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How Production Firms Adapt to War

The Case of Liberia

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Abstract

How do production firms adapt to civil war? The answer to this question will inform the potential for economic development during and after conflict. Many businesses survive violent conflict, and in some cases even thrive. Understanding these successes will help policymakers to support the "coping economy" during civil wars, and to understand better the post-conflict economy as a system. In this paper I use the case of production firms operating in Liberia's capital, Monrovia, during the country's civil war to argue that successful wartime firms continually adapt their supply chain structures in response to a shifting combat frontier by dispersing their functions spatially and temporally. Such adaptability depends on the rapid gathering (via business networks) and processing (at the place of production) of information. This contention represents a micro-level explanation for, and also a conditioning of, the generally accepted view that industries that survive civil war tend to be non-capital intensive and non-trade intensive.

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1 Introduction

From its inception, development economics has revered the industrialization process. Economists from Smith to Rostow and from Gershenkron to Lewis have emphasized the importance of industrial factories as crucibles in which the division of labor is refined, a labor force is developed, and technical knowledge is generated and shared. And though the poorest countries with weak industrial sectors are also the ones that tend to fall prey to the so-called "conflict trap", little research on economies in conflict has explored how production firms operate.

Much recent research has focused on those types of "contested sectors" like the extractive industries that can drive and prolong violent conflict. A few examples include Fearon (2005), Humphreys (2005), Karl (1997), Klare (2002), Le Billon (2001), Ross (2004), and Snyder (2004). Furthermore, research on the private sector in conflict has emphasized the vulnerability of capital concentrations and the trade routes that link them. Collier (1999), for instance, asserts that capital- and trade-intensive sectors (notably including industrial production and manufacturing) are "war vulnerable," while sectors like agriculture are not. And a growing body of conflict research seems ready to strike from the agenda study of firm level economic actors typically characterized by concentrated capital, labor, and trade requirements. Rather, it seeks to understand the role of "entrepreneurs" in conflict—a term used alternately for those who innovate in the private sector and those who simply start small, replicative businesses. Regardless of the definition adopted, this "entrepreneurship and conflict" literature connotes economic activity carried out by atomistic individuals, and not by larger coordinated firms.

Many production firms survive and even thrive in the face of violent conflict. The fact that the survivors are, for the most part, producers of inelastic or inferior goods that are expensive to import is not surprising. But the fact that they continue to operate at all may be surprising, given their high capital and labor intensiveness. Using the case of Monrovia, Liberia, during that country's protracted civil war, I contend that production firms that survive or thrive in violent conflict do so by performing a delicate balancing act between concentrating capital and labor to produce efficiently in the pockets of relative calm, and dispersing them spatially and temporally when the combat frontier approaches one of the production chain components. Such adaptability relies upon rapidly gathering information (via production networks) and processing it (at the place of production).

1.1 The Importance of Production Firms

There are good theoretical reasons to seek to understand the adaptations of production firms in the world's poorest and most conflict affected countries. Caruso's (2008) model of a two-sector economy at war suggests that investment in an "uncontested sector" (i.e., one whose value added is not wholly up for grabs in the struggle) can increase total welfare. Industrial manufacturing is a good candidate for a real-world uncontested sector because its value adding mechanisms are sophisticated and primarily knowledge-based (as opposed to the resource extraction industries, for instance, whose value is largely not added, but found). This distinction means that a production firm's entire coordinated production network must be functional in order to generate profit for would-be "taxers". Manufacturing shares the trait of sophisticated, knowledge-intensive value adding processes with the service sector. However, the manufacturing sector has

the potential to buy from, as well as sell to rural populations. By sourcing its raw materials locally from rural areas, it can link industrial capital concentrations with hinterlands in mutually beneficial ways[1]. By contrast, the service sector in less developed countries typically only sells to, not buys from, rural areas.

The special place occupied by the manufacturing sector—neither easily appropriated, nor necessarily beneficial to a narrow urban elite—may in turn place serious limitations on the levels of destructiveness of any profit-maximizing rebel group wishing to capture it. There are at least a couple of possible causal mechanisms that might account for this: the first top down, and the second bottom up. First, in a top-down scenario, the potential for taxation (or extortion) by a rebel group may incent rebel leaders to preserve the value adding processes intact, which becomes in effect the goose that lays the golden eggs. Second, in a bottom-up scenario, the often rural support base of the rebel group[2] may erode with diminishing industrial demand for their produce. This reasoning implies the hypothesis that the more an economy's product is generated through industrial manufacturing, the less destructive conflict should be. Given the fact that the recent occurrence of a civil war raises the risk of a country descending into widespread violence within a decade from just 9 to 40 percent (Collier 2007), the adaptations of the private sector during one conflict may bear on the risk and extent of violence the next time around.

A preliminary ordered logistic regression analysis using cross-country panel data for 185 countries from the years 1960 to 2006 finds that, controlling for sectoral composition, year, standard macro-economic indicators, and trade flows, every percentage point rise in the value of manufactured goods as a fraction of total merchandise exports is associated with a significant 1.3 percent decrease in conflict-related deaths. Similarly, a twofold increase in the absolute value of manufactured goods produced is significantly associated with a decline in conflict-related deaths of roughly 35 percent. Contrariwise, a twofold increase in absolute value of agricultural goods and general services is significantly associated with an *increase* in conflict-related deaths of about 44 and 373 percent respectively.[3]

1.2 Literature Review

This paper contributes to an emerging body of work on economies in conflict (Pugh and Cooper 2004; Berdal and Malone 2000). There are few precedents to draw in terms of studies of firms in war specifically. Given the lacuna in the conflict literature on organizations in war, it is helpful to begin filling the gap with existing organizational theory literature, which emphasizes the causal link between environment and organizational structure. Lawrence and Lorsch (1969) posit that vertical organizations are better suited to predictable environmental influences, while horizontal ones are better suited to the unpredictable. Such a theory implies that a wartime business would tend to "flatten" or outsource its hierarchy. March (1991) creates a model in which an organization's adaptability to "turbulence" is a function of the likelihood of turbulence

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[1] See, for instance, Evans 1992.

[2] On the increasing tendency of civil wars to pit rural hinterlands against urban centers, see Grünewald and Levron (2004).

[3] These estimates are provided from an unpublished analysis the author is currently performing.

and the rate of acquisition of new information on the environment,[4] suggesting that wartime businesses would be willing to pay premiums for information on emerging risks. In an argument that also touches on organizational learning, economist Alice Amsden (2001) asserts that a key component to late industrializing corporate success is transforming foreign technology into organizational know how. This raises the question of whether difficulties in sourcing more foreign technology may result in attempts to substitute investments in human capital aimed at improving in-house repair and maintenance services—and a possible ironic effect that damage to physical capital may catalyze this organizational learning.

On the subject Supply Chain Management (SCM), the theory of "dispersal economies" (Li and Polenske 2004) states that distant target markets justify more decentralized distribution networks, and that businesses choose to minimize SCM costs in balancing transportation costs against inventory costs. Therefore, as transportation costs rise, businesses shift their emphasis to geographically dispersed inventory locations. In war, large shipments may be differentially targeted at military checkpoints (especially at the combat frontier), and so militate against large concentrations of stock en route or in situ. In effect, we may infer that as an approaching combat frontier in essence renders distribution and sourcing points behind it progressively farther away, distribution and sourcing networks will decentralize.

1.3 Research Design for the Empirical Study

1.3.1 Case Selection

This study chose Liberia as a case study for a number of reasons. First, the Liberian Civil War lasted for 14 years—long enough for businesses to consider the war environment as a status quo, rather than a brief, exceptional period. This consideration is particularly important given the increasing frequency in modern times of low burning, long lasting civil wars (Karl 1997; Klare 2002).

Second, the war was intense enough to do major damage to the economy as a whole and consequently present serious, sustained challenges to the survival of local firms. Faced with continuing instability over 14 years, FDI into Liberia largely dried up during the war. Inflation rose dramatically, and was estimated at 15 percent in 2003. Through war, falling commodities prices and mismanagement, the Liberian per capita GDP in US$ plummeted from US$1,269 in 1980 to US$163 in 2005 (a decline of over 87 percent), as core foreign exchange earning sectors such as rubber and iron ore came to a virtual standstill (IMF 2006). Of the 175 countries where the Human Development Index was calculated in 1999, Liberia ranked 174; only Sierra Leone was lower (UNDP 2000)—a country which had experienced a similar and related set of conflicts but had simply started off poorer than Liberia. As the war dragged to a close in late 2003, violence surged and civilian exposure to the conflict intensified. At that time, 76 percent of the population lived on less than US$1 per day, and 52 percent lived on less than 50 cents (GoL 2004).

Third, peace has been definitively reestablished and the democratic process successfully relaunched, allowing for clear identification of instances where wartime adaptations are

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4   Though March specifically models the rate of turnover, it can be argued that his model more plausibly tests the rate of information gathering.

retained for non-conflict related reasons. With the arrival of UNMIL in October 2003, all violence came abruptly to an end, and the UN continues to spend US$750 annually to support the mission (Sachs 2008). Fourth, the termination of hostilities was recent enough that many of the current firm managers were employed by the same firms during a substantial part of the war. This is particularly true of the so-called Second Liberian Civil War, between Charles Taylor's government and rebel groups LURD and MODEL from 1999 to 2003.

Finally, Monrovia during the war was a paradigmatic example of a capital city besieged. It is home to a preponderant proportion of the country's industry (and one-third of its population), which experienced the approach of a combat frontier in 1990–2 (led by Charles Taylor's NPFL and Prince Johnson's splinter faction INPFL), and thrice again in 2001–3 with the advance on the city of LURD from the north and MODEL from the southeast.

1.3.2 Methods

I employed semi-structured interviews to obtain information on business operations before, during, and after the wars. I chose this qualitative method because (i) many business records detailing employment levels, etc. were destroyed during the war, and those that were not were difficult to gain access to, (ii) no official statistics were gathered on wartime business operations, and (iii) even if they had been, the situation changed so rapidly that such snapshots would not be able to convey the dynamic process of adaption through any sort of "comparative statics" analysis.

1.3.3 Firm Selection

I studied 11 Liberian production firms, gathering anywhere from one to three manager interviews at each. Because of the inherent difficulty in finding employees from firms that had not survived the war, firms were necessarily limited (with the exception of Parker Paints) to those that has survived. Therefore, the dependent variable was not taken to be "survival", but rather supply chain structure. The independent variable was the geographic location of the combat frontier in relation to the firm, its suppliers, and its markets.

Potential firms were identified by (i) preliminary examination of a detailed map of Monrovia landmarks compiled by the Humanitarian Information Centre of Liberia, (ii) a street-by-street driving tour of major business concentrations, and (iii) snowball information-gathering during the interview process. Selected firms had to (a) be accessible (at least one manager had to be willing to talk about wartime operations), (b) focus on domestic serving production, and (c) have been founded before the commencement of (and probably continued operating during) the Second War (1999–2003). Firms were also chosen so as to maximize variation in ownership (local versus foreign) and location. Firm selection was stratified by location, where three sections of Greater Monrovia were identified:

1. *Continuously-held central Monrovia*: while fighting did come to certain parts of central peninsular Monrovia in the First War (1989–1992) and again briefly in April 1996, and although the downtown was shelled during the Second War (1999–2003), central Monrovia never fell to non-government forces (though the

government/non-government distinction is blurred at some points during the war).

2. *Northern Monrovia*: this area, which includes the large industrial concentration on Bushrod Island and the Freeport of Monrovia (also on Bushrod Island), is situated across the mouth of the Mesurado River from central Monrovia. Because of its proximity to the city, it has repeatedly been targeted as the main route to the capital by rebel armies, and so all of the long standing businesses there have had to contend with operating under rebel control.

3. *Eastern Monrovia*: this area consists of the ex-urban townships scattered around the eastern portion of the lagoon, from Red Light in the southeast to Gardnersville in the northeast. These areas did not come under direct rebel control during the Second War, but government control was eroded here and the GoL was unable to prevent widespread looting and breakdown of civil order.

Such variation was meant to distinguish the strategies employed by three classes of firms: those continuously under government control, those sporadically under rebel control, and those sporadically in an administrative no man's land.

2   Supply Chain Management in a Predatory Environment

SCM is typically conceived as the process of integrating three components of the supply chain, or production network: supply, production, and distribution. It is intuitively obvious that in the long run, the amount of finished goods a firm distributes cannot exceed the amount it produces, nor can the amount produced exceed the amount sourced. Expressed symbolically:

$$S \geq P \geq D \tag{1}$$

where S is the amount of material successfully supplied to the production process, P is the amount of material successfully processed during production, and D is the amount successfully distributed as final goods. Furthermore, it is intuitively clear that the long run Pareto optimal solution for a profit-maximizing firm will be to set all components at par with one another:

$$S = P = D \tag{2}$$

In this way, the firm is neither sourcing more than it can process, nor processing more than it can distribute. This is an important, if obvious, point, when revenue is only generated upon distribution.

If we now assume for the sake of simplicity that the amounts of materials successfully supplied, processed and distributed are linear functions of combined material and labor inputs (s, p, d respectively, which firms choose) and production coefficients (σ, π, δ respectively, which firms are assumed for the moment to take), then we may define the Pareto optimal equation in (2) as:

$$s\sigma = p\pi = d\delta$$

where $s + p + d \leq 1$

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and $(0,0,0) \leq (s,p,d) \leq (1,1,1)$ (3)

Unconstrained, this equation simply tells us that in Pareto optimality, (s, p, d) vary with the inverse of (σ, π, δ).

If we now consider the productivity coefficient to be the multiplicative product of a technological parameter measuring productivity and a measure of freedom from the risk of predation (A_i and ρ_i, where $0 \leq \rho_i, \leq 1$),[5] we get the following equation:

$$sA_S\rho_S = pA_P\rho_P = dA_D\rho_D$$

where $(0,0,0) \leq (s,p,d) \leq (1,1,1)$ (4)

If we now allow that firms recognize that dispersed economic activity decreases predation, we can see that firms do not take (σ, π, δ) unequivocally, but rather can disperse their activities spatially and temporally to raise the production coefficients.[6] Alternatively, the firm can choose to shift its expenditure on capital and/or labor. To see this, we can reasonably posit that the chance that an input will escape predation may be expressed as an increasing function of the measure of dispersal of economic activity ((G, H, I) for activities (S, P, D) respectively) and a decreasing function of the efforts to predate or to "tax" goods by rebels, government, or civilians (r_i):

$$\rho_i = \frac{(G,H,I)}{r_i + (G,H,I)} \quad \text{for} \quad i = (S, P, D), \quad \text{where} \quad (0,0,0) \leq (G,H,I) \leq (1,1,1) \quad \text{and}$$

$$s + p + d + G + H + I \leq 1 \qquad (5)$$

Given the form of (5) the value of ρ_i is bounded between zero and unity. Since we have established that (G, H, I) are associated with opportunity costs and diseconomies of scale, they can in essence be treated factors of production. Treating r_i as a constant and abbreviating the production functions as $f(s, G)$, $f(p, H)$, and $f(d, I)$, we might construct cost equations to be minimized:

$$\min_{s,G} Cost_{supply} = s\varphi + G\gamma \qquad (6a)$$

$$\min_{s,G} Cost_{production} = p\chi + H\eta \qquad (6b)$$

$$\min_{s,G} Cost_{distribution} = d\psi + I\iota \qquad (6c)$$

such that
$f(s, G) = f(p, H)$,
$f(p, H) = f(d, I)$,
$f(s, G) = f(d, I)$, and
$s + p + d + G + H + I \leq 1$.

In these cost equations, (φ, χ, ψ) represent the marginal costs of the supply chain inputs (e.g., wages and rents in the case of labor and capital), whereas (γ, η, ι) represent the marginal costs of economic activity dispersal in each component. Given the constraints, we can write the Lagrangian function for the supply component as follows:

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5   The described function for each supply chain component now begins to resemble a Cobb-Douglass production function of the form $Y = AL^\alpha K^\beta$, except for the addition of ρ_i to model the risk of predated inputs, the combination of the labor and capital terms in one, and the exclusion of the input elasticities as exponents.

6   Firms also recognize that choosing high value inputs in any process heightens the risk of predation, and so may try to substitute low value inputs into each process.

$$\mathfrak{L}(s, G, \lambda_1, \lambda_2, \lambda_3) = s\varphi + G\gamma - \lambda_1[f(p, H) - f(s, G)] - \lambda_2[f(d, I) - f(p, H)] - \lambda_3[f(d, I) - f(s, G)] - \lambda_4(s + p + d + G + H + I - 1)$$

$$(7)$$

which will have the first order conditions

$$\frac{\partial \mathfrak{L}}{\partial s} = \varphi + \lambda_1 f_s + \lambda_3 f_s - \lambda_4 = 0 \tag{8a}$$

$$\frac{\partial \mathfrak{L}}{\partial G} = \gamma + \lambda_1 f_G + \lambda_3 f_G - \lambda_4 = 0 \tag{8b}$$

$$\frac{\partial \mathfrak{L}}{\partial \lambda_1} = f(s, G) - f(p, H) = 0 \tag{8c}$$

$$\frac{\partial \mathfrak{L}}{\partial \lambda_2} = f(p, H) - f(d, I) = 0 \tag{8d}$$

$$\frac{\partial \mathfrak{L}}{\partial \lambda_3} = f(s, G) - f(d, I) = 0, \text{ and} \tag{8e}$$

$$\frac{\partial \mathfrak{L}}{\partial \lambda_4} = s + p + d + G + H + I - 1 = 0 \tag{8f}$$

8c–8f simply represent the production constraints. 8a and 8b can be rearranged to show that the minimum cost will occur when the marginal cost of output due to increasing inputs and dispersal are at parity:

$$\frac{\varphi}{f_s} = -\lambda_1 - \lambda_3 = \frac{\gamma}{f_G} \tag{9a}$$

The same operation can be performed for the other two supply chain components to yield:

$$\frac{\chi}{f_p} = \lambda_1 - \lambda_2 = \frac{\eta}{f_H}, \text{ and} \tag{9b}$$

$$\frac{\psi}{f_d} = \lambda_2 + \lambda_3 = \frac{\iota}{f_I} \tag{9c}$$

These in turn can be rearranged to imply that the summed marginal costs of output for inputs in all supply chain components is equal to zero at optimality:

$$\frac{\varphi}{f_s} + \frac{\chi}{f_p} + \frac{\psi}{f_d} = 0 = \frac{\gamma}{f_G} + \frac{\eta}{f_H} + \frac{\iota}{f_I} \tag{10}$$

It may also be helpful to recall Equations 8a and 8b in their expanded forms:

$$\frac{\partial \mathfrak{L}}{\partial s} = \varphi + \lambda_1 \left[A_S \left(\frac{G}{r_S + G} \right) \right] + \lambda_3 \left[A_S \left(\frac{G}{r_S + G} \right) \right] - \lambda_4 = \varphi + \left(\frac{A_S G}{r_S + G} \right)(\lambda_1 + \lambda_3) - \lambda_4 = 0 \tag{11a}$$

and

$$\frac{\partial \mathfrak{L}}{\partial G} = \gamma - \lambda_1 \left[s A_S r_S \left(\frac{1}{(r_S + G)^2} \right) \right] + \lambda_3 \left[s A_S r_S \left(\frac{1}{(r_S + G)^2} \right) \right] - \lambda_4 = \gamma - \left(\frac{s A_S r_S}{(r_S + G)^2} \right)(\lambda_1 - \lambda_3) - \lambda_4 = 0$$

$$.$$

$$(11b)$$

In other words, greater investment in sourcing production factors (capital and labor) may be precipitated by (i) increasing marginal input costs, (ii) rising technological sourcing productivity, (iii) greater investment in dispersal, (iv) falling efforts to predate goods, (v) greater importance of the disjuncture between supply, and production, and supply and distribution, and (vi) falling importance of the budget constraint. Likewise, greater investment in dispersal may be associated with (a) greater marginal dispersal costs, (b) falling investment (or inability to invest further) in inputs, (c) falling technological productivity, (d) rising efforts to predate goods, (e) greater importance of the disjuncture between supply and production, and (f) falling importance of the disjuncture between supply and distribution and of the budget constraint. Notice, then, that rising predation in the supply chain is inversely related to investment in the supply process (e.g., hiring truck drivers). Therefore, the rate at which predation decreases such investment diminishes as predation rises. That is, the response is sharpest at the onset of predation, less as it worsens. The effect of predation on dispersal investment is more equivocal. Dispersal investment (e.g., paying more petty traders) will tend to grow with more predation (again diminishing at higher levels of predation) if it is more important to maintain the sync between supply and distribution than it is between supply and production. However, dispersal investment will tend to shrink with predation if it is more important to maintain the sync between supply and production than between supply and distribution. The former would tend to be the case when the inputs are relatively valuable, the latter when the inputs are relatively low value.

3   Dispersal Strategies in Production Networks

The forgoing intuitions are borne out by reports from firm managers working in Monrovia during the civil war. First, from the constrained maximization model, we guess that the degree of dispersal will be influenced by the levels of predation. Second, dispersal of economic activity in production network components can take different forms depending on which production network component was affected: specifically, supply and distribution channels tended to disperse spatially and temporally, while production centers, because of their fixed capital requirements, could generally only employ temporal dispersal. Finally, consistent with March's (1991) theory of information throughput in turbulent times, production networks were employed as information-gathering antennae, informing the shape, and extent of network dispersal.

3.1   Determinants of Predation Levels

The degree of predation in any component of the production process depend on three primary factors:

1. Proximity to the combat frontier

2. Rebel (and citizen) conduct

3. Value of the targeted good

3.1.1 Proximity to the combat frontier

Proximity to the combat frontier was sometimes difficult for firms to gauge, both because the combat frontier was blurry at best, and because it moved very rapidly and often in unexpected ways. The General Manager of RITCO, a firm located on Bushrod

Island that fell repeatedly under LURD control during the Second War, described the inability to make contingency plans under such uncertain circumstances:

> You see that war actually becomes something like, um, overnight, they on you [sic], so there is nothing you could do. The only thing you could do is you have to find a means of way [sic] to hide yourself in order to protect your life. Everybody say [sic] to hell with business, only the life [matters]. When you can't make anything, you start from there. You don't think about distributing or what, or production value left in the plant. You don't think about that.

3.1.2 Rebel/Civilian Behavior

The predatory tendencies of rebel soldiers varied dramatically from the First War to the Second, with clear consequences for the private sector. Lidow (2008) argues that the degree of predation among soldiers is a function of top down versus bottom up financing mechanisms for militia units, as well as the amount of socialization that goes into their recruiting and training. That is, when militia commanders have control of the purse strings, they can influence more directly the type of behavior their subordinates exhibit. This explanation seems to resonate with business managers, who consistently point out that NPFL and INPFL rebel commanders during the First War had much more influence over their men than LURD and MODEL commanders in the Second War.

Furthermore, predation was associated not just with soldiers of the various warring factions, but also with the civilian population, which participated in looting in areas and times when rule of law was weak. For instance, despite the fact that the Parker Paints production facility was located in Paynesville, an area hit by the NPFL during the First War, owner Philip Parker remarked about the damage looters did to his factory at that time, "to be honest, we lost most of our capital because of civilians". A manager at USTC explained that "[A]nybody could loot. Any civilian who was brave enough could loot. Any soldier who had a little gun could go looting, if the property was not protected". Well-disciplined rebel soldiers might sometimes even restrain the excesses of civilian looters. Speaking of Prince Johnson, the rebel INFPL commander who took over Bushrod Island and the MB facility located there during the First War, one MB manager remarked:

> He was really strong, he was a strong commander, so he had them under control. Disciplined them when they went wrong, so they were afraid of him. They were afraid to harass us civilians and all of that. So the island was better compared to central Monrovia and the other side.

3.1.3 Value of the Targeted Good

Valuable goods were obviously more coveted than less valuable, but value depended ultimately on the prices the products would fetch on the local market. Therefore, finished products tended to be targeted by predators more than intermediary ones, which in turn were more targeted than raw materials. In fact, raw materials were mostly left untouched by looters (though of course some extremely valuable raw materials, such as gold, diamonds, and timber continued to be targeted for their value on the international market). Philip Parker of Parker Paints related that his raw materials were actually jeopardized by the value of their own containers:

… When I got back (amazing!), we had lost close to half a million [US] dollars worth of raw materials, you know why? Truly, truly amazing. For the containers! When I got back, the factory was 8 inches floating in pigments, alkaline residues, whatever. Truly amazing. We lost close to half a million dollars. But for the containers, if you believe it. They wanted the empty drums, the plastic drums, so they just emptied US$250 worth of raw materials on the ground so they could sell the drum for US$2.

Similarly, the General Manager of CEMENCO remarked:

What … helped is that there was the raw material that nobody could do anything with. Okay, but the other things, generators, the vehicles, office equipment, and what have you, nothing can plan to protect.

3.2 A Typology of Dispersal Strategies and their Competitors

Liberian firm managers described four basic strategies for dealing with increased predation: (i) dispersal (and/or outsourcing), (ii) increased throughput, (iii) investment in strengthened property rights, and (iv) accommodation. Which strategy was chosen depended upon the tendency of predatory groups, whether military or civilian, to loot, and the firm's willingness to expend financial versus social capital (see **Error! Reference source not found.**). Importantly, dispersal strategies were preferentially employed when firms did not have strong financial resources on which to draw but faced situations where groups had a strong tendency to loot—a situation unfortunately common in Third World civil wars.

The war environment dispersed economic activity in three primary ways: through investment, spatially, and temporally.

3.2.1 Increased Materials Throughput

This strategy corresponds to increasing (s, p, d) in Equation (4) above. It simply implies investing more resources in the supply, production, or distribution process in the hopes of meeting previous output standards. This strategy was most often employed in extraordinary cases or crises where the predation was erratic, rare, or unpredictable, making more systematic risk-offsetting strategies too costly to implement on a permanent basis. It most often took the forms of (i) more input goods purchased, (ii) greater investment in fixed capital, or (iii) more hired staff.

Examples of the first form include NICOM's and MB's repurchase of looted inputs (described below in Section 3.2.4). Another example is the common practice of overstocking production inputs to be able to produce in the event of disrupted supply chains. Overstocking came with its own risks, however, as LISWINCO found out when a stray rocket struck its wood stockpile and the lot went up in smoke. Moreover, investment in fixed capital was most often associated with accommodating oversized supply stockpiles. CEMENCO, for instance, invested in an expanded clinker warehouse.

Table 1. Survival strategies of production firms in war, including dispersal

| | | Rebel/civilian tendency towards looting | |
		Low	High
Resources required of the firm predated	Financial capital	Increased materials throughput	Property rights investments
	Non-financial capital[7]	Accommodation	Spatial and temporal dispersal

Source: the author.

Increased investment in human resources was often required when damaged equipment forced businesses to adopt more low tech, manpower-intensive contingencies. An example of this was found at NICOM and RITCO, both of which engineered back up manual production equipment, such as capping machines. RITCO's manager explained:

> When the machines are broken down, what do we do? We go to manual! When the machine it is pumping and it broke down, what do I do? I have to go to manual by using a cup. If it is sealing and it cannot seal then I have to look for the hand machine, hand sealing. So all the time I get the manuals and everything waiting, because not every day is better day. You prepare you [rself] in times of war.

Consequently, both firms acquired the in-house capacity to fix most technical problems associated with manual machines and generators. They integrated machinists and technical personnel into their usual production staff. Whilst the larger, foreign-owned firms such as USTC, CEMENCO, and MB already had large repair shops, they grew larger still.

Finally, increased investment in human resources was required simply by high turnover rates among employees. The latter were caused either by deaths among staff or, more commonly, by their physical displacement. The manager of RITCO explained why he was forced to spend so much time and money on retraining:

> We … suffered casualties of about six or five employees … They went to central [Monrovia] for food and they were caught up … in the firing. We compensate[d] their family … nothing we can do … [We hired replacements [r]ight away. You know, industry is like a machine. When a part [is] broken, you have to buy it and put it back before you can continue.

Likewise, the finance manager at USTC recounted his frustrations with high turnover:

> [Turnover]'s still high. During the war a lot of our staff had to leave, a lot of them to the United States on various resettlement programs, immigrant programs are still running … We did lose a lot of key staff. And we continue to experience the differences since 2003. You find

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7 Typically social or physical capital.

yourself having to retrain people over and over again … It gets frustrating working in this environment.

3.2.2 Property Rights Investments

This strategy was simply to reinforce one's own property rights through sheer force or cunning.[8] An example of the first is USTC, which hired a large security force to guard its compound. The manager of the Aluminium Factory showed cunning when he safeguarded production machinery by disabling the factory's forklifts, which would have been required to load the large machines onto trucks. The manager of Parker Paints resorted to camouflage:

> You know, one of the things we did, we made the factory look as if nothing was there. You know if you walk there, we put as much junk as possible, so that nobody would assume that there was anything there … Equipment wise I lost two compressors and a couple of motors. But I have all my mills, all my cans, equipment, my welders … we mothballed everything, too, so … we make sure that they aren't hit by rain. Every now and again we fire them up. So I mean we're not too far gone to get started again. It won't take that much.

3.2.3 Accommodation with Predatory Groups

It was common for businesses with large compounds to invite government or rebel contingents to encamp there, using their buildings as barracks. This tactic reduced the risk of predation from other groups and citizens. The manager of Parker Paints explained that:

> You had to be flexible. When ECOMOG was here, you still had rampant crime. We would allow some ECOMOG soldiers who were stationed in the area to use it [the paint factory compound] as a subbase, so they were there for a while. You know you just had to be creative.

MB hosted Prince Johnson's troops to good effect during the First War, as a manager there describes:

> [We] never had a serious problem with them … There was minor problems with the employees, or maybe sometimes they coming in to get free beer or all of that, but other than that … he [Prince Johnson] had them under control, you know.

However, the protection earned might be withdrawn if and when the guest contingent was forced to evacuate, as LURD forces did from the CEMENCO compound. As the CEMENCO manager explained:

> Yeah, they lived in the yard, so for the time they were there, they were taking care, but when they were about to pull out,

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> they took away everything they could put their hands on:
> doors, windows, you just name it, everything.

It is interesting to note that the accommodation strategy was resorted to most often when the combat frontier had passed over the production center, bringing it under rebel control. As Olsen (2000) has noted, once the bandits become "stationary" (as opposed to roving to pick off supply and distribution shipments), they tend also to become less predatory—thus providing a possible causal connection between the location of the combat frontier in relation to the production network, and the tendency of a group to loot.

3.2.4 Spatial and Temporal Dispersal

Investment Dispersal: FDI tended to flee the country in the war years, of course, but much domestic investment, especially that of local entrepreneurs, sensibly minimized risk exposure through portfolio diversification—a move which may have deprived certain industries of "critical mass" in capital formation. Philip Parker described branching out into other industries in the years leading up to and during the war:

> So I diversified, out of the paint, into other things which I thought, not a big investment, you still make money, and exposure isn't that great basically. I do [engine retooling and] other things. I'm into mining also—small scale gold and diamond mining. So basically you diversified into businesses where, one, you didn't have too much government interference, and [two,] you didn't have too much exposure.

Temporal Dispersal: Dispersal at the firm level can be classified as either temporal or spatial. To generalize, firms in Liberia spatially and temporally dispersed their supply and distribution networks, and only temporally dispersed their production (because production machinery was largely stationary).

Temporal dispersal diseconomies in the workplace stemmed primarily from the stop-and-go nature of all economic activity during the war. During the First War, for instance, USTC's production was characterized by "very limited operations: off and on". However, temporal dispersal in production not only served to keep production staff safe in times of intensified fighting, but also protected the value added during the production process. By timing the production process exactly so that the finished products could immediately be offloaded to distributors, firms could avoid being targeted for what they produced. Thus the production process itself served as the fulcrum of the entire supply chain, regulating when and how much value was embodied in products. The fittest companies in that climate were those that could take "worthless" raw materials and rapidly produce finished products whenever distributors became available to take the processed goods off of their hands. One of NICOM's managers noted that:

> As we produce, the buyers come …, so we don't keep too much of stock. And it so happened within that time [during the war] we did not have too much finished stock, although we had some stock in process that we got caught up with [one time], but the actual finished stock wasn't much.

Companies were thus forced to forego semi-processed materials (often produced in foreign owned factories in the formal sector) for less predated raw materials (sourced by local business people in the informal sector). The owner of LISWINCO explained:

> Until that time [1990, when the NPFL/INPFL closed in on Monrovia],
> we used to get our wood directly from the [foreign owned] saw mills.
> After 1990, people [informal, petty loggers] start using power saws,
> going to the bush to get the wood, so we would take wood from them.

Spatial Dispersal: Supply and distribution routes that crossed the combat frontier were particularly vulnerable to predation (depending on the value of the good). They therefore tended to splinter into reticulated webs of small routes where poaching and "taxation" could be minimized through networks of trust. This family of strategies corresponds to increasing the value of (*G*, *H*, *I*) in the model presented in Section 2. Dispersed supply and distribution networks required an army of traders with intimate knowledge of geography and the local inhabitants. One manager remarked that "[a] lot of small scale trading [took place]. People who had never been involved in business before became traders". They thus required more investments in human resources to create redundant networks and coordinate their deliveries. For instance, when NICOM began to source more product inputs locally, its purchasing manager increased the purchasing department's staff from 12 to 16, in order to accommodate the larger number of small shipments it contracted.

> Supply/distribution dispersal often implied outsourcing as well. The
> small traders that entered the transportation market were generally not
> directly employed by firms, but rather informal. Firms typically
> outsourced jobs that were risky, required little skill, and required
> knowledge of the local social geography. The prototypical examples
> were distribution and sourcing operations in rural areas. An MB manager
> explained: "Nobody could venture out there. No business would do that.
> It was very risky. So we had the people come in to buy".

> RITCO's manager expanded:

> [A]s a businessman, I will not take a convoy to go across [the combat
> frontier to distribute]. Immediately it does and they're caught, full of
> mead. First thing [the rebels will assume] is [that] I have a different
> intention, have come to spy their arsenals, or worse … to leak
> information. So I will be either executed, or you know anything they are
> wanting to do they will do because I have no business to be there. So this
> is what we do: we sell to the petty vendors within our zone and they
> rather convey that across, because they know their way out, small, small
> routes that go to come back.

CEMENCO's general manager described the distribution adjustments they made:

> At that time [before the war], we had trucks that conveyed the cement to
> our distributors in the leeward counties … But those trucks and other
> equipment was [sic] taken during the 1990 war. Everything was looted.
> So … we continued to distribute to people in those counties who were
> qualified, they applied and were selected, and then they were given a
> distributorship. And they were responsible to transport their own cement
> to those counties in which they established a distributorship.

Supply routes, however, varied in their dispersal potential: inputs with local substitutes lent themselves to radical supply chain dispersal, while those without required that

alternative routes to specialized goods be found, often by crossing international borders to access other ports. Alcoholic spirit flavors, for instance, included some of both types: while RITCO took to sourcing flavors through Côte d'Ivoire and Ghana, NICOM, diversified its product line to deemphasize drinks mixed with imported flavors, introducing the now-popular "Bitter Cola" cooler. *NICOM*'s production manager explained the rational: "it's produced from cola nuts that can be gotten locally".

Market hyperactivity represents one manifestation of spatial and temporal dispersal of supply and distribution chains. The accepted wisdom asserts that war stifles market activity, as sellers and buyers will not be able or willing to get to and from markets with their wares in tow (Humphreys 2003). In the Liberian case, however, market activity was only stifled for brief periods of extreme tension. As fighting subsided, though, markets became if anything hyperactive, where hyperactivity is defined as the processing of many more transactions than actual products produced. At least two factors produced this market hyperactivity: "the recycling effect" and the "hot potato effect".

Recycling occurs when a good is looted and the victim must then repurchase the same or a similar product on the market. CEMENCO's General Manager explained that during the Second War: "… the only thing was that the trucks that were looted from the place, we had to compensate them [the rebels] to get the trucks from them". In other words, they had to buy their own trucks back from the looters. This pattern was replicated in the cases of many businesses, especially when the product was crucial to the production process and when the only prospective buyer was the original owner. The production manager of NICOM, a spirits manufacturer, related that:

> … At a certain point in time [during the Second War] the Freeport was also looted, and we found some of our flavors, some of our alcohol [on the market], and we had to rebuy them [from the looters]… Nobody can buy your own thing, so we had to buy our own thing from them, and pay for it twice.

A manager at the national brewery, MB, related a similar anecdote about repurchasing looted equipment from the looters:

> When we got back in there [the brewery], it was devastating. They were there for like two weeks, but when we got in there, almost everything was gone. And when some of the machines they couldn't take away, they would remove the motors from them, so we had to go back on the market try to look for them, and they were reselling them. And nobody could buy them because we had the machines and nobody else had the machines! So nobody could buy the parts, so they resold to us!

The net effect of recycling is obviously to drain the capital resources of businesses and to redistribute it to the appropriative economy.

The hot potato effect occurred as traders and vendors grew less willing to carry finished products for long periods of time (whether to resale or transport them) than raw materials. In effect, as products became more processed (and thus more targeted), the discount rate on any investment concerning them would rise to compensate for the unwanted attention they attracted. This complicates the oft cited observation that social discount rates rise during war for specific targeted demographics (see e.g., Leaning,

Arie, and Stites 2004): while that is true, rates seem to vary also by type of product. This logic informs the entire balancing act between supply, production, and distribution (as explained in Sections 2 and 3.3). The owner of LISWINCO, a manufacturer of contract grade wood and steel products, for example, described how distributors during and even after the war wanted less stock on hand (furniture, in that case), requiring more flexible, just in-time production:

> Now the stores can take only a certain amount, like 12 to 15 pieces only. Before, they used to keep 25 to 50 pieces always in stock. This time, [if] they want something … they will call for it.

The same held true for the looters themselves. Property rights were so routinely violated that whether one had produced a product or simply stolen it, it was safer to get rid of it as soon as possible. As Philip Parker noted:

> It was astounding to see the mentality: rebels would take over a house, strip it bare, sell the doors, the window frames, even the wiring from the walls—everything—and then they would move into it!

Hyperactive markets actually meant that there were many more traders and vendors needed to distribute the same (or a smaller) number of goods. An especially large market grew up at Red Light, a traffic intersection that during the war was under the protection of ECOMOG forces, and which linked the markets of the rural, rebel-held territories with that of urban, government controlled Monrovia. As a manager at MB described:

> It [Red Light] was kind of a small marketplace, but now it's bigger than Waterside [Market in downtown Monrovia], bigger than everywhere else, because that was the point of contact between the business people on this side and the business people on that side… So they [petty traders] would come, and some people would take the drinks from the factory there, carry there to sell and buy, some would go as far as to the [MB] factory and buy.

Large, active markets kept final goods constantly on the move and safer from predation. Predictably, though, large numbers of transactions heightened transactions costs. These costs tended to be lower than costs inflicted by predation when supply or distribution routes crossed the combat frontier, and thus spatial dispersal increased as the frontier approached.

3.3 The Balancing Act

3.3.1 Production as Nerve Center

The tripartite balance between supply, production, and distribution was a challenge for firms operating in peacetime as well as in war. However, wartime production demanded more rapid and finetuned responses to balance the equation because the situation could change so rapidly, and because there was an imperative not to be caught with processed or finished goods on hand. As explained above, half processed or fully processed goods attract unwanted attention from soldiers or civilian looters, and will likely be summarily expropriated if found. Raw materials, on the other hand, are rarely considered valuable on the market. Thus, while excess raw materials can be stockpiled, production and distribution have to remain constantly in lock step with one another. Because

distribution was most often outsourced, production is the variable in the equation that lends itself most easily to control. Thus, the production process must be able to gear up and shut down quickly in response to opportunities to distribute. As a manager at NICOM explained, daily production during the war was estimated based on the number of petty traders waiting at the compound gates.

3.3.2 The Role of Information

Accurate information about new developments in the war was essential for coordination of all supply chain components. That information was obtained in one or both of two ways: technologically, and through employee networks. During the Second War, foreign-owned firms with capital reserves to draw on invested in expensive satellite internet hook-ups to monitor constantly updated security websites. Such was the case at USTC, whose finance manager explained, "there were websites you could go and get security briefings on Liberia. Yes, the UN provided that service. Even the US government had that service". Smaller firms used the radio to get information, but managers reported that they did not fully trust radio broadcast information.

More commonly, firms relied on word of mouth for predictions about the timing and location of upcoming attacks. As a USTC manager related:

> There were some managers that were members of some groups downtown where they get information from. Based on that … some days, they come and say, "Our trucks are not going to town". They may not explain why, but we trust them for that. And it won't be long before you hear [about] something going [on] downtown.

Smaller, less well-endowed firms relied on this second information gathering method more intensively. A manager at NICOM described the daily process of gathering and disseminating information to petty traders:

> We called our fellow workers that live within the vicinity: "What news is downtown? Is there fighting?" At the time, we were not distributing, anyone who wanted to purchase had to come to us, so we were called in emergencies, "How is the situation this morning? Do you think it's safe for us to come to Monrovia?" We'd say, "Okay, everything is calm", and then, "We venture out and come". Sometimes we come maybe one hour, two hours, and then [snaps] thing breaks up again, and then everybody has to go back to his or her hideout.

The ability to rely on technology to gather and diffuse information enabled larger companies to downsize dramatically during the war. A manager at USTC related that "During the war, of course, we didn't even have up to 50 people here [a reduction of about 60 percent vis-à-vis the pre-war workforce]. Basically, production, guys in the garage to drive us. Hardly any distribution". Smaller firms, though, might not be able to downsize as much, as with NICOM, which cut staff by 40 percent. NICOM, however, was then sourcing locally from petty traders and had a relatively protected location in central Monrovia. Meanwhile, the Manager of RITCO, a firm of about the same size and product line on the intermittently rebel-held Bushrod Island, felt he could not fire any staff at all for risk of losing vital information sources. As he explained:

When the rebels are grouping themselves together, you know we are all brothers and sisters in the country, so while the young men across there is planning something, he at the same time is advising his sister or the brother here that: be careful, we are coming! So at the end of the day, that information is sent to us, and we guard ourselves.

Locally sourcing companies had the added advantage of being able to ask the petty traders who supplied them about conditions in the areas they had just traversed. LISWINCO's owner, for instance, always made a point to ask traders where they had been and what they had seen and heard.

3.4 Supply Chain Morphologies

The balancing act described above may suggest why certain negative effects of war on the private sector might accompany counter-intuitive positive ones. On the negative side, economies in conflict are often hollowed out of intermediary industries, and the private sector as a whole becomes much less efficient (Humphreys 2003). On the positive side, civil war may spur technical learning and knowledge accumulation among local production firms that do survive (McDougal 2008). These phenomena are jointly explained by spatial dispersal.

In a non-conflict setting, a simple production network is characterized by the diagram in Figure 1. Raw materials suppliers supply to the nearest processor, which then ships to producers who need specific types of intermediary goods. For instance, in pre-war Liberia, timber fellers would ship trees to saw mills, which would make a variety of cuts, from the hig value (planks and boards) to the less valuable (joists, short bits for furniture, and eventually saw dust). These mills could then ship exactly what was needed by each industry (export lumber, particle board, furniture) and wastage was limited. As described in Section 3.2.4, the combat frontier cut LISWINCO, a furniture manufacturer, off from the mills (which subsequently went out of business), forcing the company to buy from petty loggers and process the wood themselves. Wood wastage was then partly mitigated by buying those logs that lent themselves to LISWINCO's products directly from the traders, as shown in Figure 2. One of the downsides was an efficiency decrease due to the multiplication of trade routes to processing. On the upside for the firm, they became adept at operating large saws to process their own timber.

On the distribution side, as described in Section 3.2.4, networks of traders came to have direct relationships with producers, rather than accessing them at rural distributions centers where the firms used to "break bulk" (as shown in Figure 3). In this sense, predation by rebel groups did not mimic transportation costs hikes, because the economies of scale in transportation were more than offset by diseconomies of scale associated with detection. For that reason, Li and Polenske's (2004) "dispersal economies" applied to the trade routes, but not to dispersed production facilities in linked industries.

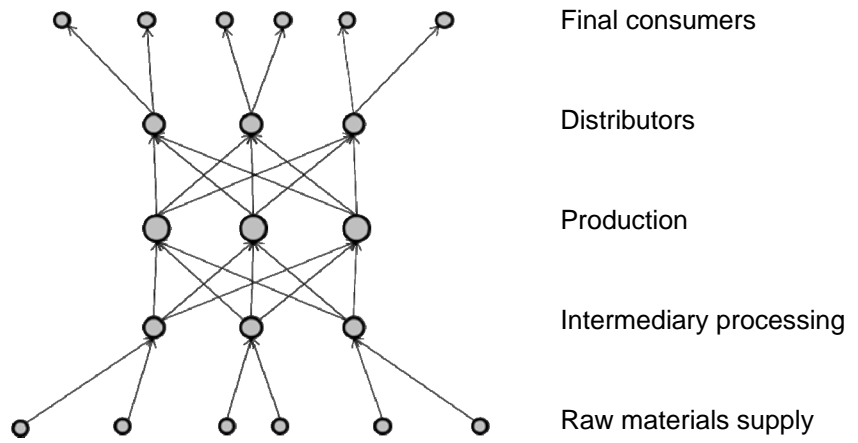Figure 1. A generic production network in peacetime

Final consumers

Distributors

Production

Intermediary processing

Raw materials supply

Figure 2. A production network with a combat frontier cutting the supply chain

Final consumers

Distributors

Production

Combat frontier

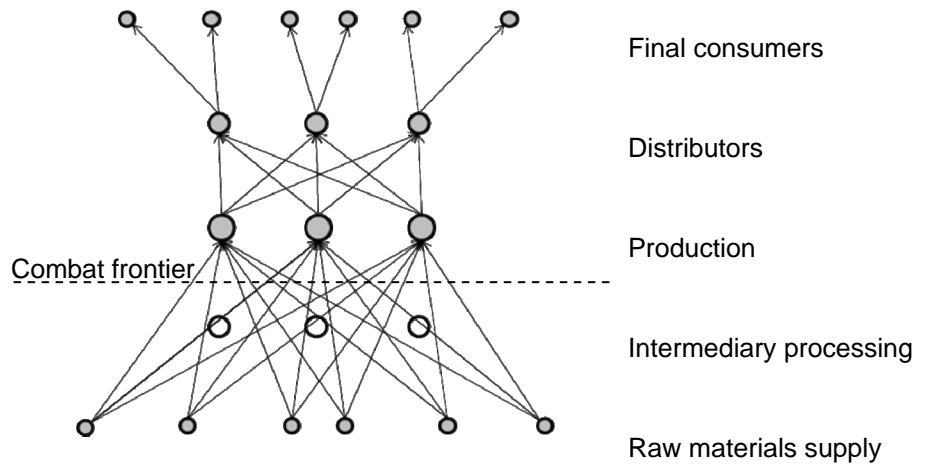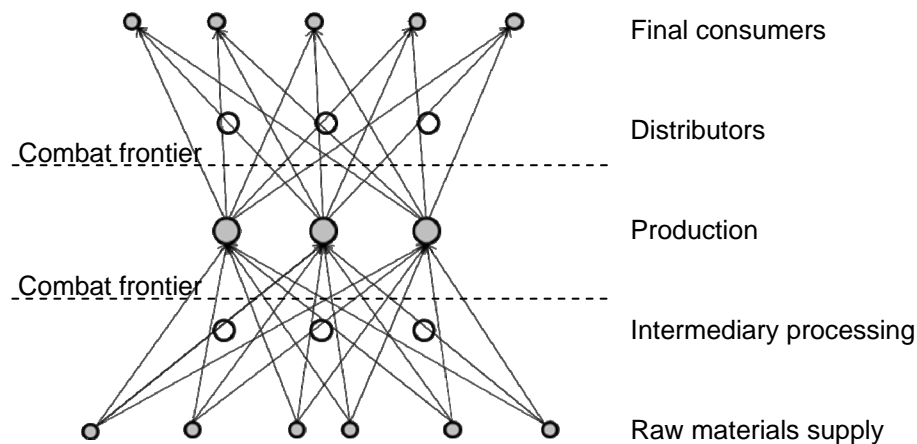Intermediary processing

Raw materials supply

Figure 3. A production network with a combat frontier cutting the supply and distribution chains

4 Conclusions

I have described in turn (i) why production firm survival is important to countries prone to conflict, (ii) why a production network analysis is an appropriate lens to view the phenomenon, (iii) how predation selects for dispersed forms of economic activity, (iv) how dispersal can help to reequilibrate the essential balance between supply chain components, (v) the importance of a constant supply of information to production firms coordinating dispersal, and finally (vi) how production morphologies adapt to the presence of combat frontiers. I contend that in Liberia, the survival of specific sectors of the economy was not simply determined by trade intensiveness or capital intensiveness of the sectors in question. Rather, it was a function of the degree to which firms were able to cope with, and take advantage of, the dispersal that was required of them by environments of high predation. Such a conclusion does not invalidate the binary view, but it does indeed complicate it.

A nuanced view of both peace and war (and all the grey areas between) as a dance between production and appropriation will give policymakers a broader range of options when trying to assure the well-being of civilian populations caught up in conflict. Especially promising possibilities for reduction of conflict destructiveness would seem to include peacetime incentives for production firms in at risk economies to source their inputs locally, so that they might become accustomed to having redundant and dispersed supply lines. Thus, the economy might not be so easily held hostage by rebel control of a single port or key international routes. Promoting upstream and downstream production industries decentralized across the country might also lessen incentives for brutality. Once war has started, other options might include ways of helping even small businesses and petty traders to become informed about developments in the war (perhaps via radio broadcasts), as well as communicate better with one another via cell phones or walkie-talkies. The latter point is especially critical considering the lock step coordination between production and distribution that is required for sustainable production during conflict. A better understanding of the daily distribution potential would allow production managers to turn out as many goods as possible without generating a stock surplus that could endanger their operations. Such options do not, of course, substitute for strong and determined interventions by a concerned regional and international community. Rather, they complement the tools already at policymakers'

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disposal, and open the doors to certain preventative and stop-gap measures that can be employed when more dramatic action is uncalled for or unfeasible.

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