A Theory of the Oil-Conflict Curse: Greed, Grievances, and Separatist Civil Wars

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Abstract

Oil-rich regions fight separatist civil wars relatively frequently—the core empirical finding about resources and conflict. However, leading "greed" and "grievances" explanations posit contradictory premises and do not articulate what is unique about oil to explain bargaining breakdown. This paper examines key features of oil production and then studies a stochastic bargaining game between a government and regional challenger, which can protect its economic production by exiting the formal economy or by coercively seceding. Three contributions follow. (1) The paper elucidates core aspects of oil production that generate "redistributive grievances," but usually not greed rebellions. (2) It improves grievance arguments by theoretically linking capital-intense and immobile oil production to bargaining failure via undermining the challenger's economic exit option. This logic also explains strategic governments' preferences to risk fighting rather than to grant limited regional autonomy to oil-producing regions. (3) Parameterizing oil production enables studying how various economic activities affect separatist incentives.

Keywords: Civil war, greed, grievances, natural resources, oil, resource curse, secession

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Considerable scholarship has established that separatist civil wars—in which a rebel group fights to establish an autonomous region or fully independent state—occur more frequently in oil-rich than in oil-poor regions (Sorens, 2011; Morelli and Rohner, 2015; Hunziker and Cederman, 2017). Exemplifying patterns found in existing research, within a broad sample of ethnic minority groups between 1945 and 2013, groups with at least one giant oil field in their territory initiated a separatist civil war more than twice as frequently as oil-poor groups, 1.3% of years compared to 0.6%.[1] These separatist civil wars have ranged across geographical regions from Africa (Angola, Nigeria, Sudan) to the Middle East (Iran, Iraq) to South Asia (India, Pakistan) to Southeast Asia (Indonesia) to Eastern Europe (Russia).

There are two leading explanations for this pattern. First, governments often indiscriminately *redistribute* wealth away from oil-rich territories, which creates incentives for aggrieved oil-rich regions to secede and eliminate government exploitation (Sorens 2011, 574-5; Ross 2012, 151-2). This redistribution argument resembles broader economic "grievances" explanations for civil war (e.g., Boix, 2008; Gibilisco, 2017). Oil production also frequently causes other sources of grievances such as environmental damage. Second, oil production provides opportunities for rebels to *disrupt* production and earn revenues during peacetime, to finance the *build-up* of an insurgent organization, and to *loot* and otherwise finance an insurgency during an ongoing civil war (Collier and Hoeffler 2005, 44; Collier et al. 2009, 13; Lujala 2010). Disruption, build-up, and looting mechanisms belong to broader "greed" explanations for civil war. Greed and grievances explanations have long enjoyed prominence in the civil war literature, as originally introduced by Collier and Hoeffler (1998, 2004). Many have emphasized the importance of these arguments in the conflict resource curse literature, including Humphreys (2005) and, more recently, Smith's (2016) review: "the theorized mechanisms linking resource wealth to civil conflict track fairly well along a grievance-greed continuum."

However, whether evaluated jointly or individually, greed and grievances theories face important shortcomings for explaining the empirical oil-separatism relationship. Considered together, these theories rest upon contradictory premises. According to grievance arguments, oil production causes separatism because *governments* are highly effective at controlling oil revenues. By contrast, greed arguments posit that the problem is *societal* actors easily accessing oil wealth. These premises cannot both be correct.

[1]Figures calculated by author by merging ethnic group and civil war data from the Ethnic Power Relations dataset (Vogt et al., 2015) with giant oil field data (Horn, 2015).

Furthermore, neither paradigm carefully isolates unique features of oil relative to other types of economic production that explain bargaining breakdown and fighting.[2] For greed arguments, why does oil provide especially pronounced looting and financing opportunities? For grievance arguments, what about oil enables particularly large redistributive taxation, and why would a strategic government take actions that could cause violent loss of a valuable revenue source? Contradictory premises and underspecified mechanisms in existing research emphasize the need to combine greed and grievance theories into a unified theoretical framework to explain the empirical oil-separatist civil war relationship, as well as to distinguish oil from other natural resources to explain bargaining failure.

This paper incorporates these arguments into a general model of economic exit and secession, providing three main contributions. First, it adjudicates contradictory grievances and greed arguments. The model analysis and substantive discussion of foundational assumptions elucidate core features of oil production that create "redistributive grievances," but usually do not enable greed mechanisms such as disruption, insurgent build-up, or looting. Second, the paper provides new insights into grievances mechanisms by embedding core attributes of oil production into a model that allows the government to strategically tax the challenger's economic production, and endogenizes production by modeling an economic exit possibility for the challenger. By additionally including a choice to coercively secede, the model formally links oil to bargaining failure. It further extends the grievances logic to account for why strategic governments will often refuse to grant limited regional autonomy deals to oil-producing regions, even if this would prevent fighting.[3] Third, by parameterizing oil production, the model enables studying the effect of various economic activities on separatist incentives—as opposed to assuming that oil is a unique good that cannot be compared to other economic causes of civil war.

A government and regional challenger interact in a stochastic game in which the challenger exogenously fluctuates between having strong and weak capacity for rebellion. In each period, the government sets a tax rate on oil and other economic production from the challenger's formal economy. The challenger responds with two choices. First, it decides how much labor to supply to the formal economy, which corresponds to an

[2] Beginning with Fearon (1995), this has become a foundational question for theories of international warfare, but is less consistently applied to studying civil wars (although see Walter 2009).

[3] This relates to a crucial issue that Debs and Monteiro (2014) raise about explaining international wars: what prevents strategic actors from taking actions to avoid the commitment problem that triggers fighting?

economic exit option. Second, it chooses whether or not to fight a separatist civil war—which would prevent future government taxation if successful. The key assumptions about oil production in the model draw from the strongly grounded substantive premise that oil is particularly easy for governments to tax because its production is highly capital-intensive in a fixed and concentrated location. Conversely, rebel groups face great difficulties to use oil production to loot or finance an insurgency. Besides a few exceptional empirical cases to the contrary, rebels have almost never engaged in large-scale oil looting during a civil war, nor have they used oil revenues to finance start-up costs for an insurgency. Below, these facts about oil production are discussed extensively (see, for example, Table 1). These properties of oil production differentiate it from other types of natural resources such as diffusely located alluvial diamonds, and from non-resource production that can more easily be relocated in response to high tax rates.

The model setup and assumptions about oil production enable explaining a new mechanism to link redistributive grievances to violence, and comparing this mechanism to greed arguments. Residents of oil-rich regions are less able to constrain government taxation through their economic exit threat than are residents of oil-poor regions. When bargaining with an oil-rich region, the government reacts to the challenger's ineffective economic exit threat by exploiting a large percentage of the region's wealth in periods the challenger has weak capacity for rebellion, which creates grievances about economic redistribution. This reduces the challenger's lifetime expected utility from accepting a deal and therefore increases its incentives to fight when temporarily strong. The analysis then shows why these core properties of oil production contradict considerable existing wisdom from the civil war literature about greed arguments. Greed mechanisms either logically *diminish* separatist incentives, or theoretically raise equilibrium separatist civil war prospects only under poorly empirically supported assumptions. Therefore, although scholars have usefully highlighted empirical examples that illustrate myriad ways in which oil production can affect civil war, the greed assumptions do not provide a compelling foundation for building a more generally applicable theory of the oil-separatist relationship.

Although the baseline model helps to sort out and explain leading arguments from the literature, a crucial question about strategic bargaining remains unanswered. What prevents a government from committing to a regional autonomy deal—and hence lower permanent taxes—with an oil-rich region that would eliminate costly fighting? This relates to broad questions regarding how oil production affects institutions (Menaldo, 2016; Mahdavi, 2017). Moving beyond the somewhat stark institution-free environment analyzed initially in which the government can never commit to tax relief in periods the challenger does not pose a coercive threat, the analysis evaluates a strategy profile in which the government offers the same tax rate to the challenger in all periods. The ease of taxing oil incentivizes the government to renege from this regional autonomy agreement by causing medium-term gains from maximum taxation to outweigh long-term costs from triggering secession. Finally, the appendix analyzes additional arguments from the literature about the large prize of capturing oil revenues, and extends the model to evaluate effects of oil discoveries and volatile oil prices.[4]

Explaining the empirical oil-separatism pattern is crucial because widespread proclamations of a "conflict resource curse" hinge in large part on this specific relationship. Other natural resources do not robustly associate with civil war onset. Correlations for alluvial diamonds, for example, are statistically fragile (Ross 2006; 2015, 250). Therefore, oil is important to examine not only because it is overwhelmingly the most valuable natural resource among internationally traded commodities—ten to one hundred times the next-most traded commodity (Colgan 2013, 12)—but also because it appears to be distinct in its systematic conflict-inducing properties. Furthermore, even when specifically examining oil, there is no systematic relationship between oil production and aggregate civil war onset at the country level (Cotet and Tsui 2013, Bazzi and Blattman 2014; Ross 2015, 251), in particular because oil does not appear to "curse" prospects for the other major type of civil war, center-seeking civil wars in which rebels fight to capture the capital (Paine, 2016).[5]

[4]This extension relates to recent formal research (Bell and Wolford, 2015), although proposes a distinct mechanism based on the opportunity cost of fighting.

[5]A related qualification to address is that dividing arguments into "greed" and "grievances" does not cover *every* proposed oil-conflict mechanism. However, this widely used typology contains many important mechanisms in this continually expanding literature. In other words, regardless of whether one sorts the mechanisms described above into different greed and grievances camps, these are the main accepted mechanisms that connect oil production to separatist civil war onset. One exception relates to rebel opportunities and the feasibility of rebellions, as studied in Fearon and Laitin (2003) and later in Collier, Hoeffler and Rohner (2009), and the specific argument advanced by many that oil weakens state capacity. Other research, however, has shown that the oil-state weakness mechanism is poorly supported empirically and theoretically (Kennedy and Tiede, 2013; Menaldo, 2016; Paine, 2016).

In addition to contributing to conflict resource research, the analysis also advances the applied formal theoretic literature by demonstrating a novel general mechanism for explaining war: economic activities that undermine a producer's economic exit option exacerbate the commitment problem. As in many models, the government is assumed to be unable to commit to offer the challenger a more favorable bargain in the present period than is dictated by the challenger's contemporaneous fighting ability. This commitment problem only provides incentives for the challenger to fight, however, if its consumption fluctuates drastically depending on its contemporaneous fighting ability. Economic activities such as oil with low output elasticity and low labor substitution undermine the challenger's economic exit option, which exacerbates the commitment problem by causing its consumption to vary dramatically between strong and weak periods. By contrast, the government's inability to *commit* to a favorable weak-period bargain does not incentivize the challenger to fight in a strong period if economic properties of its production provide *incentives* for the government to offer a low tax rate even in weak periods. This demonstrates how endogenizing economic production in a bargaining model delivers important insights about prospects for bargaining breakdown.

Therefore, the model builds off and contributes to existing bargaining models of civil war (Fearon, 2004) and regime transitions (Acemoglu and Robinson, 2006) that use a general commitment problem mechanism (Powell, 2004; Krainin, 2017). The key difference from Fearon (2004) is to endogenize economic production. The model also provides distinct findings even from other formal models that have applied a conflict bargaining framework to study oil politics, such as Dunning (2005, 2008), by integrating oil production into a general model of endogenous economic exit and secession. Fearon (2004) mentions how lootable natural resources that facilitate contraband—the opposite of the present argument for oil—lengthen civil wars, but does not discuss oil production. Acemoglu and Robinson's (2000) model of franchise expansion also allows an out-of-power faction to allocate labor between a taxable and non-taxable sector, but they introduce this assumption only to generate interior tax rates (as they discuss, pp. 1170) and do not take comparative statics on the elasticity of labor supply or on other aspects of production. The findings also contribute to a broader economics of conflict literature that examines natural resources (Olsson and Fors, 2004; Kenkel, 2017) and to models of economic inequality and political order (Boix, 2008; Tyson, 2017).

Finally, the conclusion discusses how the present model that examines greed and grievances explanations for civil war in a unified framework offers broader theoretical contributions to and testable empirical implications for the resource curse and the broader civil war literature.

1 Who Controls Oil Revenues and How?

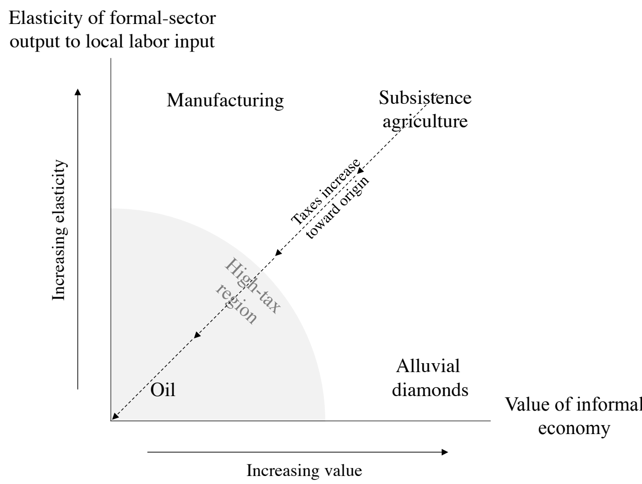
Redistributive grievance theories and greed-based disruption/start-up/looting theories impose divergent premises about whether governments or societal actors tend to control the bulk of oil wealth. Before studying a government and challenger's strategic interaction to show how regional oil production affects the likelihood of bargaining breakdown in the game, it is necessary to incorporate substantive considerations about who controls oil revenues and how. Key attributes of oil production—compared to other natural resources and to other economic activities—undermine the effectiveness of the challenger's threat to exit the formal economy, which the model analysis will link to a higher equilibrium tax rate. By contrast, these same features of oil production create difficulties for rebels to accrue oil revenues. Empirically, large-scale rebel looting of oil has occurred very rarely. Overall, strong substantive considerations support that governments rather than rebel groups control the preponderance of oil revenues, which features centrally in the comparative statics analysis below.

1.1 How Oil Differs from Other Resources: Government Control Over Oil Revenues

Oil production—compared to other natural resources and broader economic activities—weakens a regional challenger's ability to constrain government taxation by threatening to exit the formal economy. Figure 1 plots different economic activities by how they affect the challenger's economic exit threat in two dimensions: the elasticity of formal-sector output to local labor input, and the value of producing in the informal economy.

High capital intensity and the ease of importing foreign labor makes oil output largely inelastic to local labor input. This corresponds to a low value on the vertical axis of Figure 1, which the labor supply stage of the model setup (see page 15) formalizes using a parameter that expresses the elasticity of output to local labor supply. Producing oil requires large capital investments, which often are foreign-funded. Ross (2012, 46) shows the capital-to-labor ratio is considerably higher in the oil and gas industry than in any other major industry for U.S. businesses operating overseas. Menaldo (2016, 131-175) describes the intimate relationship between oil production in developing countries and foreign capital, technology, and technical production

Figure 1: Taxability of Different Economic Activities



Notes: The two dimensions in Figure 1 correspond to two key parameters that will be introduced in the model analysis: the elasticity of formal-sector output to local labor input (η), and the value of the informal economy (ω). An economic activity's value on each dimension depends on various substantive factors discussed in the text. Factors such as high capital intensity of formal-sector production and the ability to replace local with foreign workers decreases the value of the vertical axis. Higher capital-intensity of formal-sector production, concentrated production areas, and immobility each decrease the value of the horizontal axis.

expertise.[6] Even labor that is needed for production can easily be imported because lower-level oil company employees require scant knowledge of local circumstances. For example, Arabian oil companies rely overwhelmingly on migrant workers (Johnston, 2015). Angola's oil industry exemplifies these characteristics. "International oil companies, and oil service companies, kept their staff and installations in Angola to a minimum, preferring wherever possible to run their Angolan operations from overseas" (Le Billon 2007, 108). Although oil production accounts for the majority of economic output and government revenues in Angola, the industry "employs less than 0.2 per cent of the active population, and is barely physically present in the country" (109). Ross (2012, 44-9) provides additional examples.

Oil production also undermines opportunities for societal actors to hide production from the government

[6]Menaldo (2016) also discusses how information asymmetries between international oil companies and governments in developing countries limit a government's ability to keep oil profits for itself. However, this concerns the distribution of rents between domestic governments and international actors, and does not contradict the present assertion that governments easily redistribute oil rents away from producing regions. The model analysis addresses why incorporating this consideration about international oil companies does not qualitatively change the core logic.

and to reap gains from informal activities outside the government's reach because oil is capital intensive, concentrated in production, and immobile. This corresponds to a low value on the horizontal axis of Figure 1, which the labor supply stage of the model setup (see page 16) formalizes using a parameter that expresses the opportunity cost of formal-sector production induced by forgone informal-sector production. Oil is a point-source resource because it is "exploited in small areas by a small number of capital-intensive operators" (Le Billon, 2005, 34). Because governments can relatively easily enforce military control over oil fields—relative to output produced in a non-concentrated area—extracting this point-source resource requires minimal bureaucratic capacity (Dunning, 2008, 40).[7] Furthermore, even a rebel group that gains military control over oil fields faces great difficulties to extracting oil and constructing a national distribution system to reap profits (Fearon, 2005, 500)—which relates to high capital costs, required technical know-how, and foreign assistance needs. Finally, because oil is an immobile asset, the challenger cannot threaten to move its oil reserves outside the reach of the government if taxed at unfavorable rates (Boix, 2003, 42-43).

These attributes distinguish oil from many other types of economic production, which Figure 1 depicts.[8] Although alluvial diamond mining resembles oil because neither require local labor for extraction and both have a fixed location, alluvial diamonds necessitate higher bureaucratic capacity to monitor and entail lower capital costs, i.e., higher value on the horizontal axis of Figure 1. Alluvial diamonds are considered a diffuse resource because they are "exploited over wide areas through a large number of small-scale operators" (Le Billon, 2005, 32). Therefore, it is easier for societal actors to steal these "blood diamonds" and to prevent the government from accruing revenues. Operating a modern manufacturing plant resembles oil production because, after sinking the costs of building the factory, it is both concentrated in location and immobile. However, most industry is not nearly as capital-intensive as is oil production and therefore requires more labor—often, local and somewhat skilled labor, i.e., higher value on the vertical axis. And some types

[7]However, this trend may change in the future as unconventional oil, including oil shales and oil sands, becomes more prevalent.

[8]Oil is not the only economic activity that could be plotted in the bottom-left quadrant of Figure 1. Kimberlite diamonds and deep-shaft minerals such as copper possess similar attributes (Le Billon 2005, 30). Unlike for oil, however, existing empirical evidence linking non-oil natural resources and separatist civil war is mixed (Ross 2015, 250). The theoretical considerations raised here may be helpful for informing future empirical work that disaggregates non-oil resources, which the conclusion discusses.

of manufacturing will be located further to the right in Figure 1. Large multinational corporations have sufficient liquidity even after sinking costs in a fixed asset to leave the country and to produce elsewhere in reaction to high taxes, whereas it is impossible to move an oil field. Subsistence agriculture differs from oil production on both dimensions because it relies heavily on local labor and is diffuse, i.e., higher values on both the horizontal and vertical axes. This discussion substantively supports Assumption 1.

> **Assumption 1.** *Oil-rich territories have lower formal-sector output elasticity (lower value on vertical axis of Figure 1) and lower opportunity costs to supplying formal-sector labor (lower value on horizontal axis of Figure 1) than oil-poor territories.*

1.2 Rebels Face Difficulties Accruing Oil Revenues

By contrast, greed arguments—disrupting oil production during peacetime, start-up financing mechanisms, and looting during ongoing civil wars—are premised on *societal* actors easily accessing oil revenues. Whether scrutinizing inherent properties of oil production or empirical evidence, the foundations of these arguments receive weak support.

Oil disruptions during peacetime. Arguments about societal actors *disrupting* and stealing oil production during peacetime require mutually exclusive assumptions from Assumption 1. Collier, Hoeffler and Rohner (2009, 13) state that oil production enables activities such as "'bunkering' (tapping of pipelines and theft of oil), kidnapping and ransoming of oil workers, or extortion rackets against oil companies (often disguised as 'community support')." Blair (2014) argues that people living near oil production sites can engage in protests, strikes, sabotage, or theft at these facilities.

Anecdotal examples show these activities have occurred. However, for these arguments to explain broader trends, disrupting or stealing oil production must be systematically easier than interrupting other types of economic production. Thus, these ideas can naturally be incorporated into the framework by assuming that oil production increases the value of the challenger's economic exit option, i.e., moving up and/or to the right in Figure 1. If withholding local labor in oil-rich regions (perhaps in the form of protests or strikes) more greatly interrupts formal-sector production than if the region produced a different type of good, then oil production corresponds with a high value on the vertical axis. Despite cases such as Iran in 1978 and Venezuela in 2002 in which successful strikes temporarily shut down each country's oil production, the key question is whether oil output is more or less affected by what local residents do compared to other economic activities. As discussed, high capital-intensity of oil production and the usual ease of replacing local with foreign workers implies low elasticity—contrary to the disruption argument. Similarly, if the challenger can more easily steal oil than other types of economic production, then this should increase the value of the informal economy and hence move oil production to the right on the horizontal axis in Figure 1. However, as noted, it is relatively easy for governments to guard oil fields because of their concentrated location, and quite difficult for rebels to gain the technical expertise and international assistance needed to reap large oil profits.

Oil-financed insurgent build-up. Another argument is that rebel groups often use oil to finance *building up* their insurgent organization, perhaps by borrowing from international actors in a "booty futures" market (Ross, 2012). However, as argued, it is difficult for aspiring rebels to gain access to oil wealth, especially when considering the international component. Empirically, rebel groups have almost never accessed oil revenues to fund start-up costs for challenging a government because, even when this might otherwise be possible, international actors often support incumbent oil-rich regimes to stabilize oil production and prices. Among Ross' (2004, 2012) review of cases, only Congo-Brazzaville in the 1990s exhibits evidence from an oil-rich country of rebels raising start-up funds via oil in a booty futures market, and this war was not separatist. In this exceptional case, rebel leader and former president Denis Sassou-Nguesso promised to restore French oil company Elf Aquitaine's monopoly over Congo's oil if he regained power, in return for assistance. However, cases in which international actors contract on future oil promises by rebel groups are extremely rare because international oil companies and their host governments favor incumbents over challengers to prevent costly disruptions to oil production. At least empirically, this argument appears true even beyond oil. Ross (2004, 50) concludes from examining 13 prominent civil wars involving a variety of natural resources that "nascent rebel groups never gained funding before the war broke out from the extraction or sale of natural resources, or from the extortion of others who extract, transport, or market resources."

The emergence of distinct states on the periphery of the Arabian peninsula in the 1920s and 1930s (e.g., Kuwait, Qatar, United Arab Emirates) provides a stark example of the West supporting weak incumbents simply because they wanted access to stable oil production (Zahlan, 2016). Local shaykhs became "kings" if they were willing to sign oil concessions with Western oil companies, and the British navy militarily supported these new incumbents. More recently, the U.S.'s support for Arabian peninsula monarchies is consistent with promoting dependable incumbents to maintain access to oil—as opposed to U.S.'s policy of democracy promotion in many oil-poor countries (Bellin, 2004).

Instead, theoretical and empirical considerations suggest that oil production in any region of a country should *decrease* the challenger's probability of winning a separatist civil war by providing funds to the government. Paine (2016) explains why governments have a large advantage over rebel groups for translating oil wealth into military capacity, contrary to common allegations that oil wealth weakens state capacity. Empirically, there is considerable evidence that oil-rich countries spend large amounts on their militaries (Wright et al. 2015, 15-17; Colgan 2015, 7 provides additional citations). This corresponds with Colgan's (2015) argument: "The government's oil income is typically so much larger than the rebels' share that the relative balance of power favors the incumbent government" and with his empirical finding that oil-rich countries win civil wars at higher rates than oil-poor countries (8). Overall, contrary to the seemingly sensible idea that a rebel group in an oil-producing territory should have an advantage in arming, these substantive considerations and empirical observations instead support the opposite assumption.

> **Assumption 2.** *An increase in oil production in the challenger's territory decreases its probability of winning a separatist civil war.*

Rebel looting during an ongoing civil war. Another major greed argument concerns rebel *looting* and consumption during an ongoing civil war (Lujala 2010; Ross 2012, 145-187). The aforementioned attributes of economic production also imply that oil production should be difficult for rebel groups to loot during ongoing civil wars. Empirically, considerable scholarship has examined rebel looting during ongoing civil wars and reveals very few cases of oil-generated rebel finance contributing to separatist civil wars. Ross (2012, 170-3) documents oil theft by rebels in the Niger Delta region of Nigeria in the 2000s during a low-intensity civil war, although even in this "exceptional case ... the government's oil revenue is larger than the rebels'" (Colgan 2015, 6). Collier and Hoeffler (2005, 44) state that one of the "two major reasons why natural resources might be a powerful risk factor" is "the opportunity that they provide to rebel groups to finance their activities during conflict." However, they do not mention rebel looting when presenting qualitative discussions of oil-secession cases in Nigeria's Biafra conflict, Indonesia, and Sudan (Collier and Hoeffler, 2005, 47-49).

To demonstrate the lack of evidence for rebel financing more systematically, Table 1 lists every oil-rich region that has initiated a separatist civil war, and the note below the table describes the sample. To assess financing, I use Rustad and Binningsbø's (2012) dataset on civil wars involving natural resources, specifically, their variable for whether or not there is evidence of resources funding the insurgency. Following Rustad and Binningsbø's (2012) temporal sample, the data run from 1946 to 2006, although below I discuss the more recent case of ISIS. Rustad and Binningsbø (2012) identify 31 natural resource civil wars that involved rebel financing, but *none* of these wars occurred in oil-rich territories. The financing conflicts instead involved natural resources such as cashew nuts, charcoal extraction, cocoa, copper, diamonds, drugs, gems, and timber. This list of conflict resources provides additional motivation for why the type of economic production is important. All of these except copper (which was present in only one of the cases) are diffuse resources that are difficult for a government to control, which indicates a high value on the horizontal axis of Figure 1.

Table 1: Separatist Civil Wars in Oil-Rich Regions: Evidence for Financing, 1946–2006

Country	**Region**	**First conflict year**	**Evidence of financing from R&B (2012)?**
Angola	Cabinda	1975	NO
Bangladesh	Chittagong Hills	1974	NO
India	Assam	1990	NO
Indonesia	Aceh	1975	NO
Iran	Kurdistan	1966	NO
Iran	Arabistan	1979	NO
Iraq	Kurdistan	1961	NO
Nigeria	Biafra	1967	NO
Nigeria	Niger Delta	2004	NO
Pakistan	Baluchistan	1974	NO
Russia	Chechnya	1999	NO
Sudan	South	1983	n.a.
Yemen	South	1994	NO

Notes: Table 1 includes every case in Ross's (2012, 165) list of separatist conflicts in oil-producing regions that Rustad and Binningsbø (2012) also code as a natural resource war (plus South Sudan, where production did not begin until after the war started), using Ross's (2012) conflict onset year. Table 1 also contains every case generated by an alternative coding procedure: spatially merging ethnic group polygons from the Ethnic Power Relations dataset (Vogt et al., 2015) with giant oil field data (Horn, 2015), and listing every group that has at least one giant oil field in their polygon and has fought a separatist civil war. Among the cases that Ross (2012) lists, the following are excluded from Table 1 because the region/ethnic group does not contain a giant oil field, nor do Rustad and Binningsbø (2012) code a natural resource war: Xinjiang (China), Bangladesh (independence war from Pakistan), or Kurdistan (Turkey).

Several cases suggest that coding *no* financing cases overstates the rarity of this phenomenon in separatist civil wars over oil-rich regions, although do not alter the main point that it has very rarely occurred. In addition to the Niger Delta case mentioned above, another possible example is southern Sudanese rebels that blew up pipelines and disrupted oil production during Sudan's second civil war, although this is more consistent with the disruption mechanism than with financing. Finally, there is clear evidence of rebels earning huge profits from oil sales during the post-2011 ISIS conflict in Iraq and Syria (Dilanian, 2014). However, there is considerable ambiguity regarding how to code ISIS' civil war aims, who have proclaimed to establish an Islamic Caliphate in territory captured from Iraq and Syria. The Armed Conflict Database (Gleditsch et al., 2002) codes ISIS as participating in a center-seeking civil in Iraq and a separatist civil war in Syria. Correlates of War (Dixon and Sarkees, 2015) codes ISIS as participating in center-seeking civil war in Iraq and an intercommunal conflict in Syria. However, regardless of how ISIS' civil war aims are coded, it is an exception to the general trend that rebel groups have rarely gained significant looting profits from oil to fund separatist insurgencies.[9]

These substantive considerations that inherent features of oil production make it more difficult to loot than other types of economic production, and empirical evidence of the rarity of widespread oil looting, instead suggest the opposite of the looting argument, which Assumption 3 states.

> **Assumption 3.** *Challengers in oil-rich territories consume a lower percentage of their production during a war than challengers in oil-poor territories.*

2 Formal Model Setup and Equilibrium Analysis

The model contains key strategic elements needed to assess core arguments from the grievance and greed paradigms. For grievances, allowing the government to endogenously tax the challenger's formal-sector production and modeling an economic exit possibility for the challenger are crucial for assessing which properties of oil production enable governments to exploit oil-rich regions. For greed, these assumptions also enable assessing competing arguments about societal actors stealing and disrupting oil production dur-

[9]Other cases of oil-funded insurgencies discussed in the literature—such as Colombia, Iraq after the 2003 U.S. invasion, and Libya in 2011—involved center-seeking civil wars. Although a similar argument about the general difficulty of looting applies to center-seeking civil wars as well (Paine, 2016), for the present exposition it is useful to disaggregate types of civil wars to highlight that this phenomenon has very rarely occurred in separatist civil war cases—and therefore is unlikely to explain why oil-rich regions fight separatist civil wars relatively frequently.

ing peacetime, and other parameters in the model enable theoretically assessing start-up finance and looting arguments. Finally, all these factors affect the equilibrium likelihood of separatist civil war—another strategic choice in the model.

2.1 Setup

A government (G) and regional challenger (C) interact in an infinite time horizon. Future payoffs are discounted by a common factor $\delta \in (0, 1)$ and time is denoted by $t \in \mathbb{Z}_+$. The stage game played in each period contains up to four sets of actions.

1. Distribution of power stage. Nature chooses whether C has strong capacity for rebellion (probability σ) or is weak (probability $1 - \sigma$) in each period. Only in a strong period can C initiate hostilities (see stage 3), and C wins a separatist civil war with probability $p \in (0, 1)$.[10] The distribution of power stage is degenerate in any period in which C has previously won a separatist civil war because, as described below, G and C's interaction ends if C secedes. Overall, there are three states of the world in this stochastic game: C is weak in the status quo territorial regime, C is strong in the status quo territorial regime, and C has seceded.

Stochastic shifts in C's ability to secede reflect that political actors can only occasionally solve collective action problems and effectively challenge the government (Acemoglu and Robinson, 2006, 123-128). Windows of opportunity may arise, for example, when the government is temporarily vulnerable. As an example, the fall of the Iranian shah in 1979 created perceptions of temporary regime weakness by Iran's oil-rich Arab and Kurd minorities and facilitated separatist attempts (Ward, 2009, 230-233). Demonstration effects from the Iranian Revolution may have also facilitated mobilization in nearby countries. "There is little doubt that the Iranian Revolution helped galvanize politics and energize dissent among Shiites in neighboring countries. The revolution helped explain both the timing and some of the forces that encouraged Saudis to take to the streets" (Jones, 2010, 186). Saudi Arabia's Shiites are concentrated in the east, which contains the majority of Saudi Arabia's oil wealth. Similarly, Angola's long-running center-seeking civil war resumed

[10]For tractability purposes and to focus mainly on C's fighting and production choices, p is exogenous. However, Assumption 2 discusses substantive factors related to regional oil production that may affect p, and work in progress by the author shows that endogenizing the probability of winning does not alter the core logic for the relationship between oil and separatist civil war onset.

after the opposition party UNITA rejected election results in 1992. The rebel group FLEC-FAC escalated its low-intensity separatist fight for oil-rich Cabinda shortly afterwards, "at a time when the government was facing its toughest military challenge yet from UNITA" (Porto, 2003, 5). This provided a window for FLEC-FAC to achieve military aims and to gain concessions.

2. Taxation stage. G proposes a tax rate $\tau_t \in [0,1]$ that would transfer τ_t percentage of C's period t formal-sector economic output to G if C accepts. For simplicity, G does not have a budget from which it can offer transfers to C, although Appendix Section A.3 discusses why introducing this possibility would not qualitatively change the results.

3. Fighting decision stage. Two constraints prevent G from taxing all of C's production. First, in a strong period, C can initiate a one-period separatist war to create an autonomous state.[11] In weak periods, however, there is no fighting constraint. Regardless of whether C accepts or fights, period t consumption also depends on C's labor supply choice.

4. Labor supply stage. The second constraint on G's taxation is that C can divert effort to produce in an informal market. This incorporates the key theoretical idea that citizens can exit the formal economy by producing outside the reach of the state or by physically migrating (de Soto, 2000; Scott, 2010), and therefore the government must provide incentives for residents to generate taxable output (Olson, 2000). Bates (1981, 85-86) discusses the prevalence in post-colonial Africa of farmers choosing to produce subsistence crops rather than taxable cash crops, and smuggling cash crops across international borders. Activities discussed above such as stealing oil output or striking to disrupt production also affect the value of the informal sector.

Formally, C chooses labor supply $L_t \geq 0$ for formal-sector production. Output equals $\theta(L_t)$ multiplied by the value of production, $Y^C \in (0,1)$. Assuming $\theta(L_t) = L_t^\eta$ and $\eta \in (0,1)$ ensures the production function exhibits strictly positive and strictly diminishing marginal returns to labor input, and η equals output elasticity. Because $\theta(\cdot)$ is a Cobb-Douglas production function with a single input, it follows that output elasticity $\frac{\partial\theta(L_t)}{\partial L_t} \cdot \frac{L_t}{\theta(L_t)} = \eta \cdot L_t^{\eta-1} \cdot \frac{L_t}{L_t^\eta} = \eta$. Larger η implies that the amount produced is more

[11] Assuming the war lasts one period is done for simplicity, and all the results would be qualitatively identical for wars of finite length $n \in \mathbb{Z}_{++}$.

greatly impacted by changes in labor input, i.e., formal-sector output is more labor-elastic. This corresponds with a higher value on the vertical axis of Figure 1.

The discussion accompanying Assumption 1 implies that η is close to 0 in territories that primarily produce oil. However, in order to consider how oil production differs from other economic activities and to facilitate comparative statics, it is crucial to consider oil production on a continuum with other types of economic activities rather than to model a separate oil sector with $\eta = 0$. Additionally, assuming that a unitary actor makes regional production decisions is for simplicity, and Appendix Lemma A.1 demonstrates that the unique symmetric equilibrium labor allocation is identical if $N \in \mathbb{Z}_{++}$ citizens of the region independently choose labor allocations after the rebel leader makes the fighting decision.

Devoting labor to the formal economy entails an opportunity cost of $\kappa(L_t) = \frac{\omega}{1+\omega} \cdot L_t^{\frac{1+\omega}{\omega}}$ for C from forgone production in the informal sector, for $\omega \in (0,1)$. Substantively, higher ω corresponds to a higher-valued option to exit into the informal economic sector and to a higher value on the horizontal axis of Figure 1. This functional form, which engenders a strictly positive and strictly increasing opportunity cost of labor, is commonly used in models with an endogenous labor supply because labor supply elasticity equals ω in the linear production technology case (e.g., Acemoglu et al. 2004; Besley and Persson 2011, 80).[12]

Payoffs. If C accepts, then in the current period it consumes formal-sector output not extracted by G minus the informal sector-induced opportunity cost of labor, $(1-\tau_t) \cdot \theta(L_t) \cdot Y^C - \kappa(L_t)$. G consumes revenues extracted from C, yielding $\tau_t \cdot \theta(L_t) \cdot Y^C$. A strategically equivalent subgame begins in period $t+1$, and future continuation values for G and C under the status quo territorial regime are denoted respectively as $V^G_{\text{s.q.}}$ and $V^C_{\text{s.q.}}$.

If instead C initiates a separatist civil war at time t, then C's formal-sector production is exogenously divided between G and C in that period. G receives $(1-\phi) \cdot x(\eta)$ percent and C receives $(1-\phi) \cdot \big(1 - x(\eta)\big)$

[12] A somewhat less abstract way to model the economy is to assume that C has one unit of labor it can sell either on the formal market at $L_t^\eta \cdot Y^C$ or on the informal market at $\frac{\omega}{1+\omega} \cdot \Big(1 - L_t^{\frac{1+\omega}{\omega}}\Big)$. Here, if C devotes all its labor to the informal sector, then the yield from the informal sector reaches its maximum value $\frac{\omega}{1+\omega}$. Additionally, C reaps 0 from the informal sector if it sets $L_t = 1$. This setup yields an identical optimal labor allocation as the setup described in the text, and I prefer the present setup because it does not impose the unnecessary upper bound of 1 on C's labor choice.

percent. The less reliant C's formal sector production is on local labor, the easier it is for G to expropriate C's resources even during a war. Formally, $x \in (0, 1)$ strictly decreases in η. Finally, $\phi \in (0, 1)$ captures the destructiveness of war. If the separatist attempt fails, then period $t + 1$ begins a subgame strategically equivalent to that in period t. If instead C successfully separates, then the tax rate drops permanently to 0 in every future period and only the labor supply stage is played. This means that G and C's interaction becomes trivial. The future continuation value for C in the subgame following successful secession is V^C_{sec}. The corresponding continuation value for G is V^G_{sec}, which equals 0 because G has lost its tax supply. Figures 2 and 3 present trees for the stage games and Table 2 summarizes the parameters and choice variables in the game.

Figure 2: Tree of Infinitely Repeated Stage Game if C Has Not Seceded

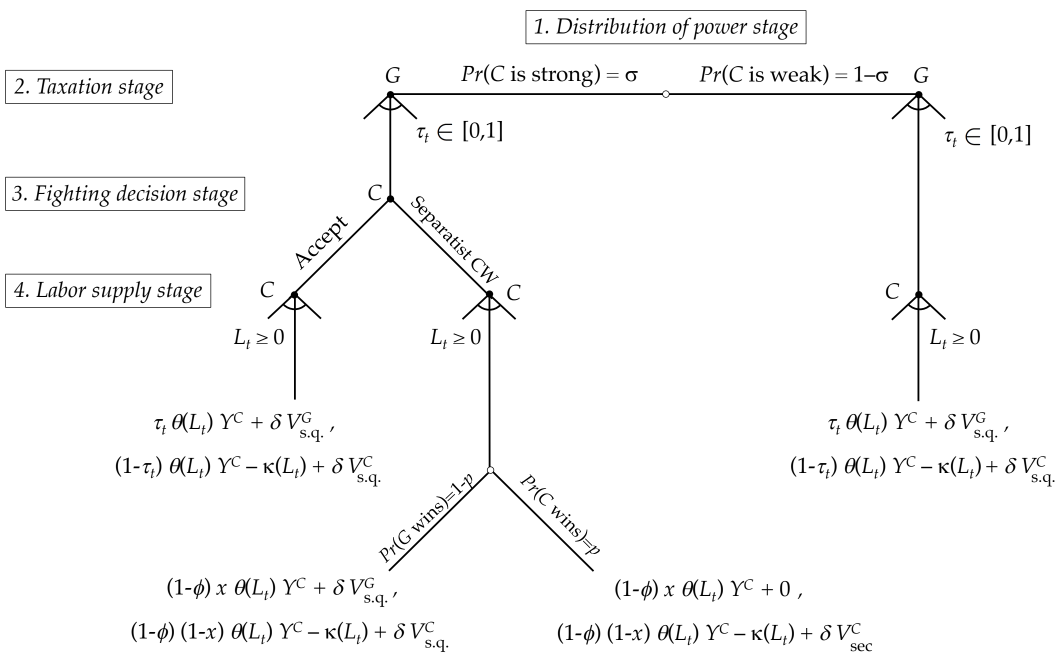


Figure 3: Tree of Infinitely Repeated Stage Game if C Has Seceded

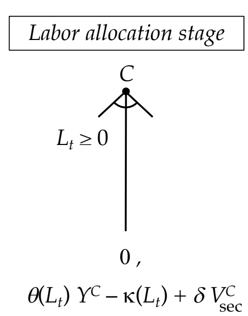


Table 2: Summary of Parameters and Choice Variables

Stage	**Variables/description**
Primitives	• G: government • C: regional challenger • δ: discount factor • t: time
1. Distribution of power stage	• σ: Probability C is strong in any period t in the s.q. territorial regime
2. Taxation stage	• τ_t: G's proposed tax rate
3. Fighting decision stage	• p: C's probability of winning if it initiates a war in a strong period • ϕ: Percentage of C's formal-sector production destroyed in the period of a separatist civil war • x: Percentage of C's formal-sector production (not destroyed by the war) that accrues to G
4. Labor supply stage	• L_t: C's formal-sector labor supply • $\theta(\cdot)$: formal-sector production function • Y^C: value of formal-sector output • η: formal-sector output elasticity • $\kappa(\cdot)$: opportunity cost, from foregoing informal-sector production, of supplying formal-sector labor • ω: parameterizes opportunity cost of formal-sector labor (higher $\omega \implies$ higher labor elasticity)
Continuation values	• $V^G_{\text{s.q.}}$: G's future continuation value in the s.q. territorial regime • $V^C_{\text{s.q.}}$: C's future continuation value in the s.q. territorial regime • V^C_{sec}: C's future continuation value in the secession subgame

2.2 Equilibrium Analysis

The analysis begins by considering an "institutions-free" environment. Formally, the analysis characterizes the Markov Perfect Equilibria (MPE) of the game.[13] This first cut at analyzing the model isolates how the challenger may coercively separate to escape its interaction with a weakly institutionalized state that is incapable of long-term commitments. Later, the analysis evaluates a non-Markovian strategy profile that enables the government, in principle, to resist exploitation even in periods the challenger is coercively weak by allowing the challenger to directly condition on actions taken in previous periods. To solve the model, this section applies the single-deviation principle to solve for equilibrium actions in a peaceful equilibrium—which is shown to be unique when one exists—and the parameter values under which a peaceful equilibrium exists. It also characterizes actions in conflictual equilibria. The analysis solves backwards on the stage game and Appendix A proves all the formal statements.

[13]Markov Perfect Equilibrium requires players to choose best responses to each other, with strategies predicated upon the state of the world and on actions within the current period. Appendix A formally defines the equilibrium concept.

Labor supply stage. C's labor tradeoff is that supplying more labor increases formal-sector output but also raises the opportunity cost induced by informal-sector exit. Increasing L_t raises C's marginal consumption by the percentage of formal-sector production it retains, $1 - \tau_t$, multiplied by the effect of increased labor supply on formal-sector output, $\frac{\partial\theta(L^*(\tau_t))}{\partial L_t}$, and by the value of production, Y^C. If C chooses to initiate a war, then effectively $\tau_t = x$. The marginal opportunity cost of supplying labor to the formal sector is $\frac{\partial\kappa(L^*(\tau_t))}{\partial L_t}$. C chooses the unique labor supply that equates these terms, which enables implicitly characterizing $L^*(\tau_t)$:

$$\underbrace{(1-\tau_t)\cdot\frac{\partial\theta(L^*)}{\partial L_t}\cdot Y^C}_{\text{MB: } C \text{ consumes more from formal sector}} \quad = \quad \underbrace{\frac{\partial\kappa(L^*)}{\partial L_t}}_{\text{MC: Opp. cost from informal sector}} \tag{1}$$

and, after substituting in functional forms, explicitly solving:

$$L^*(\tau_t) = \Big[(1-\tau_t)\cdot\eta\cdot Y^C\Big]^{\frac{\omega}{1+\omega\cdot(1-\eta)}}. \tag{2}$$

C's labor choice is the only strategic decision following a successful separatist attempt. Lemma 1 states optimal actions, per-period consumption amounts, and continuation values in this subgame.

Lemma 1 (Actions/consumption in a period following successful secession)**.** *If C has successfully seceded before period t, then C chooses $L_t = L_0^* \equiv \big(\eta\cdot Y^C\big)^{\frac{\omega}{1+\omega\cdot(1-\eta)}}$, and $V_{sec}^C = \frac{1}{1-\delta}\cdot\big[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\big]$.*

Fighting decision stage. If C has not previously seceded and G makes an unattractive proposal, then in a strong period C can deviate from a peaceful strategy profile by fighting. C's allure of initiating a separatist war is that G cannot tax its production in any future period if C wins. More formally, C will accept a proposal τ_t in a strong period if current- and expected future-period consumption is at least as large as its lifetime expected utility from initiating a civil war:

$$\overbrace{(1-\tau_t)\cdot\theta\big(L^*(\tau_t)\big)\cdot Y^C - \kappa\big(L^*(\tau_t)\big) + \delta\cdot V_{s.q.}^C}^{E[U_C(\text{accept }\tau_t)]} \geq$$
$$\underbrace{(1-\phi)\cdot(1-x)\cdot\theta\big(L^*(x)\big)\cdot Y^C - \kappa\big(L^*(x)\big) + \delta\cdot\Big[p\cdot V_{sec}^C + (1-p)\cdot V_{s.q.}^C\Big]}_{E[U_C(\text{secede})]} \tag{3}$$

C optimally accepts offers satisfying Equation 3 in strong periods because fighting in the current period—the single deviation from accepting—is not profitable.

Taxation stage: weak periods. Although C cannot fight in a weak period, G still faces a tradeoff when setting the tax rate. G will consume its proposed share of C's formal-sector output, $\tau_t \cdot \theta\big(L^*(\tau_t)\big) \cdot Y^C$. On the one hand, raising taxes enables G to consume a larger *percentage* of C's formal-sector production. On the other hand, a higher tax rate also decreases the equilibrium *amount* of formal-sector production. Higher taxes cause C to substitute away from taxable labor by diminishing C's marginal consumption from supplying labor, as Equations 1 and 2 demonstrate. This effect lowers $\theta\big(L^*(\tau_t)\big)$. G sets τ_t to balance this tradeoff, and therefore the unique revenue-maximizing tax rate $\overline{\tau}$ is implicitly defined by:

$$\underbrace{\theta\big(L^*(\overline{\tau})\big) \cdot Y^C}_{\text{MB: } G \text{ receives higher } \% \text{ of } C\text{'s formal-sector output}} = \underbrace{\overline{\tau} \cdot \frac{\partial \theta\big(L^*(\overline{\tau})\big)}{\partial L_t} \cdot \left[-\frac{dL^*(\overline{\tau})}{d\tau_t} \right] \cdot Y^C}_{\text{MC: } C\text{'s formal-sector output decreases}}. \tag{4}$$

This yields an explicit solution of:

$$\overline{\tau} = \frac{1 + \omega \cdot (1 - \eta)}{1 + \omega}. \tag{5}$$

Lemma 2 summarizes this discussion.

Lemma 2 (Actions/consumption in a weak period)**.** *If C is weak in period t, then G offers $\tau_t = \tau_w^* = \overline{\tau}$, for $\overline{\tau}$ defined in Equations 4 and 5. C chooses $L_t = L^*(\tau_t)$, for $L^*(\tau_t)$ defined in Equations 1 and 2. In equilibrium, $L_t = \overline{L} \equiv \Big[(1 - \overline{\tau}) \cdot \eta \cdot Y^C\Big]^{\frac{\omega}{1+\omega\cdot(1-\eta)}}$. Denoting C's equilibrium current-period consumption amount as $U_C(weak)$ and G's as $U_G(weak)$, these terms equal:*

- $U_C(weak) = (1 - \overline{\tau}) \cdot \theta\big(\overline{L}\big) \cdot Y^C - \kappa\big(\overline{L}\big)$
- $U_G(weak) = \overline{\tau} \cdot \theta\big(\overline{L}\big) \cdot Y^C$

Taxation stage: strong periods. In a period with strong capacity for rebellion, C wins a civil war with positive probability. Consequently, it might be optimal for C to attempt to secede rather than accept G's most-preferred tax rate detailed in Lemma 2. In equilibrium, if G cannot buy off C in a strong period by offering $\tau_t = \overline{\tau}$, then if possible it will choose the unique tax rate $\tau_s^* \in [0, \overline{\tau})$ that makes C indifferent between accepting or fighting, i.e., that satisfies Equation 3 with equality. G clearly will never set a tax rate lower than is needed to induce acceptance, and Appendix A explains why G always prefers to buy off C in a strong period if the one-period war is sufficiently destructive.

Alternatively, in a strong period, it might be optimal for C to reject *any* proposal by G, including $\tau_t = 0$. This implies that a civil war will occur. To understand why peaceful bargaining may not be possible, if C's likelihood of having strong capacity for rebellion, σ, is small, then C will only rarely experience periods along the equilibrium path in which it receives a favorable tax rate because G cannot commit to tax at less than $\overline{\tau}$ in a weak period. If additionally C is relatively likely to win a civil war (high p) and is patient (high δ), then it may be optimal for C to fight when temporarily strong and to forgo short-term consumption to achieve higher expected long-term consumption. Note that for any $x > 0$ or $\phi > 0$, C consumes strictly more in the current period from accepting a tax rate of 0 rather than fighting and consuming $(1-\phi)\cdot(1-x)$ percent of its production. By contrast, high enough σ is sufficient for peace because G can credibly offer tax concessions frequently enough that C's opportunity cost of fighting in a strong period outweighs the expected benefits of fighting.

Formally, Equation 6 substitutes $\tau_t = 0$ as well as equilibrium consumption amounts and continuation values from Lemmas 1 and 2 into Equation 3 solved with equality to define a threshold $\overline{\sigma} < 1$ with the following properties. For any $\sigma > \overline{\sigma}$, there exists a continuum of tax proposals that C will optimally accept in a strong period. If $\sigma < \overline{\sigma}$, then C will reject any tax offer, even $\tau_t = 0$, in a strong period. To see that a large enough σ is sufficient for peace, the second line of Equation 6 cancels out if $\sigma = 1$, leaving a strictly positive term. Lemma 3 summarizes these considerations.

$$\begin{aligned}\Phi(\overline{\sigma}) \equiv\ & \overbrace{(1-\delta)\cdot\Big\{\big[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\big] - \big[(1-\phi)\cdot(1-x)\cdot\theta\big(L^*(x)\big)\cdot Y^C - \kappa\big(L^*(x)\big)\big]\Big\}}^{C\text{'s contemporaneous gains from accepting } \tau_t = 0 \text{ rather than fighting}} \\ & - \underbrace{\delta p(1-\overline{\sigma})\cdot\Big\{\big[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\big] - \big[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C - \kappa\big(\overline{L}\big)\big]\Big\}}_{C\text{'s long-term opportunity cost from forgoing fighting}} = 0 \qquad (6)\end{aligned}$$

Lemma 3 (Actions/consumption in a strong period)**.** *Define τ_s^* as the equilibrium strong-period tax rate proposal.*

- *If $\sigma > \overline{\sigma}$, then G offers $\tau_t = \tau_s^* = \overline{\tau}$ if this satisfies Equation 3, and otherwise offers the unique $\tau_t = \tau_s^* \in (0, \overline{\tau})$ that satisfies Equation 3 with equality. C accepts with probability 1 any offer that satisfies Equation 3 and chooses $L_t = L^*(\tau_t)$, for $L^*(\tau_t)$ defined in Equations 1 and 2. C fights with probability 1 in response any offer that does not satisfy Equation 3 and chooses $L_t = L^*(x)$. In equilibrium, $L_s^* \equiv \Big[(1-\tau_s^*)\cdot\eta\cdot Y^C\Big]^{\frac{\omega}{1+\omega\cdot(1-\eta)}}$. Denoting C's equilibrium current-period consumption amount as $U_C(strong)$ and G's as $U_G(strong)$, these terms and the status quo future continuation values equal:*
  - $U_C(\mathit{strong}) = (1-\tau_s^*)\cdot\theta(L_s^*)\cdot Y^C - \kappa(L_s^*)$
  - $V_{\mathit{s.q.}}^C = \frac{1}{1-\delta}\cdot\Big[\sigma\cdot U_C(\mathit{strong}) + (1-\sigma)\cdot U_C(\mathit{weak})\Big]$*. Lemma 2 defines $U_C(weak)$.*
  - $U_G(\mathit{strong}) = \tau_s^*\cdot\theta(L_s^*)\cdot Y^C$
  - $V_{\mathit{s.q.}}^G = \frac{1}{1-\delta}\cdot\Big[\sigma\cdot U_G(\mathit{strong}) + (1-\sigma)\cdot U_G(\mathit{weak})\Big]$*. Lemma 2 defines $U_G(weak)$.*
- *If $\sigma < \overline{\sigma}$, then $\tau_t \in [0,1]$. C initiates a separatist civil war in response to any tax offer, and chooses $L_t = L^*(x)$. In equilibrium, $L_s^* = \Big[(1-x)\cdot\eta\cdot Y^C\Big]^{\frac{\omega}{1+\omega\cdot(1-\eta)}}$. Denoting C's continuation value following a strong period in the status quo regime as V_{strong}^C and G's as V_{strong}^G, the following equilibrium current-period consumption and future continuation terms differ if $\sigma < \overline{\sigma}$ as opposed to $\sigma > \overline{\sigma}$:*
  - $U_C(\mathit{strong}) = (1-\phi)\cdot(1-x)\cdot\theta\big(L^*(x)\big)\cdot Y^C - \kappa\big(L^*(x)\big)$
  - $V_{\mathit{strong}}^C = U_C(\mathit{strong}) + \delta\cdot\Big[p\cdot V_{\mathit{sec}}^C + (1-p)\cdot V_{\mathit{s.q.}}^C\Big]$
  - $U_G(\mathit{strong}) = (1-\phi)\cdot x\cdot\theta\big(L^*(x)\big)\cdot Y^C$
  - $V_{\mathit{strong}}^G = U_G(\mathit{strong}) + \delta\cdot\Big[p\cdot V_{\mathit{sec}}^G + (1-p)\cdot V_{\mathit{s.q.}}^G\Big]$

Proposition 1 states the equilibria. If $\sigma > \overline{\sigma}$, then there is a unique equilibrium that features peaceful bargaining in every period. If $\sigma < \overline{\sigma}$, then there are a continuum of payoff-equivalent equilibria strategy profiles that along the equilibrium path feature a separatist civil war in every strong period until C successfully separates.

Proposition 1 (Equilibrium)**.** *The three lemmas summarize optimal actions and equilibria consumption amounts in each of the game's three states:*

- *If C has seceded: see Lemma 1.*
- *If C is weak: see Lemma 2.*
- *If C is strong: see Lemma 3.*

3 Theoretical Findings: Redistributive Grievances, But Not Greed

Combining players' strategic tradeoffs with the substantive consideration that governments—not societal actors—tend to control oil income yields the main theoretical implications. The first result explains why oil-facilitated redistributive taxation enhances the challenger's incentives to initiate a separatist civil war. The theoretical logic improves upon existing grievance arguments by explaining how oil differs from other natural resources to cause bargaining failure via undermining the challenger's economic exit option. The model also shows why these core properties of oil production contradict considerable existing wisdom from the civil war literature about greed arguments. Disruption/start-up finance/looting mechanisms either logically *diminish* separatist incentives, or theoretically raise equilibrium separatist civil war prospects only under assumptions that are poorly empirically supported for oil production. Formally, the following considers comparative statics on the relationship between (1) the various parameters that Assumptions 1 through 3 link to different aspects of regional oil production and (2) the existence of a peaceful equilibrium.

3.1 Redistributive Grievances Result

Redistributive grievances create secession incentives because the government taxation effects of regional oil production—expressed by assuming oil production corresponds with low ω and low η—transfer more resources from the challenger to the government in weak periods, which makes it harder for G to buy off C in strong periods. This is a generally relevant and novel mechanism to explain fighting.

Regional oil production raises G's revenue-maximizing tax rate—the equilibrium tax rate in weak periods—by diminishing C's economic exit threat. More precisely, oil production relaxes the elasticity constraints that determine G's marginal cost of taxation. Although higher taxes cause C to substitute away from supplying formal-sector labor, which decreases taxable production (Equations 1 and 2), the magnitude of this effect on G's marginal cost of taxation (see Equation 4) depends on formal-sector output elasticity and labor supply elasticity. If formal-sector output elasticity η is low—as with oil production (Assumption 1)—then a decrease in C's labor supply only minimally adversely affects formal-sector output. This corresponds with a low value on the vertical axis of Figure 1. If the labor supply elasticity parameter ω is low—as is also the case with oil production (Assumption 1)—then an increase in taxation only minimally adversely affects equilibrium labor supply because C's returns from producing in the informal sector are low. This corresponds with a low value on the horizontal axis of Figure 1.[14] This logic explains why any economic base located in the bottom-left quadrant of Figure 1 is subject to high government taxes in weak periods, which captures the idea of C harboring redistributive grievances toward the government. Lemma 4 formally states the linkage between C's economic exit option parameters and G's optimal tax rate, and Appendix A further illustrates the elasticity logic with a more general parameterization of G's tax problem.

Lemma 4 (Redistributive grievances effect)**.** *An increase in C's oil production increases the revenue-maximizing tax rate $\overline{\tau}$ that G levies in weak periods, i.e., increases redistributive grievances, by decreasing output elasticity (η) and by decreasing the opportunity cost of supplying labor (ω). Formally:*

Part a. $-\frac{d\overline{\tau}}{d\eta} > 0$.

Part b. $-\frac{d\overline{\tau}}{d\omega} > 0$.

This redistributive grievance effect increases the range of parameters for which separatist civil wars will occur in equilibrium. C has two tools to guard against high taxes: its threat to fight and its threat to exit the formal sector. Having strong contemporaneous coercive power is sufficient to prevent exploitation because G would rather buy off C in a strong period than trigger fighting. Furthermore, an effective economic exit threat, i.e., high η and/or ω, prevents high taxes even in weak periods because G does not want to undermine its tax base. By contrast, an oil-rich C faces a high equilibrium tax rate in weak periods. Producing oil therefore causes a large gap between how much C consumes in weak periods and how much it would consume in every period if it successfully seceded. This increases C's incentives to initiate a separatist civil war in a strong period because gaining its own state would eliminate future government exploitation, hence alleviating redistributive grievances.

This result provides a novel general mechanism to explain fighting: economic activities that undermine a producer's economic exit option exacerbate the commitment problem. As in many models, G is assumed to be unable to commit to offer C a more favorable bargain in the present period than is dictated by C's contemporaneous fighting ability. However, G's inability to *commit* to a favorable weak-period bargain does not incentivize C to fight in a strong period if the economic properties of C's production provide *incentives* for G to offer a low tax rate even in weak periods—which oil does not. Table 3 summarizes these considerations and Proposition 2 states this result formally.

[14] A low value of η also exerts a reinforcing indirect effect that decreases the elasticity of labor supply.

Table 3: Characteristics of periods in which C is exploited

		C's contemporaneous fighting ability	
		Weak	*Strong*
C's economy	*Oil-poor (more effective economic exit threat)*	C is not exploited	C is not exploited
	Oil-rich (less effective economic exit threat)	C is exploited	C is not exploited

Proposition 2 (Redistributive grievances raise secession incentives)**.** *An increase in C's oil production through its effect on increasing economic grievances increases the likelihood of separatist civil war in equilibrium, i.e., increases the range of σ values small enough that fighting occurs. Formally, for $\overline{\sigma}$ defined in Equation 6:*

Part a. $-\frac{d\overline{\sigma}}{d\overline{\tau}} \cdot \frac{d\overline{\tau}}{d\eta} > 0.$

Part b. $-\frac{d\overline{\sigma}}{d\overline{\tau}} \cdot \frac{d\overline{\tau}}{d\omega} > 0.$

Evidence from a wide range of oil-rich regions that have fought separatist civil wars supports Proposition 2. In Iraq, Kurds have historically claimed that the oil-rich Kirkuk area "is Kurdish and therefore must be part of any Kurdish autonomous area. They further claim they should receive a percentage of oil revenues from the area" (Zanger, 2002, 41). In Angola, Cabinda (which produces most of the country's oil) is "one of the poorest provinces in Angola. An agreement in 1996 between the national and provincial governments stipulated that 10% of Cabinda's taxes on oil revenues should be given back to the province, but Cabindans often feel that these revenues are not benefiting the population as a whole" (Porto, 2003, 3).

More broadly, Table 4 contains the same cases as Table 1 and for each lists whether Rustad and Binningsbø (2012) code evidence that the conflict was related to the distribution of natural resource revenues. Ten of the 12 oil-separatist cases in their dataset exhibit evidence of distribution. Additionally, although South Sudan is not included in their dataset because oil production had not begun when the war broke out, evidence provided below shows clear intent by the Sudanese government to distort the future distribution of oil profits.

The theoretical logic is also unchanged when additionally considering the important role of international actors in developing countries' oil production (Menaldo, 2016). Even if international oil companies can limit G's take of oil profits, this does not help C. G will still heavily redistribute away from oil-producing regions in periods C does not pose a coercive threat—but grant concessions to C in strong periods. This variance in C's consumption drives Proposition 2. Instead, bargaining between governments and international oil com-

Table 4: Oil-Separatist Cases: Evidence for Redistributive Grievances, 1946–2006

Country	Region	First conflict year	Evidence of redistributive grievances from R&B (2012)?
Angola	Cabinda	1975	YES
Bangladesh	Chittagong Hills	1974	YES
India	Assam	1990	YES
Indonesia	Aceh	1975	YES
Iran	Kurdistan	1966	NO
Iran	Arabistan	1979	YES
Iraq	Kurdistan	1961	YES
Nigeria	Biafra	1967	YES
Nigeria	Niger Delta	2004	YES
Pakistan	Baluchistan	1974	YES
Russia	Chechnya	1999	YES
Sudan	South	1983	n.a.
Yemen	South	1994	NO

Notes: See the note for Table 1.

panies might be better conceptualized in the model as affecting the prize of winning, Y^C, which Appendix Section C.1 analyzes.

3.2 Greed Results: Disruption, Looting, and Financing

The main results for the three variants of rebel looting theories follow from combining the substantive discussion above with the logic of the model. Because governments rather than societal actors control the preponderance of oil revenues, substantive considerations about how oil affects C's economic exit option (ω and η), the likelihood of C winning a civil war (p), and consumption during a war (x) all oppose implications from greed theories.

Oil disruptions during peacetime. Peacetime disruption arguments do not provide a satisfactory explanation for the prevalence of separatist civil wars in oil-rich regions for two reasons. First, as discussed above, these arguments imply that oil production increases the economic exit parameters η and ω. This contradicts the strongly empirically grounded assumption that oil production weakens C's economic exit option, which Assumption 1 summarizes.

Second, even if the assumptions behind these looting/disruption arguments were generally empirically relevant, the theoretical logic implies that oil production should *lower* separatist civil war incentives by triggering the opposite logic as just presented for the redistributive grievance mechanism. Research such as Blair (2014) has posited that threatening to interrupt oil production increases oil-rich residents' bargaining power relative to the government. In the language of the present model, higher η or ω increases the value of C's economic exit option, which decreases the equilibrium tax rate in weak periods and increases the size of the parameter space in which G can buy off C in a strong period. In other words, the opposite of Assumption 1 implies that oil production—as opposed to other economic bases—helps to smooth C's income across periods and therefore reduces C's incentives to launch a separatist bid when temporarily strong, via the logic of Proposition 2.

Oil-financed insurgent build-up. Rebel build-up theories imply that C can use oil profits to gain a coercive advantage for launching a civil war. However, the discussion above showed that separatist rebels have never gained oil funding prior to launching an insurgency, and instead oil production almost always advantages the government's military over a rebel group. This grounded Assumption 2, which states that an increase in oil production decreases C's probability of winning a separatist civil war. By decreasing C's expected utility to fighting, this directly yields Proposition 3.

> **Proposition 3** (Oil hinders insurgent success)**.** *An increase in C's oil production through its effect on decreasing its probability of winning decreases the likelihood of separatist civil war in equilibrium, i.e., decreases the range of σ values small enough that fighting occurs. Formally, for $\overline{\sigma}$ defined in Equation 6, $-\frac{d\overline{\sigma}}{dp} < 0$.*

Rebel looting during an ongoing civil war. Rebel looting theories claim that rebel groups fighting for oil-rich territories tend to consume considerably more during the war than groups fighting for oil-poor territories. However, empirically, widespread rebel looting has occurred very rarely during separatist civil wars—again, because of the ease with which governments accumulate oil revenues. This yielded Assumption 3, which states that an increase in oil production lowers the percentage of the challenger's formal-sector production that it retains in the period of a war. The model incorporates this by assuming lower η decreases C's share of its regional production during the war, $1 - x(\eta)$—hence the easy government revenue properties of oil directly contradict the rebel looting argument. Because higher x decreases C's expected utility to fighting, this effect directly engenders Proposition 4.

> **Proposition 4** (Oil depresses looting possibilities)**.** *An increase in C's oil production through its effect on decreasing its percentage share of formal-sector production during a war decreases the likelihood of separatist civil war in equilibrium, i.e., decreases the range of σ values small enough that fighting occurs. Formally, for $\overline{\sigma}$ defined in Equation 6, $\frac{d\overline{\sigma}}{dx} < 0$.*

Although these substantive considerations and theoretical results suggest that rebel greed mechanisms do not provide a compelling explanation for the oil-separatist relationship, the conclusion discusses the importance of examining greed mechanisms in the context of other natural resources, such as alluvial diamonds.

4 Committing to Regional Autonomy?

Existing grievance theories have overlooked a key question: what prevents a government from committing to a regional autonomy deal—and hence lower permanent taxes—with an oil-rich region that would eliminate costly fighting? This section moves beyond the somewhat stark institution-free environment analyzed initially in which the government can never commit to tax relief in periods the challenger does not pose a coercive threat. It analyzes a non-Markovian subgame perfect Nash equilibrium (SPNE) in which G makes the same tax offer to C in every period, backed by C's threat to fight in the first period it has strong capacity for rebellion following a deviation by G. Although G can always offer low enough permanent taxes to prevent civil war—unlike with the Markovian equilibrium in which G could not commit to tax relief in weak periods—it is optimal for G to deviate to a higher tax rate if C can only infrequently carry out its coercive threat. Oil increases the profitability of this deviation by raising the revenue-maximizing tax rate (as Lemma 4 showed), which increases the value of medium-term gains from maximum taxation relative to long-term costs from triggering secession. Overall, the result shows how strategic government actions cause redistribution-based grievances to arise in equilibrium. South Sudan illustrates the empirical relevance of the mechanism. These considerations are also relevant for understanding why governments often fail to address other sources of grievances in oil-producing regions, such as environmental degradation. Appendix Section B provides additional formal details.

4.1 Theoretical Logic

Suppose G makes the same offer $\tau_t = \hat{\tau}$ to C in every period t. Although C's continuation value after seceding, $\hat{V}^C_{sec} = \frac{1}{1-\delta} \cdot \left[\theta(L^*_0) \cdot Y^C - \kappa(L^*_0)\right]$, is unchanged from above, its per-period average continuation value in the status quo territorial regime is now $\hat{V}^C_{s.q.} = \frac{1}{1-\delta} \cdot \Big[(1-\hat{\tau}) \cdot \theta\big(L^*(\hat{\tau})\big) \cdot Y^C - \kappa\big(L^*(\hat{\tau})\big)\Big]$ because C receives the same offer in every period, strong or weak. C will accept this offer rather than initiate a separatist civil war in a period with strong capacity for rebellion if and only if:

$$(1-\hat{\tau})\cdot\theta\big(L^*(\hat{\tau})\big)\cdot Y^C-\kappa\big(L^*(\hat{\tau})\big)+\delta\cdot\hat{V}^C_{s.q.}\geq$$

$$(1-\phi)\cdot(1-x)\cdot\theta\big(L^*(x)\big)\cdot Y^C-\kappa\big(L^*(x)\big)+\delta\cdot\Big[p\cdot\hat{V}^C_{sec}+(1-p)\cdot\hat{V}^C_{s.q.}\Big]. \tag{7}$$

The assumed punishment strategy is that if G ever reneges by proposing some $\tau_t > \hat{\tau}$, then C initiates a separatist civil war in the next strong period. This where relaxing the Markov assumption has bite because C conditions its action on G's choices in previous periods. Appendix Section B discusses in more detail that, after a failed war, G and C are assumed to return to the original strategy profile with G offering $\hat{\tau}$ in every period and C accepting any tax rate no greater than that. The analysis focuses on the best possible peaceful payoff for G: the lowest possible $\hat{\tau}$ that enables buying off C in a strong period. Define $\underline{\hat{\tau}}$ such that $\hat{\tau}=\underline{\hat{\tau}}$ solves Equation 7 with equality (see Appendix Equation B.1). Importantly, a unique $\underline{\hat{\tau}}>0$ always exists. That is, with this SPNE profile but unlike with the MPE, it is always possible for G to set $\hat{\tau}$ low enough to satisfy C's no-fighting constraint. C cannot profitably deviate to fight if taxation in the status quo regime is low enough in every period, for example, if G proposes 0 taxes in every period.

Crucially, however, the *government* might have a profitable deviation to renege in a weak period by making an exploitative tax proposal even though this would trigger costly fighting in the next strong period. The optimal deviation for G entails taxing at the revenue-maximizing rate $\overline{\tau}$ in all periods until the civil war occurs. If the expected number of periods until the secession attempt is high enough, i.e., if σ is sufficiently low, then G can profitably deviate from the posited SPNE strategy profile. Formally, G does not have a profitable deviation from proposing the compromise tax rate $\underline{\hat{\tau}}$ in every period if and only if:

$$\delta(1-\delta)\sigma\cdot\underbrace{\Big[\underline{\hat{\tau}}\cdot\theta\big(L^*(\underline{\hat{\tau}})\big)-(1-\phi)\cdot x\cdot\theta\big(L^*(x)\big)\Big]}_{G\text{'s expected loss in war period}}+\quad\delta^2\sigma\cdot\underbrace{p\cdot\underline{\hat{\tau}}\cdot\theta\big(L^*(\underline{\hat{\tau}})\big)}_{G\text{'s expected loss in every post-war period}}\geq$$

$$(1-\delta)\cdot\underbrace{\Big[\overline{\tau}\cdot\theta(\overline{L})-\underline{\hat{\tau}}\cdot\theta\big(L^*(\underline{\hat{\tau}})\big)\Big]}_{G\text{'s gains in every pre-war period}} \tag{8}$$

The left-hand side of Equation 8 states G's net expected loss in utility in all periods including and after the first strong period that follows the optimal deviation. This loss is strictly positive because (a) fighting is assumed to be strictly costly for G (see Assumption B.1) and (b) the best possible outcome for G is that it wins the war, in which case it receives the same consumption stream if it had not deviated. By contrast, if G loses (which occurs with probability p), then it can never tax C's production again. The right-hand side of Equation 8 states G's net expected gain in utility in every period before the first strong period if it optimally deviates. This gain is strictly positive because G taxes at the revenue-maximizing rate $\overline{\tau}$ in these periods rather than at the compromise rate $\underline{\hat{\tau}}$, which is strictly less than $\overline{\tau}$ in the substantively interesting parameter range in which C can credibly threaten to fight in response to the revenue-maximizing tax rate.

The expected loss captured by the left-hand side of Equation 8 strictly increases in σ and equals 0 if $\sigma = 0$, which formalizes why G might have a profitable deviation: if C only rarely has strong capacity for rebellion, then in expectation G can reap the gains of reneging for many periods before paying the cost. The appendix shows the unique $\hat{\sigma}$ that solves Equation 8 with equality (Equation B.5). It is conceptually similar to $\overline{\sigma}$ defined in Equation 6: the strategy profile is incentive compatible for G if $\sigma > \hat{\sigma}$ but not otherwise.

The analog to the comparative statics prediction in Proposition 2 is unchanged (Proposition B.2). The effect of a weaker economic exit option on increasing $\overline{\tau}$ strictly raises fighting prospects by increasing G's expected gains from deviating and taxing at $\overline{\tau}$ in periods before the war, relative to upholding the regional autonomy deal.

4.2 Summary of Logic and Empirical Example

Analyzing this strategy profile shows that G may deviate from a regional autonomy deal—i.e., offering the same rate rate in every period, regardless of C's contemporaneous coercive strength. The benefit of deviating to impose the revenue-maximizing tax rate is that G increases its consumption in all periods until the next period in which C has strong capacity for rebellion, when it will secede. Oil production raises the benefit of deviating by increasing G's gains from imposing the revenue-maximizing tax rate. Thus, the easy revenue properties of oil (Assumption 1) undermine G's incentives to comply with a regional autonomy deal.

Sudan provides an example of a government actively undermining existing agreements to try to gain control over oil revenues. The (northern) Sudanese government granted an autonomous region in the south after a civil war that ended in 1972. Less than a decade later, oil discoveries in the south coincided with aggressive moves by the Khartoum government that effectively abrogated the settlement of 1972. In 1980, Sudan's president "announced plans to redraw the borders between southern and northern provinces. When this proposal was blocked by the regional government, he conveniently created a new province . . . and removed the oil fields altogether from southern administrative jurisdiction" (Ofcansky, 1992). A second major separatist civil war broke out in 1983 in reaction to the government's reneged promises.

4.3 Environmental Damage

Although the present analysis has focused on redistributive grievances, residents of oil-rich territories often harbor grievances over oil-induced environmental damage, as in the Niger Delta. This extension suggests an explanation for why governments often fail to address these grievances. Suppose oil production inflicts a per-period environmental degradation cost on C of $d(\cdot)$. G's environmental policies affect this cost, and G can spend $e_t \geq 0$ in any period to improve environmental conditions, i.e., $d'(e_t) < 0$. G can profitably deviate from choosing stringent environmental standards in every period if C can only infrequently coerce the government, and hence environmental damage may arise in equilibrium even though this source of grievances contributes to civil war.

5 Additional Results: Large Prize and Volatile Oil Income

A distinct greed hypothesis is that oil production raises fighting prospects by creating a lucrative prize of secession (Collier and Hoeffler 2005, 44; Laitin 2007, 22). Although this argument is not mutually exclusive of the premise that governments rather than rebels control oil revenues, Appendix Section C.1 analyzes the baseline model to show the theoretical effect of a large prize is ambiguous, and does not provide a compelling explanation for why oil-rich regions fight separatist civil wars relatively frequently.

Appendix Section C.2 extends the model to analyze how volatile oil income may create an additional secession incentive. Ross (2012, 50-54) and Karl (1997) each detail this aspect of oil production, albeit without linking it to civil wars. Two important components of this variance are (a) discovering a new oil field, especially a giant oil field, can cause a dramatic spike in income, and (b) historically, international oil prices have been quite volatile. The extension incorporates these considerations by assuming periods differ between boom and bust. The main finding is that greater inter-period volatility in formal-sector income increases the likelihood of separatist civil wars if bust periods occur infrequently. The overall logic resembles the prize mechanism despite yielding a somewhat different substantive implication. Focusing on an opportunity cost mechanism also distinguishes the finding from Bell and Wolford (2015), who analyze oil discoveries and shifts in the future distribution of power.

6 Conclusion and Empirical Implications

Oil-rich regions fight separatist civil wars relatively frequently—the core empirical finding about resources and conflict. However, leading "greed" and "grievances" explanations posit contradictory premises and do not articulate what is unique about oil to explain bargaining breakdown. This paper examined key features of oil production and then studied a stochastic bargaining game between a government and regional challenger, which can protect its economic production by exiting the formal economy or by coercively seceding. The analysis provided three main contributions. First, it elucidated core aspects of oil production that generate redistributive grievances (Proposition 2), but usually not greed rebellions (Propositions 3 and 4). Greed mechanisms either logically *decrease* prospects for separatist civil war—as discussed for disruptions during peacetime—or require imposing assumptions that are empirically untenable for oil production. For example, Table 1 and the accompanying discussion showed that widespread rebel looting has occurred very rarely during separatist civil wars for oil-rich regions.

Second, the model improved upon existing grievances arguments by theoretically linking capital-intense and immobile oil production to bargaining failure via undermining the challenger's economic exit option (Proposition 2). An ineffective economic exit option causes the government to tax at high rates in periods the challenge has weak capacity for rebellion, which inhibits peaceful bargaining in strong periods. The analysis also explained strategic governments' preferences to risk fighting rather than to grant limited regional autonomy to oil-producing regions (Proposition B.2). Addressing core questions about why oil production prevents actors from reaching a peaceful bargain generates more precise mechanisms to link grievances to fighting, and highlights potentially testable implications. Two crucial considerations in the model are the leverage of the workforce to prevent government taxation, and whether fear of government reneging can undermine negotiations in at times that local residents have successfully mobilized.

Third, by presenting a general model of economic exit and coercive secession, these findings carry theoretical and empirical implications for various grievances and greed mechanisms in the broader civil war literature. The focus on economic redistribution relates to some non-natural resources research (Boix, 2008; Cederman, Weidmann and Gleditsch, 2011), and broader notions of inequality and grievances have featured prominently in recent ethnic conflict research. The present theory offers at least two contributions to this broader framework. First, related to redistributive grievances, it provides a framework for understanding how properties of economic production—such as output elasticity, the value of exiting to an informal sector, and price volatility—affect civil war incentives. The theoretical implications from the model yield hypotheses that could be tested empirically for various economic commodities, for example, by combining the theoretical logic of the model with the commodities in different positions in Figure 1. Second, the model analysis of regional autonomy deals and endogenous institution-building (i.e., the non-Markovian equilibrium) also carries insights into broader sources of grievances such as ethnic groups excluded from power in the central government (Cederman, Gleditsch and Buhaug, 2013). Why would a government exclude ethnic groups if this raises the likelihood of a costly activity, civil war?

One direct implication from the model regarding political exclusion is a non-monotonic relationship between ethnic group strength and civil war, especially in authoritarian regimes that lack institutions for credible commitment. Governments will negotiate concessions with well-organized groups (i.e., high σ) to prevent war. However, governments should take advantage of internally divided groups that face difficulties coordinating for rebellion (i.e., low σ) because the government can rip off the group for long periods of time before facing a future rebellion, following the logic of the regional autonomy subgame perfect Nash equilibrium. Finally, groups with very low organizational capacity ($\sigma \approx 0$ or very low p) cannot credibly threaten to rebel, and therefore government exploitation will not trigger fighting.

Additionally, understanding why greed theories cannot explain the oil-separatist relationship may also help to better understand scope conditions for mechanisms such as rebel looting and finance. Natural resources more easily looted than oil—such as alluvial diamonds—provide more viable sources of rebel finance. Therefore, if looting is a generally relevant mechanism for causing civil wars, then we should expect easily lootable resources such as alluvial diamonds to be systematically associated with separatism but not difficult-to-loot resources such as oil. However, although additional research is needed, existing empirical results show the opposite: oil and separatism are strongly positively correlated whereas the empirical relationship between alluvial diamonds and civil war is somewhat weak (Ross 2006, 286-7; Ross 2015, 250). Perhaps the non-finding for alluvial diamonds arises because these minerals are secondary to state weakness for causing civil war onset. Only in the context of severe state weakness can rebels control territory and mine diamonds—although this is considerably easier for alluvial diamonds than for oil. This provided the context in which rebels looted and financed their armies using alluvial diamonds during conflicts in Angola, Liberia, and Sierra Leone, but can also account for why the overall phenomenon is rare (Ross, 2006, 287). Government failure to control diamond mines in Sierra Leone coincided with a more general collapse of state capacity. As late as the 1980s, diamonds had provided a crucial revenue source for maintaining authoritarian stability and peace in Sierra Leone.

Overall, distinguishing oil from other types of economic production and integrating these considerations into a general model of economic exit and secession not only advances greed and grievance causes of civil war theoretically, but also helps to transcend the greed-grievance divide by distinguishing more precise mechanisms that can be evaluated empirically.

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Supplementary Information

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A Additional Information for Main Theoretical Results

A.1 Proofs for Equilibrium Existence Results

A Markov Perfect Equilibrium (MPE) requires players to choose best responses to each other, with strategies predicated upon the state of the world and on actions within the current period. Three types of periods compose the three values of the state variable μ_t in a generic period t. If C is strong in period t, then $\mu_t = \mu^s$. If C is weak in period t, then $\mu_t = \mu^w$. If C has won a civil war in a previous period, then $\mu_t = \mu^0$. The superscripts respectively stand for "strong," "weak," and "0 taxation after secession."

If $\mu_t \in \{\mu^s, \mu^w\}$, then G's strategy is a function $\tau(\cdot)$ that assigns a tax rate to each state. Formally, $\tau : \{\mu^s, \mu^w\} \to [0,1]$, and τ_s^* and τ_w^* represent equilibrium choices. If $\mu_t = \mu^0$, then τ_t is fixed at 0 by assumption. C's strategy consists of two functions, $\alpha_s(\cdot)$ and $L(\cdot)$, that respectively assign an acceptance/fighting decision and a formal-sector labor supply to each state of the world and to G's current-period choice of τ_t. Formally, $\alpha_s : \{\mu^s\} \times [0,1] \to [0,1]$, and α_s^* represents the equilibrium probability of acceptance term. Additionally, $L : \Big(\{\mu^s, \mu^w\} \times [0,1]\Big) \cup \{\mu^0\} \to \mathbb{R}_+$, and L_s^*, L_w^*, and L_0^* represent equilibrium choices. An MPE is a strategy profile $\big\{\tau_s^*, \tau_w^*, L_s^*, L_w^*, L_0^*, \alpha_s^*\big\}$ such that G's and C's strategies compose best responses to each other. An MPE strategy profile is peaceful if $\alpha_s^* = 1$.

Proof of Lemma 1. C solves:

$$L^*(\tau_t) \in \arg\max_{L_t \geq 0} \; (1-\tau_t) \cdot \theta(L_t) \cdot Y^C - \kappa(L_t) + \delta \cdot V_{\text{s.q.}}^C$$

For expositional clarity, I will solve this as an unconstrained optimization problem and then verify that the constraint $L_t \geq 0$ is satisfied. Because $\theta(L_t)$ is strictly concave in L_t and $\kappa(L_t)$ is strictly convex in L_t, the objective function is strictly concave in L_t. This implies that the solution to the first-order condition is the unique maximizer. The first order condition implicitly defines L^*:

$$(1-\tau_t) \cdot \frac{\partial \theta(L^*)}{\partial L_t} \cdot Y^C - \frac{\partial \kappa(L^*)}{\partial L_t} = 0$$

Substituting in $\frac{\partial \theta(L_t)}{\partial L_t} = \eta \cdot L_t^{\eta-1}$ and $\frac{\partial \kappa(L^*)}{\partial L_t} = L_t^{\frac{1}{\omega}}$ yields:

$$\underbrace{(1-\tau_t) \cdot \eta \cdot L_t^{\eta-1} \cdot Y^C}_{\text{MB}} = \underbrace{L_t^{\frac{1}{\omega}}}_{\text{MC}}$$

This solves to:

$$L^*(\tau_t) = \Big[(1-\tau_t) \cdot \eta \cdot Y^C\Big]^{\frac{\omega}{1+\omega\cdot(1-\eta)}} \tag{A.1}$$

Finally, because by assumption $\tau_t \leq 1$, $\eta > 0$, and $Y^C > 0$, $L^*(\tau_t) \geq 0$ for all τ_t. The consumption terms stated in Lemma 1 follow directly. ■

Lemma A.1 formalizes the claim from the text that the results would be unchanged if residents of the region independently make labor allocation decisions after the rebel leader makes a decision to fight or not.

Lemma A.1. *If $N \in \mathbb{Z}_{++}$ residents independently choose how much labor to supply, then total labor allocation in the unique symmetric equilibrium is identical to the case considered in the paper of a single leader among C choosing the labor allocation.*

Proof. Assume $\theta(\cdot)$ and $\kappa(\cdot)$ are each a function of average labor input. Therefore, a generic resident i solves:

$$\max_{L_i} \ (1-\tau_t) \cdot \left(\frac{L_i + \sum_{N \setminus \{i\}} L_j}{N} \right)^{\eta} \cdot Y^C - \frac{\omega}{1+\omega} \cdot \left(\frac{L_i + \sum_{N \setminus \{i\}} L_j}{N} \right)^{\frac{1+\omega}{\omega}}$$

Denote the per-person equilibrium labor supply as L^* and the average equilibrium labor supply as $\overline{L}^* \equiv \frac{\sum_N L^*}{N}$. Solving the first-order condition yields:

$$(1-\tau_t) \cdot \eta \cdot \frac{1}{N} \cdot \left(\overline{L}^*\right)^{-(1-\eta)} \cdot Y^C = \frac{1}{N} \cdot \left(\overline{L}^*\right)^{\frac{1}{\omega}}$$

This yields the same average labor supply function in the text:

$$\overline{L}^*(\tau_t) = \Big[(1-\tau_t) \cdot \eta \cdot Y^C\Big]^{\frac{\omega}{1+\omega\cdot(1-\eta)}}$$ ■

The following lemma will be used to prove Lemma 2.

Lemma A.2. *If $a \in (0,1)$, then $f(\tau) = \tau \cdot (1-\tau)^a$ is strictly concave in τ over $\tau \in (0,1)$.*

Proof. It suffices to show that the second derivative is strictly negative. $f' = (1-\tau)^a - \tau \cdot a \cdot (1-\tau)^{a-1}$ and $f'' = -a \cdot (1-\tau)^{a-2} \cdot \big[2 \cdot (1-\tau) + \tau \cdot (1-a)\big]$. This term is strictly negative if $a \in (0,1)$ and $\tau \in (0,1)$. ■

Proof of Lemma 2. Solving backwards on the stage game, Equation 2 characterizes C's optimal labor supply function. G solves:

$$\overline{\tau} \in \arg \max_{\tau_t \in [0,1]} \ \tau_t \cdot \theta\big(L^*(\tau_t)\big) \cdot Y^C + \delta \cdot V^G_{\text{s.q.}},$$

For expositional clarity, I will solve this as an unconstrained optimization problem and then verify that the constraint $\tau_t \in [0,1]$ is satisfied. After substituting in functional forms, this objective function is equivalent to:

$$\overline{\tau} \in \arg \max_{\tau_t \in [0,1]} \ \tau_t \cdot \Big[(1-\tau_t) \cdot \eta \cdot Y^C\Big]^{\frac{\omega\eta}{1+\omega\cdot(1-\eta)}} \cdot Y^C + \delta \cdot V^G_{\text{s.q.}}.$$

Because $\omega \in (0,1)$ and $\eta \in (0,1)$, $\frac{\omega\eta}{1+\omega\cdot(1-\eta)} \in (0,1)$. Furthermore, because $Y^C > 0$, $\left[\eta \cdot Y^C\right]^{\frac{\omega\eta}{1+\omega\cdot(1-\eta)}} \cdot Y^C > 0$. Therefore, invoking Lemma A.2 implies that the objective function is strictly concave in τ_t, which implies that the solution to the first-order condition is the unique maximizer.

The first-order condition solves to:

$$\left[(1-\overline{\tau}) \cdot \eta \cdot Y^C\right]^{\frac{\omega\eta}{1+\omega(1-\eta)}} \cdot Y^C \cdot \left[1 - \overline{\tau} \cdot \left(1 - \frac{\omega\eta}{1+\omega(1-\eta)}\right)\right] = 0 \tag{A.2}$$

Rearranging yields:

$$\overline{\tau} = \frac{1+\omega\cdot(1-\eta)}{1+\omega}$$

Because $\omega > 0$ and $\eta < 1$ by assumption, $\overline{\tau} > 0$. Because additionally $\eta > 0$ by assumption, $\overline{\tau} < 1$. ■

Definition A.1 characterizes a minimum discount rate for C to be able to credibly separate in a strong period in reaction to being offered $\tau_t = \overline{\tau}$ in every period in the status quo territorial regime. Sufficient patience is necessary because C does not reap the expected gains of fighting until the future.

Definition A.1 (Lower bound discount rate for fighting to be credible)**.**

$$\underline{\delta}_C \equiv \frac{\left[(1-\overline{\tau}) \cdot \theta(\overline{L}) \cdot Y^C - \kappa(\overline{L})\right] - \left[(1-\phi)\cdot(1-x)\cdot\theta\big(L^*(x)\big)\cdot Y^C - \kappa\big(L^*(x)\big)\right]}{p \cdot \left\{\left[\theta(L_0^*) \cdot Y^C - \kappa(L_0^*)\right] - \left[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C - \kappa(\overline{L})\right]\right\}}$$

Definition A.2 revises Equation 3 to characterize the current-period tax offer in a strong period that makes C indifferent between accepting and fighting, holding fixed future equilibrium values. This offer is unique because $\Psi(\tau_t)$ strictly decreases in τ_t, which can be shown by applying the envelope theorem to C's consumption function. It is only possible to have $\Psi(\tau_t) = 0$ if $\delta > \underline{\delta}_C$.

Definition A.2 (Indifference condition for current-period tax rate)**.**

$$\Psi(\tau_t) \equiv \left[(1-\tau_t)\cdot\theta\big(L^*(\tau_t)\big)\cdot Y^C - \kappa\big(L^*(\tau_t)\big)\right] - \left[(1-\phi)\cdot(1-x)\cdot\theta\big(L^*(x)\big)\cdot Y^C - \kappa\big(L^*(x)\big)\right]$$
$$+\frac{\delta p}{1-\delta}\cdot\left\{\sigma\cdot\left[(1-\tau_s^*)\cdot\theta(L_s^*)\cdot Y^C - \kappa(L_s^*)\right] + (1-\sigma)\cdot\left[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C - \kappa(\overline{L})\right]\right\}$$
$$-\frac{\delta p}{1-\delta}\cdot\left[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\right] = 0$$

Before proving Lemma 3, the following explains why G will always buy off C in a strong period if possible, i.e., why G does not have a profitable deviation from choosing the highest tax rate that satisfies Equation 3. (Assuming this amount does not exceed $\overline{\tau}$. If C would accept $\tau_t = \overline{\tau}$, i.e., if $\delta < \underline{\delta}_C$, then G optimally sets $\tau_t = \overline{\tau}$.) Choosing a strictly lower tax proposal than needed to gain acceptance would decrease G's utility by diminishing its revenues without altering C's acceptance/fighting choice. If instead G deviated by choosing a higher tax rate that does not satisfy Equation 3, then G may experience a net gain during the period of the war because it consumes $(1-\phi)\cdot x$ percent of C's formal-sector production if a war occurs. However, the best-case scenario for G is that it wins the war—which yields the same future continuation value for G as buying off C. The worst-case scenario is that G loses and can never tax C again. Therefore, in future periods, G is strictly worse off in expectation from deviating from a peaceful strategy profile. Given these considerations, Assumption A.1 characterizes a minimum destructiveness of fighting for G to prefer to offer $\tau_t = 0$ to C in a strong period and induce peace, rather than to offer a higher tax rate that does not satisfy Equation 3. This rules out the strategically uninteresting case in which G triggers a war to enable extracting more resources from C's region for one period (despite strictly lower expected consumption in every future period).

Assumption A.1 (Fighting is sufficiently destructive for G to always buy off C)**.**

$$\phi > \overline{\phi} \equiv 1 - \frac{\delta \cdot p \cdot (1-\sigma)\cdot \overline{\tau}\cdot \theta(\overline{L})}{x \cdot \theta\big(L^*(x)\big)}$$

By similar logic, although G is not given an explicit choice to initiate a civil war, if instead it were, it would not exercise this option even in a weak period. Initiating a fight in a weak period would yield strictly lower consumption for G in the period of the fight—$(1-\phi)\cdot x\cdot\theta\big(L^*(x)\big)\cdot Y^C$ rather than maximum revenue amount $\overline{\tau}\cdot\theta(\overline{L})\cdot Y^C$—and the same expected consumption stream in future periods. This would therefore be a strictly unprofitable deviation.

The proof of Lemma 3 begins by defining C's optimal acceptance function and G's optimization problem for τ_t, and proving that three cases partition the parameter space. In the first two cases, a peaceful path of play is possible in equilibrium. Case 1 characterizes optimal actions if G can induce acceptance from C in a strong period by offering $\tau_t = \overline{\tau}$. Case 2 characterizes optimal actions if G cannot induce acceptance from C in a strong period by offering $\tau_t = \overline{\tau}$ but there do exist $\tau_t > 0$ such that G can induce acceptance. Case 3 characterizes optimal actions if a peaceful path of play is not possible in equilibrium.

Proof of Lemma 3.

Preliminaries. Solving backwards on the stage game if $\mu_t = \mu^s$, Equation 2 characterizes C's unique optimal labor supply function. For the fighting decision stage, recall that $\alpha_s(\tau_t)$ denotes C's probability of acceptance given the period t proposed tax rate if the continuation values specify acceptance in all future periods. Any equilibrium must satisfy:

$$\alpha_s(\tau_t) = \begin{cases} 0 & \Psi(\tau_t) < 0 \\ [0,1] & \Psi(\tau_t) = 0 \\ 1 & \Psi(\tau_t) > 0, \end{cases} \tag{A.3}$$

for $\Psi(\tau_t)$ defined in Definition A.2. C cannot profitably deviate to $\alpha_s(\tau_t) > 0$ if $\Psi(\tau_t) < 0$, or to $\alpha_s(\tau_t) < 1$ if $\Psi(\tau_t) > 0$.

If G chooses τ_t to buy off C, it solves:

$$\max_{\tau_t\in[0,1]} \tau_t \cdot \Big[(1-\tau_t)\cdot\eta\cdot Y^C\Big]^{\frac{\omega\eta}{1+\omega\cdot(1-\eta)}} \cdot Y^C + \delta\cdot V^G_{\text{s.q.}} \text{ s.t. } \Psi(\tau_t)\geq 0 \tag{A.4}$$

This optimization problem posits a single deviation for G from the posited equilibrium strong-period tax offer τ_s^* because τ_s^* is assumed to be fixed in future periods, a term subsumed into the continuation value

$V^G_{\text{s.q.}}$ and into $\Psi(\tau_t)$. Equation A.4 can be written as a Lagrangian with an inequality constraint. Because the optimal strong-period tax rate is interior for the same reasons as shown in Lemma 2, I ignore the boundary constraints on the tax rate to avoid notational clutter. Defining the Lagrange multiplier on the inequality as λ, the first-order condition enables implicitly solving for τ_s^*:

$$\left[(1-\tau_s^*)\cdot\eta\cdot Y^C\right]^{\frac{\omega\eta}{1+\omega(1-\eta)}}\cdot Y^C\cdot\left[1-\tau_s^*\cdot\left(1-\frac{\omega\eta}{1+\omega(1-\eta)}\right)-\lambda\right]=0,$$

This term is nearly is identical to Equation A.2. The difference arises from the multiplier λ, and that part of the expression results from applying the envelope theorem to C's consumption function. This simplifies to the first KKT condition:

$$(1)\quad \lambda^*=1-\tau_s^*\cdot\left(1-\frac{\omega\eta}{1+\omega(1-\eta)}\right)$$

The other KKT conditions are:

$$(2)\ \lambda^*\cdot\Psi^*(\tau_s^*)=0,\quad (3)\ \lambda^*\geq 0,\quad (4)\ \Psi^*(\tau_s^*)\geq 0,$$

which follows from substituting in the equilibrium term $\tau_t=\tau_s^*$ and modifying the definition of $\Psi(\cdot)$ in Definition A.2 to define:

$$\begin{aligned}\Psi^*(\tau_s^*)\equiv&\left[(1-\tau_s^*)\cdot\theta(L_s^*)\cdot Y^C-\kappa(L_s^*)\right]-\left[(1-\phi)\cdot(1-x)\cdot\theta\big(L^*(x)\big)\cdot Y^C-\kappa\big(L^*(x)\big)\right]\\&+\frac{\delta p}{1-\delta}\cdot\left\{\sigma\cdot\left[(1-\tau_s^*)\cdot\theta(L_s^*)\cdot Y^C-\kappa(L_s^*)\right]+(1-\sigma)\cdot\left[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C-\kappa(\overline{L})\right]\right\}\\&-\frac{\delta p}{1-\delta}\cdot\left[\theta(L_0^*)\cdot Y^C-\kappa(L_0^*)\right]=0\end{aligned}$$

Three cases generically partition the parameter space:

1. $\Psi^*(\overline{\tau})>0$
2. $\Psi^*(\overline{\tau})<0<\Psi^*(0)$
3. $\Psi^*(0)<0$

Cases 1 and 2 feature peaceful bargaining in equilibrium. Applying the envelope theorem to C's consumption function establishes that $\Psi^*(\tau_s^*)$ strictly decreases in τ_s^*, which implies that these cases partition the parameter space.

Case 1. $\boldsymbol{\Psi^*(\overline{\tau})>0}$. Need to show that if $\Psi^*(\overline{\tau})>0$, then $\tau_s^*=\overline{\tau}$. First, prove $\tau_s^*=\overline{\tau}$ is a solution. If $\Psi^*(\overline{\tau})\geq 0$ and $\tau_s^*=\overline{\tau}$, then the fourth KKT condition is trivially satisfied. Substituting the term for $\overline{\tau}$ from Equation 5 into the first KKT condition yields $\lambda^*=0$, which also trivially satisfies the second and third KKT conditions.

Second, prove $\tau_s^*=\overline{\tau}$ is the unique solution by generating contradictions for alternative candidate solutions.

- Any $\tau_s^*>\overline{\tau}$ cannot be a solution. λ^*, as defined in KKT condition 1, is a strictly decreasing function of τ_s^*. Because $\lambda^*=0$ for $\tau_s^*=\overline{\tau}$, the first KKT condition implies $\lambda^*<0$ for any $\tau_s^*>\overline{\tau}$, which violates the third KKT condition. (For high enough τ_s^*, C may reject the offer.

This does not alter the proof, however, because it is not incentive-compatible for G to offer $\tau_s^* > \overline{\tau}$ and experience fighting rather than to consume maximum revenues in every period.)

- If $\Psi^*(\overline{\tau}) = 0$, then $\tau_s^* = \overline{\tau}$ is a solution (see above), and it is unique because the strict monotonicity of $\Psi^*(\tau_s^*)$ implies that any solution is unique.
- If $\Psi^*(\overline{\tau}) > 0$, then any $\tau_s^* < \overline{\tau}$ cannot be a solution. KKT condition 1 shows that $\lambda^* > 0$ for any $\tau_t < \overline{\tau}$. Furthermore, because Ψ^* strictly decreases in τ_s^*, if $\Psi^*(\overline{\tau}) > 0$ and $\tau_s^* < \overline{\tau}$, then $\Psi^*(\tau_s^*) > 0$. Having both $\lambda^* > 0$ and $\Psi^*(\tau_s^*) > 0$ violates the second KKT condition.

Case 2. $\boldsymbol{\Psi^*(\overline{\tau}) < 0 < \Psi^*(0)}$. I will further disaggregate this case into four parts. Part 1 solves for the offer $\tau_t = \tau_s^*$ such that $\Psi^*(\tau_s^*) = 0$. Part 2 shows that C does not have a profitable deviation from playing $\alpha_s(\tau_s^*) = 1$, i.e., accepting with probability 1 the strong-period offer that makes it indifferent between accepting and fighting. Part 3 shows that no equilibrium exists in which $\alpha_s(\tau_s^*) < 1$, i.e., there is no equilibrium in which C rejects with positive probability an offer that makes it indifferent between accepting and fighting. Part 4 shows that G cannot profitably deviate from offering $\tau_t = \tau_s^*$.

Part 1. Need to show that if $\Psi^*(\overline{\tau}) < 0 < \Psi^*(0)$, then there exists a unique $\tau_s^* \in (0, \overline{\tau})$ such that $\Psi^*(\tau_s^*) = 0$. If $\Psi^*(\overline{\tau}) < 0$, then only τ_s^* such that $\tau_s^* < \overline{\tau}$ can possibly satisfy the fourth KKT condition from the optimization problem in Equation A.4. The first KKT condition implies for any $\tau_s^* < \overline{\tau}$ that $\lambda^* > 0$ (which trivially satisfies the third KKT condition). This in turn implies that only τ_s^* such that $\Psi^*(\tau_s^*) = 0$ satisfy the second KKT condition (which also trivially satisfies the fourth KKT condition). Applying the intermediate value theorem demonstrates the existence of at least one $\tau_s^* \in (0, \overline{\tau})$ such that $\Psi^*(\tau_s^*) = 0$.

- We are currently assuming $\Psi^*(\overline{\tau}) < 0$.
- We are currently assuming $\Psi^*(0) > 0$.
- $L^*(\tau_t)$ is a continuous function and $\theta(\cdot)$ is assumed to be continuous in L_t. Therefore, $\Psi^*(\cdot)$ is continuous in τ_s^*.

Furthermore, the strict monotonicity of $\Psi^*(\cdot)$ in τ_s^* implies the τ_s^* that satisfies all four KKT conditions is unique.

Part 2. Follows immediately from Equation A.3 and from defining τ_s^* as the solution to $\Psi^*(\tau_s^*) = 0$.

Part 3. I will demonstrate that there does not exist an equilibrium strategy profile in which $\alpha_s(\tau_s^*) < 1$ by generating a contradiction. If $\alpha_s(\tau_s^*) < 1$, then a peaceful equilibrium strategy profile requires offering some $\tau_t > \tau_s^*$ (see the definition of a peaceful equilibrium strategy profile above when defining the equilibrium concept, and Equation A.3). Modifying Equation A.4, G therefore chooses:

$$\max_{\tau_t \in [0,1]} \tau_t \cdot \left[(1 - \tau_t) \cdot \eta \cdot Y^C \right]^{\frac{\omega\eta}{1+\omega\cdot(1-\eta)}} \cdot Y^C + \delta \cdot V^G_{\text{s.q.}} \text{ s.t. } \Psi(\tau_t) > 0$$

The strict inequality on the constraint generates an open set problem that yields a profitable deviation for G from any τ_t such that $\tau_t > \tau_s^*$.

Part 4. Combining Equation A.3 and Part 3 establishes that the only possible equilibrium acceptance functions for C involve acceptance with probability 1, if $\tau_t \geq \tau_s^*$, or acceptance with probability 0, if $\tau_t < \tau_s^*$. If it is possible to induce acceptance, i.e., if $\Psi^*(\overline{\tau}) < 0 < \Psi^*(0)$, then G cannot profitably deviate to making an unacceptable offer $\tau_t > \tau_s^*$ if:

$$\tau_s^* \cdot \left[(1-\tau_s^*) \cdot \eta \cdot Y^C\right]^{\frac{\omega\eta}{1+\omega\cdot(1-\eta)}} \cdot Y^C + \delta V_{\text{s.q.}}^G \geq (1-\phi) \cdot x \cdot \theta\big(L^*(x)\big) \cdot Y^C + \delta \cdot \left[p \cdot V_{\text{sec}}^G + (1-p) \cdot V_{\text{s.q.}}^G\right]$$

Because the left-hand side of the equation reaches its lower bound at $\tau_s^* = 0$, Assumption A.1 provides a sufficient condition for satisfying this inequality. The proof of Case 2 shows G will not deviate to choosing $\tau_t < \tau_s^*$.

Case 3. $\boldsymbol{\Psi^*(0) < 0}$. I will further disaggregate this case into two parts. First, I characterize the conditions under which $\overline{\sigma} \in (0, 1)$, defined in Equation 6. Second, I characterize equilibrium actions in a conflictual equilibrium.

Part 1. Because $\Psi^*(\cdot)$ strictly decreases in τ_s^*, it follows that $\Psi^*(\cdot) < 0$ for all $\tau_s^* \in [0, 1]$ if $\Psi^*(0) < 0$. For $\delta < \underline{\delta}_C$ (Definition A.2), algebraic manipulation easily demonstrates that $\Psi^*(0) > 0$ for all σ. In this case, $\overline{\sigma}$ is set to 0. If $\delta > \underline{\delta}_C$, then applying the intermediate value theorem demonstrates the existence of at least one $\overline{\sigma}$ that satisfies $\Psi^*(\tau_s^*) = 0$. Note that $\Phi(\overline{\sigma})$ defined in Equation 6 is equivalent to $\Psi^*(0)$.

- $\Phi(0) < 0$ if $\delta > \underline{\delta}_C$
- $\Phi(1) = \theta(L_0^*) \cdot Y^C - \kappa(L_0^*) > 0$
- $\Phi(\cdot)$ is continuous in σ

Furthermore, because $\Phi(\cdot)$ strictly increases in σ, $\overline{\sigma}$ constitutes a unique threshold such that $\Phi(\cdot) < 0$ if $\sigma < \overline{\sigma}$ and $\Phi(\cdot) > 0$ if $\sigma > \overline{\sigma}$.

Part 2. If and only if C strictly prefers to fight in a strong period than to accept a tax offer of 0, any equilibrium will feature fighting in every strong period. This is formalized as:

$$V_s^C \geq U_C(\tau_t = 0) + \delta \cdot \left[\sigma \cdot V_s^C + (1-\sigma) \cdot V_w^C\right], \tag{A.5}$$

where V_s^C is C's continuation value in the posited strategy profile in a strong period, V_w^C is C's continuation value in a weak period, and $U_C(\tau_t = 0) = \theta(L_0^*) \cdot Y^C - \kappa(L_0^*)$. The following two equations enable solving for V_s^C and V_w^C:

$$V_s^C = U_C(\text{war}) + \delta \cdot \left\{p \cdot \frac{U_C(\tau_t = 0)}{1-\delta} + (1-p) \cdot \left[\sigma \cdot V_s^C + (1-\sigma) \cdot V_w^C\right]\right\} \tag{A.6}$$

$$V_w^C = U_C(\tau_t = \overline{\tau}) + \delta \cdot \left[\sigma \cdot V_s^C + (1-\sigma) \cdot V_w^C\right], \tag{A.7}$$

for $U_C(\text{war}) = (1-\phi) \cdot (1-x) \cdot \theta\big(L^*(x)\big) \cdot Y^C - \kappa\big(L^*(x)\big)$ and $U_C(\tau_t = \overline{\tau}) = \big(1-\overline{\tau}\big) \cdot \theta\big(\overline{L}\big) \cdot Y^C - \kappa\big(\overline{L}\big)$. Solving the system of equations defined by Equations A.6 and A.7 and substituting the continuation values into Equation A.5 yields $\sigma \leq \overline{\sigma}$, for the same $\overline{\sigma}$ defined in Equation 6. This is consistent with the imposed parameter assumption $\sigma < \overline{\sigma}$ for the conflictual equilibrium. Finally, G cannot profitably deviate from mixing over all possible τ_t in a strong period. Because C fights in response to any offer, G's utility is not a function of τ_t.

For all these cases, the equilibrium strategic actions immediately imply the consumption amounts stated in Lemma 3. ■

A.2 Proofs for Comparative Statics Predictions

Proof of Lemma 4. $-\frac{d\overline{\tau}}{d\eta} = \frac{\omega}{1+\omega} > 0$ because $\omega > 0$ by assumption. $-\frac{d\overline{\tau}}{d\omega} = \frac{\eta}{(1+\omega)^2} > 0$ because $\eta > 0$ by assumption. ■

The relationship between elasticity and the tax rate, discussed in the text, can be illustrated even more clearly in a more general parameterization of a government's tax problem. Suppose C's optimal formal-sector labor supply is $\big[(1-\tau_t)\cdot\mu\big]^{\alpha}$, for some $\mu \in (0,1)$ and $\alpha \in (0,1)$, and formal-sector output equals L_t^{β}, for some $\beta \in (0,1)$. Here, α is labor-supply elasticity and β is output elasticity. Then, G's tax objective function is $\tau_t \cdot \big[(1-\tau_t)\cdot\mu\big]^{\alpha\beta}$ and the optimal tax rate solves to $\tau^* = \frac{1}{1+\alpha\beta}$. This is clearly a strictly decreasing function of both the labor supply elasticity parameter and the output elasticity parameter.

The following lemma will be used to prove Propositions 2 through 4.

Lemma A.3. *For a generic parameter ϵ, if $\frac{\partial\Phi(\overline{\sigma})}{\partial\epsilon} > 0$, for $\Phi(\overline{\sigma})$ defined in Equation 6, then $\frac{\partial\overline{\sigma}}{\partial\epsilon} < 0$. If $\frac{\partial\Phi(\overline{\sigma})}{\partial\epsilon} < 0$, then $\frac{\partial\overline{\sigma}}{\partial\epsilon} > 0$.*

Proof. Using the implicit function theorem to calculate the partial derivative of $\overline{\sigma}$ (defined in Equation 6) with respect a generic parameter ϵ yields:

$$\frac{\partial\overline{\sigma}}{\partial\epsilon} = \frac{\frac{\partial\Phi(\overline{\sigma})}{\partial\epsilon}}{-\frac{\partial\Phi(\overline{\sigma})}{\partial\sigma}}$$

It suffices to demonstrate that the denominator is strictly negative:

$$-\frac{\partial\Phi(\overline{\sigma})}{\partial\sigma} = -\delta p \cdot \Big\{\Big[\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\Big] - \Big[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C - \kappa(\overline{L})\Big]\Big\} < 0.$$

The strict positivity of the term in brackets follows because C's consumption function strictly decreases in τ_t, which can be shown by applying the envelope theorem to C's consumption function. ■

Proof of Proposition 2. Applying the envelope theorem demonstrates that $\frac{d\overline{\sigma}}{d\overline{\tau}} = \frac{\partial\overline{\sigma}}{\partial\overline{\tau}}$. Therefore, for parts a and b, because of Assumption 1, Lemma 4, and Lemma A.3, it suffices to demonstrate that $\frac{\partial\Phi(\overline{\sigma})}{\partial\overline{\tau}} = -\delta p(1-\overline{\sigma})\cdot\theta(\overline{L})\cdot Y^C < 0.$ ■

Proof of Proposition 3. It is trivial to demonstrate that $\frac{d\overline{\sigma}}{dp} = \frac{\partial\overline{\sigma}}{\partial p}$. Because of Assumption 2 and Lemma A.3, it suffices to demonstrate that $-\frac{\partial\Phi(\overline{\sigma})}{\partial p} = -\delta(1-\overline{\sigma}) \cdot \Big\{\big[\theta(L_0^*) \cdot Y^C - \kappa(L_0^*)\big] - \big[(1-\overline{\tau}) \cdot \theta(\overline{L}) \cdot Y^C - \kappa\big(\overline{L}\big)\big]\Big\} > 0$. ■

Proof of Proposition 4. Applying the envelope theorem demonstrates $\frac{d\overline{\sigma}}{dx} = \frac{\partial\overline{\sigma}}{\partial x}$. Because of Assumption 3 and Lemma A.3, it suffices to demonstrate $\frac{\partial\Phi(\overline{\sigma})}{\partial x} = (1-\delta) \cdot (1-\phi) \cdot \theta\big(L^*(x)\big) \cdot Y^C > 0$. ■

A.3 Government Transfers?

For simplicity, the setup does not provide a budget from which G can offer C transfers in any period. However, introducing this possibility would not qualitatively alter Lemmas 2 and 3. G would not offer transfers in a weak period because C does not pose a coercive threat. Transfers from G would facilitate a wider range of parameters in which G can buy off C in a strong period by raising the opportunity cost of seceding, but the absence of equilibrium transfers in a weak period would still imply that, for low enough σ, G would not be able to buy off C in a strong period with a finite budget constraint.

B Additional Formal Details for "Committing to Regional Autonomy?"

The following formally states the strategy profile.

Proposition B.1. ***Part a.*** *If $\sigma > \hat{\sigma} > 0$ and $\delta > \underline{\delta}_C$, for $\hat{\sigma}$ defined below in Equation B.5 and $\underline{\delta}_C$ defined in Definition A.1, the following composes a SPNE strategy profile. Define $\mathbb{W}$ as the set of periods since the greater of the first period of the game and the period in which the most recent civil war occurred. $\hat{\underline{\tau}}$ is defined below in Equation B.1.*

1. *G's tax offer:*
   (a) *If $\tau_j \leq \hat{\underline{\tau}}$ for all $j \in \mathbb{W}$, then $\tau_t = \hat{\underline{\tau}}$.*
   (b) *If $\tau_j > \hat{\underline{\tau}}$ for any $j \in \mathbb{W}$, then $\tau_t = \overline{\tau}$.*
2. *C's separatist civil war decision if $\mu_t = \mu^s$:*
   (a) *If $\tau_j \leq \hat{\underline{\tau}}$ for all $j \in \mathbb{W}$, then C accepts $\tau_t \leq \hat{\underline{\tau}}$ and fights otherwise.*
   (b) *If $\tau_j > \hat{\underline{\tau}}$ for any $j \in \mathbb{W}$, then C fights in response to any $\tau_t \in [0,1]$.*
3. *C sets labor optimally according to Equation 2.*
4. *Secession subgame is identical to the MPE in Proposition 1.*

Part b. *If $\delta < \underline{\delta}_C$, then G proposes $\tau_t = \overline{\tau}$ in every period, C accepts any offer $\tau_t \leq \overline{\tau}$, and C sets labor optimally according to Equation 2. Secession subgame is identical to MPE.*

Part a is the main case of interest. It describes equilibrium actions if a peaceful path of play is possible and $\hat{\underline{\tau}} < \overline{\tau}$. Part b is the trivial case in which C's discount rate is so low that it prefers to accept any offer in a strong period no greater than the G's revenue-maximizing tax rate because it assigns sufficiently low weight to the potential gains from fighting (note that the full strategy specification for part b entails a threshold value of τ_t higher than $\overline{\tau}$ that C will accept).

This is not the only non-Markovian SPNE of the game, of which there are infinite, but it is substantively relevant for several reasons. First, the constant tax rate across periods naturally expresses the idea of a regional autonomy deal. Notably, within the class of punishment strategies stated in Proposition B.1, cooperation could be sustained for a lower value of σ if G taxed at 0 in strong periods and at a rate in weak periods that satisfies Equation 7 with equality (which will exceed $\underline{\hat{\tau}}$). This minimizes G's incentives to deviate from the cooperative strategy in a weak period. However, the intuition is qualitatively similar for this strategy profile, and it is less substantively interesting because we would not expect governments and regional challengers to construct regional autonomy deals in this manner. Second, the chosen punishment strategy—C punishes any deviation by G with a civil war in the next period it can, before returning to cooperation—also appears substantively relevant. Although cooperation could be achieved for a wider range of σ values with a grim trigger-type punishment strategy with war in every strong period after a single defection, empirically, it seems infeasible for a challenger to follow-through with permanent war (plus, initiating even a single civil war is quite a costly punishment in reaction to a deviation).

The following proves the non-trivial case with an interior tax offer.

Proof of Proposition B.1, part a. First, need to prove the existence of a unique $\underline{\hat{\tau}} \in (0, \overline{\tau})$. Equation 7 follows from identical considerations as Equation 3 and states the conditions under which C will accept a constant per-period tax offer $\hat{\tau}$. Substituting

$$\hat{V}^C_{sec} = \frac{\theta(L^*_0) \cdot Y^C - \kappa(L^*_0)}{1-\delta} \text{ and } \hat{V}^C_{s.q.} = \frac{(1-\hat{\tau}) \cdot \theta\big(L^*(\hat{\tau})\big) \cdot Y^C - \kappa\big(L^*(\hat{\tau})\big)}{1-\delta}$$

into Equation 7 and re-arranging yields:

$$\chi(\underline{\hat{\tau}}) \equiv (1-\delta) \cdot \Big\{ \Big[(1-\underline{\hat{\tau}}) \cdot \theta\big(L^*(\underline{\hat{\tau}})\big) \cdot Y^C - \kappa\big(L^*(\underline{\hat{\tau}})\big) \Big] - \Big[(1-\phi) \cdot (1-x) \cdot \theta\big(L^*(x)\big) \cdot Y^C - \kappa\big(L^*(x)\big) \Big] \Big\}$$
$$- \delta \cdot p \cdot \Big\{ \Big[\theta(L^*_0) \cdot Y^C - \kappa(L^*_0) \Big] - \Big[(1-\underline{\hat{\tau}}) \cdot \theta\big(L^*(\underline{\hat{\tau}})\big) \cdot Y^C - \kappa\big(L^*(\underline{\hat{\tau}})\big) \Big] \Big\} = 0 \qquad \text{(B.1)}$$

Applying the intermediate value theorem demonstrates the existence of at least one $\hat{\tau} \in (0, \overline{\tau})$ that satisfies Equation B.1:

- $\chi(0) = (1-\delta) \cdot \Big\{ \Big[\theta(L^*_0) \cdot Y^C - \kappa(L^*_0) \Big] - \Big[(1-\phi) \cdot (1-x) \cdot \theta\big(L^*(x)\big) \cdot Y^C - \kappa\big(L^*(x)\big) \Big] \Big\} > 0$ because $\phi > 0$, $x > 0$, and the envelope theorem implies C's consumption is a strictly decreasing function of x.
- $\delta > \underline{\delta}_C$ implies $\chi(\overline{\tau}) < 0$.
- $\theta(\cdot)$ and $\kappa(\cdot)$ are assumed to be continuous functions of τ_t, which implies $\chi(\cdot)$ is continuous in $\hat{\tau}$.

Additionally, applying the envelope theorem to C's consumption function shows that $\chi(\underline{\hat{\tau}})$ strictly decreases in $\underline{\hat{\tau}}$, which establishes the uniqueness of $\underline{\hat{\tau}}$.

Now we can check the incentive-compatibility of each action specified in the Proposition B.1 strategy profile.

1a. G's lifetime expected utility to following the strategy profile in any period is:

$$\frac{1}{1-\delta} \cdot \hat{\underline{\tau}} \cdot \theta\big(L^*(\hat{\underline{\tau}})\big) \cdot Y^C. \tag{B.2}$$

G's most profitable deviation entails offering $\tau_t = \overline{\tau}$ in a period that C has weak capacity for rebellion. The lifetime value of this deviation, evaluated from the perspective of the period of the defection, is denoted as V_w^G and equals:

$$V_w^G = \overline{\tau} \cdot \theta(\overline{L}) \cdot Y^C + \delta \cdot \Big[\sigma \cdot V_s^G + (1-\sigma) \cdot V_w^G\Big],$$

where V_s^G expresses G's lifetime expected utility from the perspective of the next period that C has strong capacity for rebellion. The recursive equation solves to:

$$V_w^G = \frac{\overline{\tau} \cdot \theta(\overline{L}) \cdot Y^C + \delta\sigma \cdot V_s^G}{1-\delta(1-\sigma)}. \tag{B.3}$$

C will initiate a civil war in the first strong period, and therefore:

$$V_s^G = (1-\phi) \cdot x \cdot \theta\big(L^*(x)\big) \cdot Y^C + \frac{\delta}{1-\delta} \cdot (1-p) \cdot \hat{\underline{\tau}} \cdot \theta\big(L^*(\hat{\underline{\tau}})\big) \cdot Y^C. \tag{B.4}$$

After the war, with probability p, G never consumes C's production again because C successfully secedes. With probability $1-p$ the secession attempt fails and the players revert to the original regional autonomy deal.

Then, can substitute Equation B.4 into Equation B.3 and compare to Equation B.2 to yield the inequality that governs G's incentive compatibility constraint in a weak period:

$$\underbrace{\frac{\hat{\underline{\tau}} \cdot \theta\big(L^*(\hat{\underline{\tau}})\big) \cdot Y^C}{1-\delta}}_{G\text{'s lifetime expected utility from following strategy profile}} \geq$$

$$\underbrace{\frac{(1-\delta) \cdot \overline{\tau} \cdot \theta(\overline{L}) \cdot Y^C + (1-\delta) \cdot \delta \cdot \sigma \cdot (1-\phi) \cdot x \cdot \theta\big(L^*(x)\big) \cdot Y^C + \delta^2 \cdot \sigma \cdot (1-p) \cdot \hat{\underline{\tau}} \cdot \theta\big(L^*(\hat{\underline{\tau}})\big) \cdot Y^C}{(1-\delta) \cdot \big[1-\delta(1-\sigma)\big]}}_{G\text{'s lifetime expected utility from deviating to the revenue-maximizing tax rate}}.$$

Algebraic re-arranging enables implicitly defining a threshold value of $\hat{\sigma}$ such that this inequality is satisfied if $\sigma > \hat{\sigma}$ but not if $\sigma < \hat{\sigma}$. The threshold $\hat{\sigma}$ is the analog of $\overline{\sigma}$ for this SPNE:

$$\Omega(\hat{\sigma}) \equiv \delta^2 \cdot \hat{\sigma} \cdot p \cdot \hat{\underline{\tau}} \cdot \theta\big(L^*(\hat{\underline{\tau}})\big) + \delta(1-\delta)\hat{\sigma} \cdot \Big[\hat{\underline{\tau}} \cdot \theta\big(L^*(\hat{\underline{\tau}})\big) - (1-\phi) \cdot x \cdot \theta\big(L^*(x)\big)\Big]$$

$$- (1-\delta) \cdot \Big[\overline{\tau} \cdot \theta(\overline{L}) - \hat{\underline{\tau}} \cdot \theta\big(L^*(\hat{\underline{\tau}})\big)\Big] = 0 \tag{B.5}$$

It is easy to see that $\hat{\sigma} > 0$, because (1) the first line of Equation B.5 cancels out if $\sigma = 0$ and (2) Equation B.5 strictly increases in σ.

1b. Because C will initiate a civil war in the next strong period regardless of G's current-period action, G cannot profitably deviate from setting the revenue-maximizing tax rate.

2a. This is incentive-compatible because $\tau_t \leq \hat{\underline{\tau}}$ satisfies Equation 8 whereas $\tau_t > \hat{\underline{\tau}}$ violates it.

2b. Because G will offer $\tau_t = \overline{\tau}$ in all periods until after the next civil war and because $\delta > \underline{\delta}_C$, C cannot profitably deviate from fighting.

3. This consideration is unchanged from the MPE case. ■

The following states formally and proves the analog to Proposition 2 for the constant-tax SPNE strategy profile, after presenting several preliminary assumptions and results. Assumption B.1 replaces Assumption A.1 used to prove Lemma 3 and Proposition 1. It states that the costs of fighting are sufficiently high that G's contemporaneous consumption in the period of a civil war is strictly lower than its contemporaneous consumption from offering the constant tax rate $\hat{\underline{\tau}}$. Lemma B.1 is the analog of Lemma A.3.

Assumption B.1.

$$\phi > \underline{\phi} \equiv 1 - \frac{\hat{\underline{\tau}} \cdot \theta\big(L^*(\hat{\underline{\tau}})\big)}{x \cdot \theta\big(L^*(x)\big)}$$

Lemma B.1. *For a generic parameter ϵ, if $\frac{\partial \Omega(\hat{\sigma})}{\partial \epsilon} > 0$, for $\Omega(\hat{\sigma})$ defined in Equation B.5, then $\frac{\partial \hat{\sigma}}{\partial \epsilon} < 0$. If $\frac{\partial \Omega(\hat{\sigma})}{\partial \epsilon} < 0$, then $\frac{\partial \hat{\sigma}}{\partial \epsilon} > 0$.*

Proof. Using the implicit function theorem to calculate the partial derivative of $\hat{\sigma}$ (defined in Equation B.5) with respect a generic parameter ϵ yields:

$$\frac{\partial \hat{\sigma}}{\partial \epsilon} = \frac{\frac{\partial \Omega(\hat{\sigma})}{\partial \epsilon}}{-\frac{\partial \Omega(\hat{\sigma})}{\partial \sigma}}$$

It suffices to demonstrate that the denominator is strictly negative:

$$-\frac{\partial \Omega(\hat{\sigma})}{\partial \sigma} = -\bigg\{\delta^2 \cdot p \cdot \hat{\underline{\tau}} \cdot \theta\big(L^*(\hat{\underline{\tau}})\big) + \delta \cdot (1-\delta) \cdot \Big[\hat{\underline{\tau}} \cdot \theta\big(L^*(\hat{\underline{\tau}})\big) - (1-\phi) \cdot x \cdot \theta\big(L^*(x)\big)\Big]\bigg\} < 0$$

The strict positivity of the term in brackets follows from Assumption B.1. ■

Proposition B.2 (Redistributive grievances in constant-tax SPNE)**.** *An increase in C's oil production through its effect on increasing G's revenue-maximizing tax rate increases $\hat{\sigma}$. Formally, for $\hat{\sigma}$ defined in Equation B.5:*

Part a. $-\frac{\partial \hat{\sigma}}{\partial \overline{\tau}} \cdot \frac{d\overline{\tau}}{d\eta} > 0.$

Part b. $-\frac{\partial \hat{\sigma}}{\partial \overline{\tau}} \cdot \frac{d\overline{\tau}}{d\omega} > 0.$

Proof. Because $\frac{d\hat{\underline{\tau}}}{d\overline{\tau}} = 0$, it follows that $\frac{d\hat{\sigma}}{d\overline{\tau}} = \frac{\partial \hat{\sigma}}{\partial \overline{\tau}} + \frac{\partial \hat{\sigma}}{\partial \hat{\underline{\tau}}} \cdot \frac{d\hat{\underline{\tau}}}{d\overline{\tau}} = \frac{\partial \hat{\sigma}}{\partial \overline{\tau}}$. Therefore, for parts a and b, because of Assumption 1, Lemma 4, and Lemma B.1, it suffices to demonstrate $\frac{\partial \Omega(\hat{\sigma})}{\partial \overline{\tau}} = -(1-\delta) \cdot \theta(\overline{L}) < 0$. ■

C Formal Exposition of Additional Results

C.1 Fighting for a Large Prize

A distinct greed hypothesis is that oil production raises fighting prospects by creating a lucrative secession prize. For example, Collier and Hoeffler (2005, 44) proclaim a second major reason that natural resources might be a powerful risk factor for civil wars is "the lure of capturing resource ownership permanently if the rebellion is victorious." Laitin (2007, 22) proclaims: "If there is an economic motive for civil war in the past half-century, it is in the expectation of collecting the revenues that ownership of the state avails, and thus the statistical association between oil (which provides unimaginably high rents to owners of states) and civil war."

Although this greed-based argument is not mutually exclusive of the premise that governments rather than rebels control oil revenues, the effect of a large prize is theoretically ambiguous. It increases the value of winning, but it also increases the opportunity cost of fighting. The conflict-inducing effect only dominates the conflict-suppressing effect if the state is coercively weak, which is often not true for oil production (Assumption 2). The prize mechanism does not provide a compelling explanation for why oil-rich regions fight separatist civil wars relatively frequently, largely for the same reasons as accepted mechanisms linking rich countries to few civil wars.

It is uncontroversial to assert that oil is a high-yield economic activity that should raise the value of C's formal-sector production, Y^C, although the necessity of negotiating with international oil companies dampens this effect somewhat (Menaldo, 2016). Correspondingly, greed theories correctly argue that the "prize of winning" oil effect raises separatist propensity, i.e., higher Y^C increases C's consumption conditional on winning a civil war (Collier and Hoeffler 2004, 2005; Garfinkel and Skaperdas 2006; Besley and Persson 2011, ch. 4). However, these theories have not carefully examined a crucial countervailing effect that renders ambiguous the overall impact of a larger prize. A larger prize also diminishes fighting incentives by raising the opportunity cost of initiating a civil war. Higher Y^C increases the amount of output destroyed from C's region during a fight. This "prize opportunity cost" effect increases the relative lucre of the wealth-sharing deal that C gets from G—compared to fighting and decreasing consumption in that period.

Formally, accepting an offer $\tau_t = 0$ from G as opposed to fighting yields a consumption differential in the period of the fight of $\Big[\theta(L_0^*) \cdot Y^C - \kappa(L_0^*)\Big] - \Big[(1-\phi) \cdot (1-x) \cdot \theta\big(L^*(x)\big) \cdot Y^C - \kappa\big(L^*(x)\big)\Big]$. Therefore, a larger prize increases the marginal opportunity cost of fighting by $\theta(L_0^*) - (1-\phi) \cdot (1-x) \cdot \theta\big(L^*(x)\big) > 0$. This is the prize opportunity cost effect. By contrast, conditional on winning, initiating a separatist civil war yields a net expected benefit of $\frac{\delta}{1-\delta} \cdot (1-\sigma) \cdot \Big\{\big[\theta(L_0^*) \cdot Y^C - \kappa(L_0^*)\big] - \big[(1-\overline{\tau}) \cdot \theta(\overline{L}) \cdot Y^C - \kappa(\overline{L})\big]\Big\}$ in future periods. Therefore, a larger prize increases the marginal benefit to fighting, conditional on winning, by $\frac{\delta}{1-\delta} \cdot (1-\sigma) \cdot \Big[\theta(L_0^*) - (1-\overline{\tau}) \cdot \theta(\overline{L})\Big]$. This is the future-period prize of winning effect. Finally, the magnitude of the prize of winning effect is modified by C's probability of winning, p, since C only reaps secessionist gains if it wins the war. Proposition C.1 states a threshold value of p that determines which of these two effects dominates the other.

Proposition C.1 (Coercive capacity and the countervailing effects of a larger prize)**.** *An increase in C's oil production through its effect on increasing the prize, Y^C, ambiguously affects the range of σ values small enough that fighting occurs.*

- *If p is sufficiently large, then the probability of winning multiplied by prize of winning effect, $p \cdot \frac{\delta}{1-\delta} \cdot (1-\sigma) \cdot \big[\theta(L_0^*) - (1-\overline{\tau}) \cdot \theta(\overline{L})\big]$, dominates the prize opportunity cost effect, $\theta(L_0^*) - (1-\phi) \cdot (1-x) \cdot \theta\big(L^*(x)\big)$, and an increase in Y^C increases the likelihood of separatist civil wars in equilibrium, i.e., increases the range of σ values small enough that fighting occurs. Formally, if $p > \overline{p}$, then $\frac{d\overline{\sigma}}{dY^C} > 0$, for $\overline{p}$ defined in the proof and $\overline{\sigma}$ defined in Equation 6.*

- *If $p < \overline{p}$, then the prize opportunity cost effect dominates the probability of winning times prize of winning effect, and an increase in Y^C diminishes $\overline{\sigma}$. Formally, if $p < \overline{p}$, then $\frac{d\overline{\sigma}}{dY^C} < 0$.*

Proof. It is trivial to demonstrate that $\frac{d\overline{\sigma}}{dY^C} = \frac{\partial\overline{\sigma}}{\partial Y^C}$. Because of Lemma A.3, the sign of $\frac{d\overline{\sigma}}{dY^C}$ has the opposite sign as $\frac{\partial\Phi(\overline{\sigma})}{\partial Y^C}$. This can be calculated as:

$$\frac{\partial\Phi(\overline{\sigma})}{\partial Y^C} = (1-\delta) \cdot \Big[\theta(L_0^*) - (1-\phi) \cdot (1-x) \cdot \theta\big(L^*(x)\big)\Big] - \delta p(1-\overline{\sigma}) \cdot \Big[\theta(L_0^*) - (1-\overline{\tau}) \cdot \theta(\overline{L})\Big]$$

$\frac{\partial\Phi(\overline{\sigma})}{\partial Y^C}$ strictly decreases in p, and is positive if $p < \overline{p}$ and negative if $p > \overline{p}$, for:

$$\overline{p} \equiv \frac{\overbrace{(1-\delta) \cdot \Big[\theta(L_0^*) - (1-\phi) \cdot (1-x) \cdot \theta\big(L^*(x)\big)\Big]}^{\text{Prize opportunity cost effect}}}{\underbrace{\delta(1-\overline{\sigma}) \cdot \Big[\theta(L_0^*) - (1-\overline{\tau}) \cdot \theta(\overline{L})\Big]}_{\text{Prize of winning effect}}}$$

■

Overall, the prize effect is indeterminate. Furthermore, the substantive considerations that yielded Assumption 2 suggest that oil-rich regions often do not exhibit the parameter values in which the overall prize effect is conflict-inducing because their oil production provides revenues to the government, which can lower p. This finding resembles Chassang and Padro-i Miquel's (2009) result that the size of the economy is insufficient to explain civil war onset. However, the present setup with endogenous labor allocation enables studying the tradeoff between the prize of winning and the opportunity cost of fighting with regard to how an aspect of state capacity impacts the overall effect, as opposed to their model where these two mechanisms perfectly cancel out. Here, if the government has strong military capacity, then the prize of winning effect is small in magnitude and a larger prize diminishes fighting prospects.

In fact, emphasizing the importance of the opportunity cost mechanism largely follows the logic of arguments for why rich countries tend not to fight civil wars. Although richer countries create a larger prize, richer citizens also face a higher opportunity cost to rebelling. Because governments in rich countries tend to have strong coercive capacity, the opportunity cost effect tends to outweigh the prize of winning effect to deter civil war. Furthermore, the fact that citizens in oil-rich regions tend not to be rich follows from the redistributive grievances argument rather than from the large prize.

C.2 Oil Discoveries and Volatile Oil Prices

To facilitate focusing on core issues in the greed and grievances debate, the model so far has abstracted away from another important attribute of oil income: volatility. Ross (2012, 50-54) and Karl (1997) each detail this aspect of oil production, albeit without linking it to civil wars. Two important components of this variance are (a) discovering a new oil field, especially a giant oil field, can cause a dramatic spike in income (Lei and Michaels, 2014), and (b) historically, international oil prices have been quite volatile (Ross 2012, 51). This section incorporates these considerations by assuming periods differ between boom and bust. The main finding is that greater inter-period volatility in formal-sector income increases the likelihood of separatist civil wars if bust periods occur infrequently. The overall logic resembles that for the prize mechanism despite yielding a somewhat different substantive implication. The first section sketches the argument and the following, more technical, section provides most of the formal details.

C.2.1 Main Theoretical Insights

Formally, the value of C's formal-sector output is Y^C in boom periods (as in the baseline game) and $\frac{Y^C}{b}$ in bust periods, for $b > 1$. Higher b decreases the value of output in bust periods and therefore corresponds with higher inter-period income volatility. Under the substantively relevant assumption that oil-rich regions have higher income volatility, we are interested in comparative statics for b. The analysis considers two cases. First, an oil discovery case in which period 1 is a bust period and all future periods are boom periods. In other words, an oil field is discovered in period 1 but does not come online until period 2. Second, a volatile prices case in which each period is boom with probability $\gamma \in (0, 1)$ and bust with complementary probability, and these draws are independent across periods. This extension features six states of the world determined by all permutations of (a) C being weak in the status quo territorial regime, C being strong in the status quo territorial regime, and C having seceded, and (b) boom and bust production periods. It is solved with MPE. This setup bears some resemblance to Dunning (2005), although his two-period model examines how price volatility affects incentives to fund public goods rather than how the present tradeoffs affect prospects for civil wars.

The key considerations are closely related to those discussed for the prize effect. With volatile income, the opportunity cost of fighting in a bust period is $\Big[\theta\big(L_b^*(0)\big) \cdot \frac{Y^C}{b} - \kappa\big(L_b^*(0)\big)\Big] - \Big[(1-\phi)\cdot(1-x)\cdot\theta\big(L^*(x)\big) \cdot \frac{Y^C}{b} - \kappa\big(L^*(x)\big)\Big]$. $L_b^*(\cdot)$ is the analog of the optimal labor supply function defined in Equation 2 for bust periods, and is formally defined below. The bust period opportunity cost decreases as volatility increases because, simply, there is less to destroy. This result follows an identical logic as the prize opportunity cost effect presented in Proposition C.1. However, although higher b also decreases the future prize of winning effect, b only affects future *bust* periods—unlike Y^C, which affects consumption in all future periods.

In the oil discovery case, all future periods are boom. The only effect of higher volatility is to lower the period 1 opportunity cost of fighting and, therefore, higher b unambiguously increases prospects for separatist civil war (assuming the non-trivial case in which C has strong capacity for rebellion in period 1). These considerations are somewhat more involved in the volatile prices case because b also affects C's consumption in some future periods. Therefore, higher b not only lowers the opportunity cost of fighting in a present bust period, but also lowers the expected utility of seceding. However, the less frequent are future bust periods, i.e., the higher is γ, the less that the volatility parameter b affects future-period considerations. If γ is sufficiently large, then the overall effect of higher b increases equilibrium prospects for separatist civil war by decreasing the opportunity cost of fighting by a greater magnitude than it decreases the expected utility of secession. Therefore, volatile oil prices may provide an additional trigger to separatism, but only when the future is expected to be valuable.

These findings about income volatility relate to some existing theoretical arguments and empirical evidence. Showing that oil discoveries can cause civil war resembles an implication from Bell and Wolford (2015), although the present result focuses on the opportunity cost mechanism rather than on oil causing future shifts in the balance of power. Instead, combining the result from this section with Proposition C.1 yields a point of congruence with Chassang and Padro-i Miquel (2009): larger *fluctuations* in income rather than higher income *levels* provide a more coherent explanation for war onset because income variability creates periods with relatively low opportunity costs of fighting relative to the expected future prize of fighting. Empirically, this theoretical result corresponds with Blair's (2014) finding that oil discoveries positively correlate with separatist civil war onset, and the Sudanese case presented in the text provides an example.

C.2.2 Formal Details

C's optimal labor choice in a bust period differs slightly from that in every period in the original model because the lower value of formal-sector output affects the marginal benefit of supplying labor. Defining C's labor supply function in a bust period as $L_b(\cdot)$ and solving a similar optimization problem as in Lemma 1, we have:

$$L_b^*(\tau_t) = \left[(1-\tau_t)\cdot\eta\cdot\frac{Y^C}{b}\right]^{\frac{\omega}{1+\omega\cdot(1-\eta)}}.$$

The revenue-maximizing tax rate $\overline{\tau}$ is unchanged in bust periods because $\overline{\tau}$ is not a function of the value of formal sector output (see Equation 5). Following similar logic as used to define $\overline{\sigma}$ in Equation 6, offering $\tau_s^* = 0$ in every strong period enables G to buy off C in a bust period in which C is coercively strong if and only if:

$$\left[\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b}-\kappa\big(L_b^*(0)\big)\right]-\left[(1-\phi)\cdot(1-x)\cdot\theta\big(L_b^*(x)\big)\cdot\frac{Y^C}{b}-\kappa\big(L_b^*(x)\big)\right]-\delta\cdot p\cdot\Big(\tilde{V}^C_{\text{sec}}-\tilde{V}^C_{\text{s.q.}}\Big)\geq 0, \quad \text{(C.1)}$$

The continuation values are defined as follows:

$$\tilde{V}^C_{\text{sec}} = \gamma\cdot\Big[\theta(L_0^*)\cdot Y^C-\kappa(L_0^*)\Big]+(1-\gamma)\cdot\left[\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b}-\kappa\big(L_b^*(0)\big)\right] \quad \text{(C.2)}$$

$$\tilde{V}^C_{\text{s.q.}} = \gamma\cdot\Big\{\sigma\cdot\Big[\theta(L_0^*)\cdot Y^C-\kappa(L_0^*)\Big]+(1-\sigma)\cdot\Big[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C-\kappa(\overline{L})\Big]\Big\}$$
$$+(1-\gamma)\cdot\left\{\sigma\cdot\left[\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b}-\kappa\big(L_b^*(0)\big)\right]+(1-\sigma)\cdot\left[(1-\overline{\tau})\cdot\theta\big(L_b^*(\overline{\tau})\big)\cdot\frac{Y^C}{b}-\kappa\big(L_b^*(\overline{\tau})\big)\right]\right\} \quad \text{(C.3)}$$

Substituting Equations C.2 and C.3 into Equation C.1 and finding a σ threshold that solves Equation C.1 with equality, denoted $\tilde{\sigma}$, yields:

$$\Gamma(\tilde{\sigma})\equiv(1-\delta)\cdot\left\{\left[\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b}-\kappa\big(L_b^*(0)\big)\right]-\left[(1-\phi)\cdot(1-x)\cdot\theta\big(L_b^*(x)\big)\cdot\frac{Y^C}{b}-\kappa\big(L_b^*(x)\big)\right]\right\}$$
$$-\delta p\cdot(1-\tilde{\sigma})\cdot\Big\{\gamma\cdot\Big(\big[\theta(L_0^*)\cdot Y^C-\kappa(L_0^*)\big]-\big[(1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C-\kappa(\overline{L})\big]\Big)$$
$$+(1-\gamma)\cdot\left(\left[\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b}-\kappa\big(L_b^*(0)\big)\right]-\left[(1-\overline{\tau})\cdot\theta\big(L_b^*(\overline{\tau})\big)\cdot\frac{Y^C}{b}-\kappa\big(L_b^*(\overline{\tau})\big)\right]\right)\right\}=0 \quad \text{(C.4)}$$

Proposition C.2 (Volatile oil income and secession)**.** *The effect of an increase in C's oil production on increasing b strictly increases the range of σ values small enough that fighting occurs if $\gamma > \tilde{\gamma}$, and strictly decreases this range of σ values otherwise. Formally, for $\tilde{\sigma}$ defined in Equation C.4, $\frac{d\tilde{\sigma}}{db} > 0$ if $\gamma > \tilde{\gamma}$, and $\frac{d\tilde{\sigma}}{db} < 0$ if $\gamma < \tilde{\gamma}$.*

Proof. Applying the implicit function theorem to Equation C.4 yields:

$$\frac{d\tilde{\sigma}}{db} = -\frac{\frac{\partial\Gamma}{\partial b}}{\frac{\partial\Gamma}{\partial\tilde{\sigma}}}$$

for

$$\frac{\partial\Gamma}{\partial b} = -\bigg\{(1-\delta)\cdot\Big[\theta\big(L_b^*(0)\big) - (1-\phi)\cdot(1-x)\cdot\theta\big(L_b^*(x)\big)\Big]$$
$$-\delta p\cdot(1-\tilde{\sigma})\cdot(1-\gamma)\cdot\Big[\theta\big(L_b^*(0)\big) - (1-\overline{\tau})\cdot\theta\big(L_b^*(\overline{\tau})\big)\Big]\bigg\}\cdot\frac{Y^C}{b^2}$$

and

$$\frac{\partial\Gamma}{\partial\tilde{\sigma}} = \delta p\cdot\bigg\{\gamma\cdot\bigg[\Big(\theta(L_0^*)\cdot Y^C - \kappa(L_0^*)\Big) - \Big((1-\overline{\tau})\cdot\theta(\overline{L})\cdot Y^C - \kappa(\overline{L})\Big)\bigg]$$
$$+(1-\gamma)\cdot\bigg[\bigg(\theta\big(L_b^*(0)\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(0)\big)\bigg) - \bigg((1-\overline{\tau})\cdot\theta\big(L_b^*(\overline{\tau})\big)\cdot\frac{Y^C}{b} - \kappa\big(L_b^*(\overline{\tau})\big)\bigg)\bigg]\bigg\} > 0$$

$\frac{d\tilde{\sigma}}{db}$ is strictly positive if and only if $\frac{\partial\Gamma}{\partial b}$ is strictly negative, which is true if and only if:

$$\gamma > \tilde{\gamma} \equiv 1 - \frac{(1-\delta)\cdot\Big[\theta\big(L_b^*(0)\big) - (1-\phi)\cdot(1-x)\cdot\theta\big(L_b^*(x)\big)\Big]}{\delta\cdot p\cdot(1-\tilde{\sigma})\cdot\Big[\theta\big(L_b^*(0)\big) - (1-\overline{\tau})\cdot\theta\big(L_b^*(\overline{\tau})\big)\Big]}$$ ■

In the oil discovery case, $\gamma = 1$ (note that this implies the continuation values are identical to those in the baseline game). Therefore, an increase in b raises equilibrium separatism prospects for all parameter values in the oil discovery case. For the price volatility case, bust periods must be sufficiently rare to generate the same result.

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