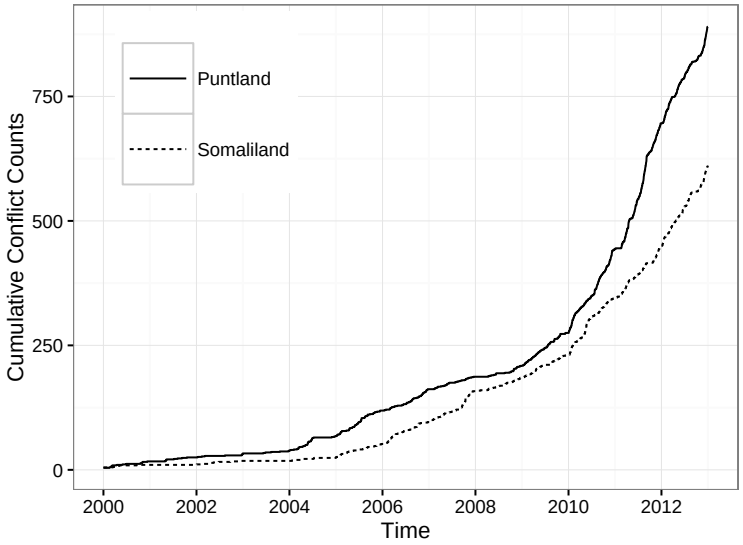

Figure 3. Cumulative counts of ACLED conflict events in Puntland (solid line) and Somaliland (dotted line), 2000-2012.

4.3 Export price shocks and conflict

Columns (2), (3), (5) and (6) in table 3 also speaks to the role of the livestock economy in the relationship between conflict and piracy. Our theoretical model predicts that a drop in livestock revenue serves as a signal of cheating from the cooperative agreement in place in Somaliland, and hence should increase conflict in that region but not in Puntland where no such agreement is in place. Columns (2) and (5) explore this possibility by adding local goat prices to the models estimated in columns (1) and (4). For ease of interpretation, and to capture the effect of substantial price changes, this variable is operationalized as a variable equal to 1 if the month-to-month percent change in price was greater than one standard deviation above the mean, -1 if month-to-month percent change in price was greater than one standard deviation below the mean, and zero otherwise. The data for this variable are again from the Food Security and Nutrition Analysis Unit - Somalia. Missing data require us to truncate the start of the time-series so the number of observations slightly declines after we introduce it to the model. The two columns confirm that a drop in revenue leads to a rise in conflict in Somaliland but not in Puntland.

While drops in local livestock prices may be most relevant signals of cheating in a setting of imperfect monitoring, herders may adjust their market behavior in the face of low prices. This raises the possibility of endogeneity in these estimates. In order to avoid this kind of endogeneity, we also use a source of exogenous variation in international lamb prices from

Table 3: Conflict, Piracy and Meat Prices

DV = Conflict Incidents	*Somaliland*			*Puntland*		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged Conflict Incidents	0.009	0.00804	0.00914	0.011	0.0111	0.0115
	(0.015)	(0.0140)	(0.0150)	(0.009)	(0.00916)	(0.00957)
Lagged Pirate Attacks	0.038	0.0540	0.0304	0.059**	0.0563*	0.0587*
	(0.039)	(0.0401)	(0.0429)	(0.026)	(0.0264)	(0.0263)
Local Sheep/Goat Price Change		-0.264*			0.0237	
		(0.125)			(0.106)	
Int'l Lamb Price Change			-0.358*			0.0142
			(0.143)			(0.105)
Monsoon	-0.142	-0.193	-0.0638	0.080	0.133	0.0769
	(0.123)	(0.133)	(0.121)	(0.109)	(0.113)	(0.110)
Constant	-0.658	-0.856	-0.691†	0.045	-0.733	0.0448
	(0.418)	(0.555)	(0.379)	(0.283)	(0.519)	(0.282)
Observations	154	125	154	154	136	154
Pseudo R^2	0.282	0.241	0.291	0.238	0.232	0.238
Log-Likelihood	-272.0	-252.8	-268.6	-326.6	-302.7	-326.6
AIC	580.0	539.5	575.1	689.3	641.3	691.2

Note: Negative binomial estimates of conflict instances. All models include year fixed effects. Robust standard errors in parentheses. † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

the International Monetary Fund.[35] Specifically, these data refer to the price in US cents per pound of frozen lamb carcasses at London's Smithfield market. Somali livestock herders are price-takers in the international market, so London sheep prices serve as an exogenous source of variation in local livestock revenues in Somalia. The idea is that sheep and goats are close substitutes in the world market, so their prices are positively correlated.[36] Thus, the London price data reflect fluctuations in international meat prices and at the same time are unlikely to be affected by the actions of pirates or herders in northern Somalia. We operationalize the international price data in the same way as the local price data: the variable takes a value of 1 if the month-to-month percent change in price was greater than one standard deviation above the mean, -1 if month-to-month percent change in price was greater than one standard deviation below the mean, and zero otherwise. Columns (3) and (6) confirm that major drops in London lamb prices increase conflict in Somaliland but not in Puntland.[37]

[35]The data can be accessed at `www.imf.org`.

[36]For example, we find that the London sheep prices from the IMF are positively correlated with the local Somali goat prices ($\rho = 0.10$ for Somaliland and $\rho = 0.08$ for Puntland).

[37]One estimation strategy that we do not present is that of instrumenting local prices with the international prices, given that they are positively correlated. We instead report the results of the reduced form approach because the local prices are very patchy (making the time series shorter) and because our goal is not to estimate the precise effect of changes in local prices but rather to provide evidence consistent with our mechanism.

Results for both the local and international prices are substantively very similar. As expected, substantial drops in livestock prices are negatively and significantly related to conflict in Somaliland. (And at the same time, it is worth noting that the estimates of the relationship between conflict and piracy in Puntland are unaffected by including price shocks.) These results provide support for the expectation that conflict in Somaliland occurs at least in part in response to imperfect signals about levels of piracy that traders in Somaliland receive from changes to meat prices. Thus, to provide the pirates with incentives to self-regulate during the high trade season, the traders in Somaliland respond to a drop in prices with conflict in order to provide a deterrent for piracy.

5 Alternative Explanations

In this section we discuss alternative theories for our findings and argue that our theory does a better job at explaining the set of empirical patterns.

One popular explanation for the relationship between downward price shocks and conflict, of the kind we see in columns (2) and (3) of Table 3, is the simple theory that says conflict rises when people become poorer as a result of the downward shock to prices. This could be because of labor market effects: when the income from productive activity goes down, criminal occupations involving theft, extortion and fraud become more attractive, leading to greater social conflict. A similar kind of labor market substitution story could also explain why piracy is greater during periods of low trade in Somaliland, as Tables 1 and 2 reveal.[38] Similarly, the fact that conflict is higher in both regions following increases in piracy could be explained by a "resource curse" argument: pirate attacks bring more conspicuous wealth to society, so fighting rises after pirate attacks because there is more to fight over.[39]

The problem with explanations that rely on labor market effects is that they fail to account for why we see the relationship between piracy and livestock exports, and price shocks and conflict, in Somaliland but not in Puntland. If the livestock trade constitutes a substantial share of the economy in both regions, then shocks to the industry should result in discernible labor market effects in both areas. More importantly, various sources stress the importance of clan and family ties in the livestock trade, suggesting that labor markets do not work in the way that the labor market substitution theory posits (e.g. Majid, 2010, Eid, 2014). In fact, these studies of the Somali livestock trade show that herders tend to follow their herds throughout the year, and that the actual shipping business is in the hands of a few specialized traders (Majid, 2010, Umar and Baulch, 2010). Put another way, one does not just quit piracy, buy a herd and start being a herder when short term livestock prices go up. There are considerable

[38] This is essentially the explanation put forward by the World Bank (report, p. 111) but with little evidence to support it.

[39] Such explanations are investigated by the extant literature on conflict. See, for example, Dal Bó and Dal Bó (2011), Dube and Vargas (2013) and Bazzi and Blattman (2014).

fixed costs that prevent this kind of labor market substitution. A more plausible possibility is that pirates are switching between piracy and working as laborers at the ports during the high trade season, but the lack of a significant relationship between piracy and the unskilled wage rate suggests that this is not the case.

Similarly, the resource curse argument fails to account for why the relationship between pirate attacks and conflict is noisier in Somaliland than in Puntland.[40] Moreover, while the resource curse argument may make sense of the relationship between conflict and piracy, its predictions run counter to the pattern we see in the relationship between price shocks and conflict. Downward price shocks lower the overall income of society, lowering the aggregate value of wealth that is contestable. Therefore, according to this explanation we should see a positive relationship between steep price changes and conflict in both regions, whereas the relationship that we do see is substantially negative in Somaliland and nonexistent in Puntland.

Our model, in contrast to these theories, provides a unified explanation for the data patterns. These data patterns and qualitative evidence that we discussed in the background section suggest that the structure of cooperation between clans is fundamentally different in Somaliland than it is in Puntland. Resource curse and labor market substitution arguments do not take into consideration these social differences, whereas our explanation does. According to our theory, the differences between the two regions are attributable to the fact that clans with diverse interests have discovered a way (albeit imperfect) to cooperate in Somaliland whereas they have not discovered an analogous self-enforcing mode of cooperation in Puntland.

6 Final Remarks

We conclude the paper with a few brief comments on the policy implications of our work, as well as our methodological contributions.

A key contribution of this paper is to characterize the conditions under which cooperative equilibria – like the one that appears to be in place in Somaliland – can be maintained. In particular, how we address the question of how restraint of predatory economic activities like piracy can be obtained via decentralized social contract in the absence of an exogenous "protector state" – conditions that we see in both Somaliland and Puntland. Our model suggests that piracy is best controlled by expansion on alternative economic activity like livestock trading, and improving the social and political institutions that promote income-sharing in society.

At the same time, our model suggests that simply trying to replicate the cooperative social agreement that appears to be in place in Somaliland in Puntland society may not work because of the structural differences between Puntland and Somaliland. Our model suggests that the Somaliland agreement may not be self-enforcing in Puntland due to these structural differences.

[40] Since there is less conflict overall in Somaliland, the resource curse explanation might posit that the relationship is, if anything, noisier in Puntland.

For those concerned with the policy implications of our work, the characterization of conditions under which the model of cooperation in Somaliland can be made self-enforcing encapsulates its main practical implication of our research.

From a methodological perspective, our paper demonstrates the value of dynamic games in describing real-world social equilibria. By specifying the theoretical relationship between piracy, livestock trading, and land-based conflict, we were able to generate a number of theoretical predictions that rationalize a set of empirical patterns. This is especially valuable in observational studies in contexts where data are limited. Our modeling approach could be useful in any context where actors switch between cooperative and non-cooperative states based on limited information. More broadly, the approach could be applied to any social phenomena where the actors' preferences change depending on some external state or problem characteristic. We leave these explorations to future studies.

Appendix: Proof of Proposition 1

A PPE supports a path automaton if, on the path of play, the PPE prescribes the same action choices that are prescribed by the path automaton.

We organize the proof as follows. We first characterize the payoffs for each group in each automaton state of the NCR, SCR[nSR] and SCR[SR]. Second, we prove part 1 of the proposition. Third, we define the functions f_C, f_{SR} and f_{nSR}. In so doing, we establish the comparative statics reported in part 2(iii). Finally, we prove parts 2(i) and 2(ii).

A. Payoffs

We characterize all payoffs as solutions to a recursive system of equations. In each case, the system of equations has a unique solution so all payoffs are unique.

NCR payoffs Let $V^p_{NCR}(PnSR)$ denote the value function for the pirates at the *Peace and no Self Regulation* state and $V^p_{NCR}(C)$ their value function at the *Conflict* state when $\omega = 1$. Under the NCR these value functions satisfy the following recursive system of equations

$$\begin{aligned} V^p_{NCR}(PnSR) &= (1-\delta)(\overline{\mu}d) + \delta\mathcal{V}^p_{NCR} \\ V^p_{NCR}(C) &= (1-\delta)(\overline{\mu}d - l - k\Lambda) + \delta\mathcal{V}^p_{NCR} \end{aligned} \tag{1}$$

where

$$V^p_{NCR} := (1-\overline{\mu})V^p_{NCR}(PnSR) + \overline{\mu}V^p_{NCR}(C)$$

is the continuation value from each state. Similarly, to compute the values of the livestock traders, let $V^\ell_{NCR}(PnSR|s)$ denote their value in the *Peace and no Self Regulation* state when $s_t = s$ and $V^\ell_{NCR}(C|s)$ their value under the *Conflict* state when $s_t = s$. These values solve the following system of equations

$$\begin{aligned} V^\ell_{NCR}(PnSR|0) &= (1-\delta)(0) + \delta\mathcal{V}^\ell_{NCR} \\ V^\ell_{NCR}(PnSR|1) &= (1-\delta)((1-\overline{\gamma})R) + \delta\mathcal{V}^\ell_{NCR} \\ V^\ell_{NCR}(C|0) &= (1-\delta)(g - k/\Lambda) + \delta\mathcal{V}^\ell_{NCR} \\ V^\ell_{NCR}(C|1) &= (1-\delta)\big[(1-\overline{\gamma})R + g - k/\Lambda\big] + \delta\mathcal{V}^\ell_{NCR} \end{aligned} \tag{2}$$

where

$$\mathcal{V}^\ell_{NCR} \equiv \theta\big[\overline{\mu}V^\ell_{NCR}(C|1) + (1-\overline{\mu})V^\ell_{NCR}(PnSR|1)\big] + (1-\theta)\big[\overline{\mu}V^\ell_{NCR}(C|0) + (1-\overline{\mu})V^\ell_{NCR}(PnSR|0)\big]$$

is the continuation value from each state.

SCR$[nSR]$ **payoffs** Now consider the SCR$[nSR]$ and let $V^p_{SCR[nSR]}(C|\ \omega)$ denote the value of the pirates in the *Conflict* state when the payoff relevant signal realization is $\omega \in \{0,1\}$, $V^p_{SCR[nSR]}(PnSR)$ their value in the *Peace and no Self Regulation* state, and $V^p_{SCR[nSR]}(PSR)$ their value in the *Peace and Self Regulation* state. These value functions satisfy the following recursive system of equations:

$$\begin{aligned}
V^p_{SCR}(C|\ 0) &= (1-\delta)(\overline{\mu}d - k\Lambda) + \delta\big[(1-\overline{\mu})\mathcal{V}^p_{SCR} + \overline{\mu}V^p_{SCR}(C|\ 1)\big] \\
V^p_{SCR}(C|\ 1) &= (1-\delta)(\overline{\mu}d - l - k\Lambda) + \delta\big[(1-\overline{\mu})\mathcal{V}^p_{SCR} + \overline{\mu}V^p_{SCR}(C|\ 1)\big] \\
V^p_{SCR}(PnSR) &= (1-\delta)(\overline{\mu}d) + \delta\mathcal{V}^p_{SCR} \\
V^p_{SCR}(PSR) &= (1-\delta)(\bar{\phi}(1-\underline{\gamma})R\Lambda + \underline{\mu}d) + \delta\big[(1-\underline{\mu})(1-\underline{\gamma})\mathcal{V}^p_{SCR} \\
&\qquad + (1-\underline{\mu})\underline{\gamma}V^p_{SCR}(C|\ 0) + \underline{\mu}V^p_{SCR}(C|\ 1)\big]
\end{aligned} \tag{3}$$

where

$$\mathcal{V}^p_{SCR} \equiv \theta V^p_{SCR}(PSR) + (1-\theta)V^p_{SCR}(PnSR)$$

is the expected value of continuing to a peaceful automaton state. Similarly, we let $V^\ell(C|\ s,\omega)$ denote the value of the traders in the *Conflict* state when $(s,\omega) \in \{0,1\}\times\{0,1\}$, and $V^\ell(PnSR)$ and $V^\ell(PSR)$ their values in the *Peace and no Self Regulation* and *Peace and Self Regulation* states respectively. These value functions satisfy the following recursive system of equations:

$$\begin{aligned}
V^\ell_{SCR}(C|\ 0,0) &= (1-\delta)(-k/\Lambda) + \delta\big[(1-\overline{\mu})\mathcal{V}^\ell_{SCR}(P) + \overline{\mu}\mathcal{V}^\ell_{SCR}(C|\ 1)\big] \\
V^\ell_{SCR}(C|\ 0,1) &= (1-\delta)(g - k/\Lambda) + \delta\big[(1-\overline{\mu})\mathcal{V}^\ell_{SCR}(P) + \overline{\mu}\mathcal{V}^\ell_{SCR}(C|\ 1)\big] \\
V^\ell_{SCR}(C|\ 1,1) &= (1-\delta)\big[(1-\overline{\gamma})R + g - k/\Lambda\big] + \delta\big[(1-\overline{\mu})\mathcal{V}^\ell_{SCR}(P) + \overline{\mu}\mathcal{V}^\ell_{SCR}(C|\ 1)\big] \\
V^\ell_{SCR}(C|\ 1,0) &= (1-\delta)\big[(1-\overline{\gamma})R - k/\Lambda\big] + \delta\big[(1-\overline{\mu})\mathcal{V}^\ell_{SCR}(P) + \overline{\mu}\mathcal{V}^\ell_{SCR}(C|\ 1)\big] \\
V^\ell_{SCR}(PnSR) &= (1-\delta)(0) + \delta\mathcal{V}^\ell_{SCR}(P) \\
V^\ell_{SCR}(PSR) &= (1-\delta)\big[(1-\bar{\phi})(1-\underline{\gamma})R\big] + \delta\big[(1-\underline{\mu})(1-\underline{\gamma})\mathcal{V}^\ell_{SCR}(P) \\
&\qquad + (1-\underline{\mu})\underline{\gamma}\mathcal{V}^\ell_{SCR}(C|\ 0) + \underline{\mu}\mathcal{V}^\ell_{SCR}(C|\ 1)\big]
\end{aligned} \tag{4}$$

where

$$\begin{aligned}
\mathcal{V}^\ell_{SCR}(P) &\equiv \theta V^\ell_{SCR}(PSR) + (1-\theta)V^\ell_{SCR}(PnSR) \\
\mathcal{V}^\ell_{SCR}(C|\ 1) &\equiv \theta V^\ell_{SCR}(C|\ 1,1) + (1-\theta)V^\ell_{SCR}(C|\ 0,1) \\
\mathcal{V}^\ell_{SCR}(C|\ 0) &\equiv \theta V^\ell_{SCR}(C|\ 1,0) + (1-\theta)V^\ell_{SCR}(C|\ 0,0)
\end{aligned}$$

are the expected values of continuing to a peaceful automaton state and a conflictual automaton state with $\omega = 1$ and $\omega = 0$, respectively.

SCR[SR] payoffs The systems of recursive value functions for the SCR[SR] are the same as above but with

$$\begin{aligned} V^p_{SCR}(C|\ 0) &= (1-\delta)(\underline{\mu}d - k\Lambda) + \delta\big[(1-\underline{\mu})\mathcal{V}^p_{SCR} + \underline{\mu}V^p_{SCR}(C|\ 1)\big] \\ V^p_{SCR}(C|\ 1) &= (1-\delta)(\underline{\mu}d - l - k\Lambda) + \delta\big[(1-\underline{\mu})\mathcal{V}^p_{SCR} + \underline{\mu}V^p_{SCR}(C|\ 1)\big] \end{aligned} \tag{5}$$

replacing the first two lines of (3), and

$$\begin{aligned} V^\ell_{SCR}(C|\ 0,0) &= (1-\delta)(-k/\Lambda) + \delta\big[(1-\underline{\mu})\mathcal{V}^\ell_{SCR}(P) + \underline{\mu}\mathcal{V}^\ell_{SCR}(C|\ 1)\big] \\ V^\ell_{SCR}(C|\ 0,1) &= (1-\delta)(g - k/\Lambda) + \delta\big[(1-\underline{\mu})\mathcal{V}^\ell_{SCR}(P) + \underline{\mu}\mathcal{V}^\ell_{SCR}(C|\ 1)\big] \\ V^\ell_{SCR}(C|\ 1,1) &= (1-\delta)\big[(1-\underline{\gamma})R + g - k/\Lambda\big] + \delta\big[(1-\underline{\mu})\mathcal{V}^\ell_{SCR}(P) + \underline{\mu}\mathcal{V}^\ell_{SCR}(C|\ 1)\big] \\ V^\ell_{SCR}(C|\ 1,0) &= (1-\delta)\big[(1-\underline{\gamma})R - k/\Lambda\big] + \delta\big[(1-\underline{\mu})\mathcal{V}^\ell_{SCR}(P) + \underline{\mu}\mathcal{V}^\ell_{SCR}(C|\ 1)\big] \end{aligned} \tag{6}$$

replacing the first four lines of (4).

B. Proof of part 1

Note that under the NCR we have $\phi_t = 0$ in every period t in which society is not in a *Conflict* state, as assumed in the main text. Consider a strategy profile in which the players play according to the NCR after every possible history of play. We claim that this strategy profile is a PPE. It is clear that the trading group has no profitable deviations: this follows from assumption (A1). It is also clear that if the players are sufficiently myopic (δ is equal to or close to 0) the strategy profile is a PPE. For higher values of δ, however, this need not be the case since the pirates may want to deviate from the *Peace and no Self Regulation* state or from the *Conflict* states to lower their next period probability of entering the *Conflict* states. These deviations would entail switching from no self-regulation to self-regulation.

To find conditions under which such one-time deviations are not profitable, we first compute the value functions of the pirates at each of the states. The solution to (1) is

$$V^p_{NCR}(PnSR) = \overline{\mu}d - \delta\overline{\mu}(l + k\Lambda) \tag{7}$$

$$V^p_{NCR}(C) = \overline{\mu}d - (1 - \delta(1-\overline{\mu}))(l + k\Lambda) \tag{8}$$

The pirates' payoff to a one-time deviation from the automaton state $S \in \{PnSR, C\}$ is

$$V^p_{dev}(S) = (1-\delta)v^p_{dev}(S) + \delta\big[(1-\underline{\mu})V^p(PnSR) + \underline{\mu}V^p(C)\big] \tag{9}$$

where $v^p_{dev}(PnSR) = \underline{\mu}d$ and $v^p_{dev}(C) = \underline{\mu}d - l - k\Lambda$. Such deviations are unprofitable if $V^p_{dev}(S) \leq V^p(S)$ for $S \in \{PnSR, C\}$, or in other words

$$v^p_{dev}(S) \leq \frac{1}{1-\delta}\Big[V^p(S) - \delta\big[(1-\underline{\mu})V^p(PnSR) + \underline{\mu}V^p(C)\big]\Big],\ S \in \{PnSR, C\} \tag{10}$$

which follows from substituting (9) and rearranging. Substituting the values of $V^p(PnSR)$ and $V^p(C)$ from (7) and (8) into (10) and then taking the derivative of the right hand side of the inequality with respect to δ yields $-(\overline{\mu}-\underline{\mu})(l+k\Lambda)$ for both states S. Thus the right hand side of (10) is decreasing in δ for both states. This implies that if the inequality holds when δ goes to 1 then the NCR is supported by the PPE for all values of δ.

Substituting $v^p_{dev}(S)$ and the values from (7) and (8) into (10), taking δ to 1 on the right hand side, and then rearranging the inequalities for both $S \in \{PnSR, C\}$ yields the same inequality for both states: $(\overline{\mu}-\underline{\mu})(d-l-k\Lambda) \geq 0$. This is satisfied by assumption (A2), which states that $d - l - k\Lambda > 0$. Therefore, deviating at either state is unprofitable.

C. Candidates for f_C, f_{SR} and f_{nSR}

Let

$$f_C = \big[1-(1-\theta)\overline{\mu} + \theta\underline{\gamma}(1-\underline{\mu})\big]d - \big[1+\theta\underline{\gamma}(1-\underline{\mu})\big]l - k\Lambda - \theta\bar{\phi}(1-\underline{\gamma})R\Lambda \tag{11}$$

Define

$$\mu[a] = \begin{cases} \overline{\mu} & \text{if } a = nSR \\ \underline{\mu} & \text{if } a = SR \end{cases}$$

and for $a \in \{nSR, SR\}$ define a vector of payoffs $\mathbf{v}[a]$ by

$$\mathbf{v}[a] = \begin{pmatrix} v^{PSR}[a] \\ v^{PnSR}[a] \\ v^{C|1}[a] \\ v^{C|0}[a] \\ v^{dev}[a] \end{pmatrix} = \begin{pmatrix} \underline{\mu}d + \bar{\phi}(1-\underline{\gamma})R\Lambda \\ \overline{\mu}d \\ \mu[a]d - l - k\Lambda \\ \mu[a]d - k\Lambda \\ \overline{\mu}d + \bar{\phi}(1-\overline{\gamma})R\Lambda \end{pmatrix}$$

Similarly, define a vector of weights $\mathbf{w}[a] = \big(w^{PSR}[a], w^{PnSR}[a], w^{C|1}[a], w^{C|0}[a], w^{dev}[a]\big)$ by

$$\begin{aligned}
w^{PSR}[a] &= 1 - \mu[a] + \theta[\overline{\mu} + \overline{\gamma}(1-\overline{\mu})] \\
w^{PnSR}[a] &= (1-\theta)\big[(\overline{\mu} + \overline{\gamma}(1-\overline{\mu})) - (\underline{\mu} + \underline{\gamma}(1-\underline{\mu}))\big] \\
w^{C|1}[a] &= -(\overline{\mu}-\underline{\mu}) - \mu[a]\big[\overline{\gamma}(1-\overline{\mu}) - \underline{\gamma}(1-\underline{\mu})\big] - \theta\big[\overline{\mu}\underline{\gamma}(1-\underline{\mu}) - \underline{\mu}\overline{\gamma}(1-\overline{\mu})\big] \\
w^{C|0}[a] &= -(1-\mu[a])\big[\overline{\gamma}(1-\overline{\mu}) - \underline{\gamma}(1-\underline{\mu})\big] + \theta\big[\overline{\mu}\underline{\gamma}(1-\underline{\mu}) - \underline{\mu}\overline{\gamma}(1-\overline{\mu})\big] \\
w^{dev}[a] &= -\big[1 - \mu[a] + \theta(\underline{\mu} + \underline{\gamma}(1-\underline{\mu}))\big]
\end{aligned}$$

We then define the functions f_{SR} and f_{nSR} by

$$f_{SR} = \mathbf{w}[SR] \cdot \mathbf{v}[SR] \qquad \text{and} \qquad f_{nSR} = \mathbf{w}[nSR] \cdot \mathbf{v}[nSR] \tag{12}$$

We show below that for both $a = nSR, SR$, the weighted average of flow payoffs represented in vector $\mathbf{v}[a]$ where weights are given by $\mathbf{w}[a]$ must be positive for the pirates to have no profitable deviation at the *Peace and Self Regulation* state. Note that the components of the vector of weights $\mathbf{w}[a]$ sum to 1 for each $a = nSR, SR$. Moreover, for both $a = nSR, SR$ the weight $w^{dev}[a]$ is negative meaning that as the flow payoff from one time deviation becomes more attractive, it is harder to support the path automaton in equilibrium.

Second, note that in the product $\mathbf{w}[a] \cdot \mathbf{v}[a]$, $a = nSR, SR$, the parameter $\bar{\phi}$ appears only in a product with $R\Lambda$ and the parameter Λ appears either as a product with $\bar{\phi}R$ or with k. The coefficient of $k\Lambda$ in $\mathbf{w}[a] \cdot \mathbf{v}[a]$ is $-(w^{C|1}[a] + w^{C|0}[a])$, which is positive for both $a = nSR, SR$. The coefficient of the term $\bar{\phi}R\Lambda$ in the product $\mathbf{w}[a] \cdot \mathbf{v}[a]$ is $(1 - \underline{\gamma})w^{PSR}[a] - (1 - \overline{\gamma})w^{dev}[a]$, which is also positive for both $a = nSR, SR$. Therefore $\mathbf{w}[a] \cdot \mathbf{v}[a]$ is increasing in Λ and $\bar{\phi}$ for both $a = nSR, SR$.

Finally, the coefficient of d in $\mathbf{w}[a] \cdot \mathbf{v}[a]$ is negative for both $a = nSR, SR$ so when d increases it is harder to provide incentives to the pirates to not deviate from the *Peace and Self Regulation* state on the path of play of either $SCR[nSR]$ or $SCR[SR]$.

These observations establish the comparative statics reported in part 2(iii) of the proposition. We now prove the remainder.

D. Proof of part 2(i)

Consider a PPE under which the players play according to the SCR$[nSR]$ and any deviation by livestock traders is met by switching to the NCR forever after. As is well-known, the payoff for each group $i = \ell, p$ in the limit as $\delta \to 1$ is the same across all automaton states and equals a weighted average of flow payoffs for each state with weights being the corresponding components of the stationary distribution of the Markov process governing automaton state transitions. Let $V^{\ell*}_{NCR}$ denote this limiting value for the traders respectively in the NCR and $V^{\ell*}_{SCR}$ the limiting values the traders in the SCR$[nSR]$. Since the NCR can be supported in equilibrium for all values of the discount factor, the livestock traders have no profitable one-time deviations for all high enough values of δ if and only if $V^{\ell*}_{SCR} - V^{\ell*}_{NCR} > 0$. To show that this holds, we compute that for a positive constant $\zeta := [1 - \overline{\mu} + \theta\underline{\mu} + \underline{\gamma}\theta(1 - \underline{\mu})]/(1 - \overline{\mu})$

$$\begin{aligned}\frac{1}{\zeta}(V^{\ell*}_{SCR} - V^{\ell*}_{NCR}) &= \theta[(1 - \bar{\phi})(1 - \underline{\gamma})R - (1 - \overline{\gamma})R] - (\overline{\mu} - \theta\underline{\mu})(g - k/\Lambda) - \underline{\gamma}\theta(1 - \underline{\mu})(k/\Lambda) \\ &\geq \theta\left[(1 - \bar{\phi})(1 - \underline{\gamma})R - \left(1 + \frac{1}{1 - \underline{\mu}}\right)(1 - \overline{\gamma})R\right] - [1 + \underline{\gamma}(1 - \underline{\mu})\theta]g - k/\Lambda > 0\end{aligned}$$

where the first inequality follows because $g-k/\Lambda > 0$ by (A1) and the second inequality follows from assumption (A3). Therefore, it is sufficient for us to examine only the no profitable one-time deviation condition for the pirates.

The solution to the recursive system of equations in (3) is unique and follows from straightforward algebra. To save space, we do not report it. In what follows we consider one-time deviations by the pirates from the two *Conflict* states, the *Peace and Self Regulation* state and the *Peace and no Self Regulation* state, characterizing conditions under which these one-time deviations are unprofitable.

1. We start by showing that when δ is high, the pirates have no incentive to deviate from the *Conflict* state when $\omega_t = \omega$. If the pirates deviate from this state, then with probability $\underline{\mu}$ we have $\omega_{t+1} = 1$ and society returns to a *Conflict* state with $\omega_{t+1} = 1$. With probability $1-\underline{\mu}$ society exits the *Conflict* states, entering the *Peace and Self Regulation* state with probability θ and the *Peace and no Self Regulation* with probability $1-\theta$. Thus, the deviation is unprofitable if and only if

$$v^p_{dev}(C|\ \omega) \leq \frac{1}{1-\delta}\Big[V^p_{SCR}(C|\ \omega) - \delta\big[(1-\underline{\mu})\mathcal{V}^p_{SCR} + \underline{\mu}V^p_{SCR}(C|\ 1)\big]\Big]$$

for $\omega \in \{0,1\}$, where $v^p_{dev}(C|\ 0) = \underline{\mu}d - k\Lambda$ and $v^p_{dev}(C|\ 1) = \underline{\mu}d - l - k\Lambda$. Substituting the values of $V^p_{SCR}(C|\ \omega)$ and $V^p_{SCR}(PSR)$ solved from the system above, and the value of $v^p_{dev}(C|\ \omega)$, rearranging and taking $\delta \to 1$ yields the same inequality for both values of $\omega \in \{0,1\}$. The inequality is

$$\frac{\overline{\mu}-\underline{\mu}}{1-\overline{\mu}+\theta\left(\underline{\mu}+\underline{\gamma}(1-\underline{\mu})\right)}\Big(\big[1-(1-\theta)\overline{\mu}+\theta\underline{\gamma}(1-\underline{\mu})\big]d-\big[1+\theta\underline{\gamma}(1-\underline{\mu})\big]l-k\Lambda-\theta\bar{\phi}(1-\underline{\gamma})R\Lambda\Big) \geq 0$$

Since the coefficient of the term in large square brackets is positive, the term in large square brackets must be positive to guarantee no profitable deviations for all high values of δ. This gives the inequality $f_C > 0$ where f_C is defined in (11). Since this inequality is satisfied by assumption, one-time deviations from either of the *Conflict* states are unprofitable.

2. Now consider a deviation for the pirates from the *Peace and Self Regulation* state. The deviation yields an instantaneous expected payoff of $\overline{\mu}d+\bar{\phi}(1-\overline{\gamma})R\Lambda$. After the deviation, the players enter the *Conflict* state with $\omega_t = 1$ with probability $\overline{\mu}$, the *Conflict* state with $\omega_t = 0$ with probability $\overline{\gamma}(1-\overline{\mu})$ and they exit the *Conflict* states entering the *Peace and Self Regulation* state with probability $(1-\overline{\mu})(1-\overline{\gamma})\theta$ and the *Peace and no Self Regulation* state with probability $(1-\overline{\mu})(1-\overline{\gamma})(1-\theta)$. Therefore, the deviation is

unprofitable if and only if

$$\overline{\mu}d + \bar{\phi}(1-\overline{\gamma})R\Lambda \leq \frac{1}{1-\delta}\Big[V^p_{SCR}(PSR) - \delta\big[(1-\overline{\gamma})(1-\overline{\mu})\mathcal{V}^p_{SCR} + \overline{\gamma}(1-\overline{\mu})V^p_{SCR}(C|\ 0) + \overline{\mu}V^p_{SCR}(C|\ 1)\big]\Big]$$

Substituting $V^p_{SCR}(PSR)$, $\mathcal{V}^p_{SCR}$, $V^p_{SCR}(C|\ 0)$, and $V^p_{SCR}(C|\ 1)$ solved from the system of recursive equations, taking the limit as $\delta \to 1$, and rearranging yields

$$\frac{1}{1-\overline{\mu}+\theta\left(\underline{\mu}+\underline{\gamma}(1-\underline{\mu})\right)}\left(\mathbf{w}[nSR]\cdot\mathbf{v}[nSR]\right) \geq 0$$

where $\mathbf{w}[nSR]$ and $\mathbf{v}[nSR]$ are the vectors defined in Section C. Since the coefficient of the product of these vectors is positive, the product of vectors must be positive to guarantee no profitable deviations for all high values of δ. This gives the inequality $f_{SR} > 0$ where f_{SR} is given by (12).

3. If the pirates do not deviate at the *Peace and no Self Regulation* state, then they receive $V^p_{SCR}(PnSR) = (1-\delta)(\overline{\mu}d) + \delta\mathcal{V}^p_{SCR}$ but if they do deviate then they receive only $(1-\delta)(\underline{\mu}d) + \delta\mathcal{V}^p_{SCR}$. Therefore, the deviation is not profitable.

E. Proof of part 2(ii)

This time let $V^{\ell *}_{SCR}$ denote the the limiting payoff of the livestock traders in the SCR[SR]. These traders have no profitable one time deviation for all high values of δ if and only if $V^{\ell *}_{SCR} - V^{\ell *}_{NCR} > 0$. We compute, as before, that for a positive constant $\xi := [1-\underline{\mu}+\theta\underline{\mu}+\underline{\gamma}\theta(1-\underline{\mu})]/(1-\underline{\mu})$

$$\begin{aligned}\frac{1}{\xi}(V^{\ell *}_{SCR} - V^{\ell *}_{NCR}) &= \theta\left[\left(\xi-\bar{\phi}\right)(1-\underline{\gamma})R - \xi(1-\overline{\gamma})R\right] - [1+\underline{\gamma}\theta(1-\underline{\mu})]g - k/\Lambda \\ &\geq \theta\left[(1-\bar{\phi})(1-\underline{\gamma})R - \left(1+\frac{1}{1-\underline{\mu}}\right)(1-\overline{\gamma})R\right] - [1+\underline{\gamma}(1-\underline{\mu})\theta]g - k/\Lambda > 0\end{aligned}$$

where the first inequality follows because $1+\frac{1}{1-\underline{\mu}} > \xi > 1$ and the second inequality follows from assumption (A3). Therefore, it is sufficient for us to examine only the no profitable one-time deviation condition for the pirates.

As before, the solution to the recursive system of equations defining the pirates payoffs in the SCR[SR] is unique, and again we do not report it to save space. We consider one-time deviations by the pirates from the two *Conflict* states, the *Peace and Self Regulation* state and the *Peace and no Self Regulation* state, characterizing conditions under which these one-time deviations are unprofitable.

1. If the pirates deviate from a *Conflict* state, then with probability $\overline{\mu}$ we have $\omega_{t+1} = 1$ and society returns to a *Conflict* state with $\omega_{t+1} = 1$. With probability $1 - \overline{\mu}$ society exits the *Conflict* states, entering a *Peace and Self Regulation* state with probability θ and a *Peace and no Self Regulation* with probability $1 - \theta$. Thus, the deviation is unprofitable if and only if

$$v^p_{dev}(C|\ \omega) \leq \frac{1}{1-\delta}\Big[V^p_{SCR}(C|\ \omega) - \delta\big[(1-\overline{\mu})\mathcal{V}^p_{SCR} + \overline{\mu}V^p(C|\ 1)\big]\Big]$$

for $\omega \in \{0, 1\}$, where $v^p_{dev}(C|\ 0) = \overline{\mu}d - k\Lambda$ and $v^p_{dev}(C|\ 1) = \overline{\mu}d - l - k\Lambda$. Substituting the values of $V^p_{SCR}(C|\ \omega)$ and $V^p_{SCR}(PSR)$ solved from the system above, and the value of $v^p_{dev}(C|\ \omega)$, rearranging and taking $\delta \to 1$ yields the same inequality for both values of $\omega \in \{0, 1\}$. The inequality is

$$\frac{\overline{\mu} - \underline{\mu}}{1 - \underline{\mu} + \theta\left(\underline{\mu} + \underline{\gamma}(1-\underline{\mu})\right)}\big(\big[1-(1-\theta)\overline{\mu}+\theta\underline{\gamma}(1-\underline{\mu})\big]d-\big[1+\theta\underline{\gamma}(1-\underline{\mu})\big]l-k\Lambda-\theta\bar{\phi}(1-\underline{\gamma})R\Lambda\big) \leq 0$$

Since the coefficient of the term in large square brackets is positive, the term in large square brackets must be negative to guarantee no profitable deviations for all high values of δ. This produces $f_C < 0$.

2. Now consider a deviation for the pirates from the *Peace and Self Regulation* state. The deviation yields an instantaneous expected payoff of $\overline{\mu}d+\bar{\phi}(1-\overline{\gamma})R\Lambda$. After the deviation, the players enter the *Conflict* state with $\omega_t = 1$ with probability $\overline{\mu}$, the *Conflict* state with $\omega_t = 0$ with probability $\overline{\gamma}(1 - \overline{\mu})$ and they exit the *Conflict* states entering a *Peace and Self Regulation* state with probability $(1-\overline{\mu})(1-\overline{\gamma})\theta$ and a *Peace and no Self Regulation* state with probability $(1 - \overline{\mu})(1 - \overline{\gamma})(1 - \theta)$. Therefore, the deviation is unprofitable if and only if

$$\begin{aligned}\overline{\mu}d + \bar{\phi}(1-\overline{\gamma})R\Lambda \leq \frac{1}{1-\delta}\Big[&V^p_{SCR}(PSR) - \delta\big[(1-\overline{\gamma})(1-\overline{\mu})\mathcal{V}^p_{SCR} \\ &+ \overline{\gamma}(1-\overline{\mu})V^p_{SCR}(C|\ 0) + \overline{\mu}V^p_{SCR}(C|\ 1)\big]\Big]\end{aligned}$$

Substituting $V^p_{SCR}(PSR)$, $\mathcal{V}^p_{SCR}$, $V^p_{SCR}(C|\ 0)$, and $V^p_{SCR}(C|\ 1)$ solved from the system of recursive equations above, taking the limit as $\delta \to 1$, and rearranging yields

$$\frac{1}{1 - \underline{\mu} + \theta\left(\underline{\mu} + \underline{\gamma}(1-\underline{\mu})\right)}\left(\mathbf{w}[SR] \cdot \mathbf{v}[SR]\right) \geq 0$$

where $\mathbf{w}[SR]$ and $\mathbf{v}[SR]$ are the vectors defined in the statement of the proposition. Since the coefficient of the product of these vectors is positive, the product of vectors must be

positive to guarantee no profitable deviations for all high values of δ. This produces the inequality $f_{SR} > 0$.

3. Finally, if the pirates do not deviate at a *Peace and no Self Regulation* state, then they receive $V^p_{SCR}(PnSR) = (1-\delta)(\overline{\mu}d) + \delta\mathcal{V}^p_{SCR}$ but if they do deviate then they receive only $(1-\delta)(\underline{\mu}d) + \delta\mathcal{V}^p_{SCR}$. Therefore, the deviation is not profitable.

□

Supplemental Table

Table 4: Summary statistics

	Somaliland				
	Mean	Std. Dev.	Min	Max	Obs.
Pirate attacks	1.35	2.08	0	11	157
Conflict incidents	3.94	5.29	0	29	155
Livestock exports	9.16	2.19	0	12.09	156
Local meat prices	0.02	0.48	-1	1	125
Int'l meat prices	0.02	0.55	-1	1	175
	Puntland				
	Mean	Std. Dev.	Min	Max	Obs.
Pirate attacks	1.32	2.15	0	14	157
Conflict incidents	5.75	7.93	0	44	155
Livestock exports	9.27	1.93	0	10.9	156
Local meat prices	0.09	0.45	-1	1	136
Int'l meat prices	0.02	0.55	-1	1	175

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