From its inception, development economics has revered the industrialization process. Economists from Smith to Rostow to 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,” very little research on economies in conflict has explored how production firms operate. They focus instead on those types of “contested sectors” like the extractive industries that can drive and prolong violent conflict – examples include Fearon (2005), Humphreys (2005) and Le Billon (2001). 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. 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, but regardless one which 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, given their high capital- and labor-intensiveness. 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).

This essay is in three parts. First, I argue the adaptations of production firms in violent conflict are important to understand because the stronger the industrial manufacturing sector is, the less intense a violent conflict is likely to be. Second, I describe how firms balance their production networks via the strategic dispersal of production chain components (supply, production, and distribution). These descriptions represent summarized results of a series of semi-structured interviews with production firm managers working in Monrovia, Liberia during that country’s civil war, in which firm selection was based upon maximizing variation in location (and thus exposure to violence), ownership (local versus foreign), and supply chain structure (diffuse versus concentrated). Third, I argue, using coded data from those same interviews, that these dispersal strategies have the effect of mimicking import substitution industrialization (ISI) policies employed by many developing countries following World War II to build domestic industrial knowledge bases.

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-wracked 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 the firm’s entire coordinated production chain must be operational in order to generate profit for would-be usurpers. That condition in turn places serious limitations on the levels of destructiveness of any profit-maximizing rebel group. This reasoning implies the hypothesis that the more an economy’s value is added through industrial manufacturing, the less destructive conflict should be.

In fact, 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 macroeconomic 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% 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%. 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% respectively.

**Dispersal Strategies in Production Networks**

**Types of Dispersal.** Predation encourages the strategic dispersal of economic activity to reduce the risk of having the good in question appropriated; the alternatives are spending more on security measures to protect it, or buying more of it to offset the losses. Dispersal can take the form of portfolio diversification (inter-firm dispersal of resources) or, more germane to the topic of this paper, spatial and temporal dispersal at the firm level. While the strategy of spatial dispersal in Liberia lent itself to modification of Monrovia firms’ supply and distribution chains, that of temporal dispersal was employed more often at the production hubs where fixed capital made spatial dispersal unfeasible. Any type of dispersal, however, decreases economies of scale and raises sourcing, production and distribution costs – whether by raising transportation costs for supply and distribution networks or decreasing factory productivity with intermittent stopping and starting.

Liberian firms that suffered from rebel predation of their supply and distribution networks largely dispersed this activity by replacing the model of in-house or contracted truckers with a “deverticalized” model (i.e., an out-sourced model in which transport functions that used to be internal to the production chain are now external). Distribution and supply routes that crossed the combat frontier were particularly vulnerable to looters, so many firms sourcing from or distributing through the free port did not radically alter that portion of their production chain until the port itself was captured by rebels. Those that sourced or distributed locally, and so increasingly found their sources and client behind the combat frontier, reported gradually deverticalizing those components of the production chains as the combat frontier approached Monrovia. They then tended to splinter into reticulated webs in which poaching and “taxation” could be minimized through networks of trust. This increasing spatial dispersal required an army of traders with intimate knowledge of geography and the local inhabitants. This army in turn required factories to coordinate their delivery rooms better, and so many companies hired more staff in their supply and warehouse departments. Finally, as will be explained in the third part, the extent of dispersal in supply chains did not depend so much on the physical location of the firm, but rather on the elasticity of substitution between imported and local inputs, since locally obtainable inputs could be more easily sourced with these highly dispersed networks. A prime example was one alcoholic spirits manufacturer that decided, after the port was taken by rebels, to switch its flavors...
from imported European esters to a natural cola flavor extracted from locally-grown cola beans.

**Balancing Act.** Successful firms were able to balance the three components of the supply chain—supply, production, and distribution—in response to the shifting combat frontier (and thus to degrees of predation). In the long run, no firm can produce more than the amount for which it has the required inputs (raw and intermediate materials), nor distribute more product than it has produced (although in the short-run, the warehousing of both raw materials and finished goods can allow for more flexibility). Keeping the components in equilibrium requires incurring costs through (a) investments (in capital or labor), and/or (b) diseconomies of scale and scope associated with the temporal or spatial dispersal of economic activity. This balancing act can be modeled using a simple Lagrangian constrained maximization function to balance production chain components (such that ) and assuming that dispersal strategies reduce the risk of goods appropriation by rebels with a simple contest success function. In fact, it can be shown that compensatory capital and labor investments in predated production chain components rise only linearly with the risk of predation, while compensatory investments in dispersal rise with the square of such predation risks. The extreme knowledge-intensiveness of dispersal coordination means it naturally occurs at nodes where human capital concentrates, notably production hubs where managers would assess news of the latest developments in the war and calibrate their operations on the fly.

**Import Substitution Industrialization**

Heightened predation around trade nodes in Liberia, and the resulting supply chain dispersal, had the effect of mimicking certain aspects of import ISI policies. Looting mimicked import tariffs by “taxing” inputs shipped into the country. Violence drove out many expatriates, thereby localizing the staffs of many companies and de facto promoting Liberian employees to management positions they may not otherwise have occupied. Production chain dispersal raised local content in products. The combination of these forces even spurred on technical learning and knowledge accumulation in medium-sized firms (even as it ravaged knowledge in society at large). This was because diffusing supply chains and substituting local inputs required learning more about how to process raw materials and develop in-house engineering expertise. Furthermore, in going further afield to source inputs that had previously come directly from the port, businesses often learned of new techniques and products that they could then put to use at home.

Of the three independent variables I attempted to maximize in the firm sample, the most important in spurring ISI-like outcomes was supply chain structure (i.e., whether supplies were mainly imported or locally sourced) and local ownership, in descending order of importance. The location of the business (proxying exposure to violence at production sites) did not play a large role, suggesting that production chain dynamics are more critical to firm adaptation than simple exposure to violence. A pair-wise correlation matrix of these traits and their relationship to ISI-type adaptations is presented in the table below.

**Pair-wise Correlations of Firm and ISI Characteristics**

*Source: McDougal (2009).*

<table>
<thead>
<tr>
<th></th>
<th>Location</th>
<th>Local Inputs</th>
<th>Local Ownership</th>
<th>Import Tariffs</th>
<th>Import Substitution</th>
<th>Staff Localization</th>
<th>Knowledge Accumulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>1.000</td>
<td>0.200</td>
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<td>0.313</td>
<td>0.428</td>
<td>-0.200</td>
<td>-0.192</td>
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<td></td>
<td>(0.533)</td>
<td>(0.078)</td>
<td>(0.349)</td>
<td>(0.190)</td>
<td>(0.606)</td>
<td>(0.572)</td>
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Local Inputs

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<th>0.624</th>
<th>-1.000</th>
<th>-0.810</th>
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<tr>
<td></td>
<td>(0.014)</td>
<td>(0.024)</td>
<td>(0.040)</td>
<td>(0.000)</td>
<td>(0.003)</td>
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Local Ownership

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<th>0.607</th>
<th>-0.791</th>
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<tr>
<td></td>
<td>(0.200)</td>
<td>(0.048)</td>
<td>(0.011)</td>
<td>(0.166)</td>
<td></td>
</tr>
</tbody>
</table>

Cell entries are Pearson’s correlation coefficients ($r$) and (statistical significance) ($p$).

Locally-sourcing firms were significantly less likely to report heightened prices in inputs mimicking tariffs. The interviews suggest that this is due to the fact that foreign goods came through easily-targetable point-sources (e.g., the port), were generally high-value, and were subject to war insurance. Locally-sourcing firms were also significantly more likely to use recourse to import substitution when the effective prices of foreign goods rose. And while they were no more or less likely to localize staff (perhaps because they tend to employ mostly Liberians already), they were significantly less likely to have developed significant in-house technical capacity than foreign-owned firms. This may or may not be related to the ability of foreign owners to pull knowledge-intensive parts of their supply chain which usually reside in their home country into Liberia. This, then, would constitute a curious case of reverse “brain drain.”

The effects of local ownership parallel those of local sourcing, with two intuitively understandable exceptions. First, local ownership is not significantly associated with felt “import tariffs.” In fact, nothing in the interviews would suggest that it would be. Second, locally-owned businesses were significantly more likely to localize staff during the war. Again, this may (or may not) be due to the fact that local owners are more embedded in the social web. It may also be due to possibility that foreign-owned firms could more easily afford capital-intensive security measures, such as radio communications, while locally-owned firms relied more heavily on local staff networks for updates on the war. Certainly, many local managers noted the importance of local staff in understanding emerging threats and adapting readily and spontaneously.

Conclusions & Speculations

Weinstein (2005) and others have noted that wars ending “naturally” typically do not relapse as readily as those ended “artificially” from external forces. This phenomenon may be due to a number of factors not considered here. But one piece of the puzzle may be that risk-minimizing strategies of production firms in war naturally tend to make the sector more “uncontested” and its value less vulnerable to looting. If rebel groups are viewed as operating on a continuum running from all-out parasitism on, to symbiosis with, productive economic units, the promotion of manufacturing may incentivize a shift toward the latter end of the range. Such speculation requires further research, but may eventually point to industrial policies that can be enacted to lower the intensity of prospective or ongoing violent conflicts.

Works cited:


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