STABILITY

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RESEARCH ARTICLE

Stability and the Economy: Cooperative Game Theoretic Implications for Economic Policy in a Dual-Sector Economy

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How does the structure of the economy affect the possibility for societal stability? This paper[1] employs a cooperative game theory lens to explore possibilities for cooperation and chaos under various growth scenarios and assumptions of distributional equality in a hypothetical 2-sector economy (industrialists and agriculturalists). It suggests that maintaining distributional equality amongst agriculturalists is only undesirable under the assumption that the manufacturing sector exhibits positive and decreasing returns to scale; if increasing or negative manufacturing returns are the case, agricultural equality becomes an important policy goal in maintaining stability. In the particular case of a shrinking economy, peace can be preserved given (a) fairly equitable land distribution, and (b) a healthy industrial sector serving agriculture. In terms of aid policy, I suggest that, under decreasing industrial returns, more resources available to an economy can promote cooperative frameworks, but that such boosts will entail a switch to economies structured around the industrial sector. I conclude with a suggestion for testing the model.

Introduction

How does the structure of the economy affect the possibility for societal stability? Rapid economic growth of nearly any sort is routinely prescribed to prevent violent conflict. Collier (Collier 2007a, 2009) has famously argued that, for countries emerging from conflict with higher chances for conflict relapse, almost any kind of (fast) growth is good growth, since a growing pie[2] implies that politics will not be a zero-sum game. This intuition is clearly undergirded by non-cooperative game theory[3] and is generally born out empirically (Collier et al. 2003; Collier & Hoeffler 2000; Collier, Hoeffler, & Rohner 2006; Humphreys 2003). Moreover, it has resulted in some creative policy ideas, such as Collier's (2007b) suggestions to minimize "bottlenecks" that are endemic to post-conflict countries, such as a withered construction sector and a government incapable of investing large amounts of money quickly in public works. But non-cooperative game theory is often geared to predicting equilibriums, whether peaceful or not; it is not designed to predict chaos, when equilibriums do not exist.

Chronic instability—the absence of economic and political equilibriums—is of growing interest to policymakers. An increasing number of areas around the world are characterized by weak states and long-term political volatility. Examples include Somalia, Haiti, Afghanistan, and Burundi. Moreover, the Arab Spring uprisings ushered in a whole new cohort of challenges for countries whose

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political trajectories experts are struggling to predict—even as they struggle to come up with convincing explanations for the causes and varying intensities of their revolutions in the first place (Dupont & Passy 2011; Hollander & Byun 2012; Momani 2012). Despite a United States foreign policy geared toward the promotion of "stability" in the Middle East and North Africa, the fall of autocratic regimes revealed not just "weak civil societies" (Dupont & Passy 2011), but also stability that had been dependent upon external coercion. Some of these economies crumbled into their constituent pieces. Libya, for instance, might be described as having dissolved into a collection of city-states with variously contested and overlapping claims on hinterlands and few economic reasons for national collaboration (Arévalo de León 2011). Following the cue of Johan Galtung (1969), we might term the state of affairs that existed previously in Arab Spring countries to be "negative stability", or imposed stability.

By contrast, this paper seeks to build an economic rationale for a "positive stability"—one predicated upon economic incentives to form durable coalitions. It seeks to employ a cooperative game theory lens to explore possibilities for cooperation and chaos, stability and instability, under various growth scenarios in a hypothetical 2-sector economy. It is important to note that "positive stability"—akin to the idea of "self-reinforcing contracts" (Weinstein 2005)—does not imply the absence of conflict. Nor does it imply "peace" in the sense that all parties voluntarily participate in cooperative arrangements that maximize their individual payouts. Rather, it merely implies that whatever patterns of allegiances emerge are stable insofar as no parties have incentives to defect from existing alliances to form new ones. Indeed, stability thus defined may imply a form of conflict that is simply protracted and intractable, whereby one or more parties are perpetually oppressed. Conversely, the absence of such stability does not imply the presence of conflict. Rather, instability in this sense implies an economic incentive structure that lacks equilibrium, where any given set of cooperative arrangements is undermined by another. While economic instability is not synonymous with conflict, the constantly shifting allegiances that it implies may plausibly stress institutions tasked with enforcing contracts and erode trust, possibly making recurrent bouts of violent conflict more likely in the absence of a strong, exogenous coercive power.

This paper is intended to provide a theoretical scaffold for efforts to answer questions such as: What redistributive or aid policies promote stability? Can these tools promote stability when the economy is shrinking? Are the lessons different for industrial versus agricultural countries? The paper is organized into three remaining sections. In Section II, a brief background is laid out. In Section III, a model is presented in the tradition of cooperative game theory. Section IV discusses the model's implications for wealth distribution, firstly between industry and agriculture, and secondly among agriculturalists. Section IV explores the model's implications for development aid policy. Section V concludes with a summary of results, some caveats, and a suggestion for testing the model empirically.

Competitive & Cooperative Theories

Most formal models of conflict adopt some version of non-cooperative game theory as their basis. This is intuitively understandable, though it means that cooperative game theory—useful in modeling decisions of rational actors in choosing whether or not to form coalitions and, if so, of what size—often gets overlooked.

The simplest non-cooperative game theory model has just two players, each of whom may choose either to cooperate or not. Depending on the payoffs for each combination of payouts, the game may be characterized as one of prisoner's dilemma, deadlock, chicken, or win-win.[4] If C represents the payout for mutual cooperation, B that for backstabbing, S that for getting suckered, and N

that for mutual non-cooperation, then the games can be defined[5]:

$$B > C > N > S \ \text{(prisoner's dilemma)},$$

$$B > N > C > S \ \text{(deadlock)},$$

$$B > C > S > N \ \text{(chicken)},$$

with any combination beginning with *C* representing a "win-win."

Non-cooperative game theory provides a fundamental justification for development economists' emphasis on economic growth as a conflict-prevention measure: when the economy is growing quickly, participants find themselves in a positive-sum game, in which competition is undesirable and cooperation is rewarded (Collier 2007a, 2009). In other words, the payout structure has been altered so that $C > (B, S, N)$.

Cooperative game theory provides an alternative lens. In it, emphasis is placed on the "core," a set of agents who form a coalition such that no defectors or joiners will make all players better off—similar to the Nash equilibrium requirement that no profitable deviation exists. However, as Lidow (2008) describes, there are important differences, two of which are central here. First, the Nash equilibrium can be Pareto suboptimal, as illustrated by the game examples above, whereas the core consists of only Pareto-optimal outcomes. Second, the Nash equilibrium only accounts for the possibility of single agents defecting, while the core allows for the possibility of group defections of any size and combination. The latter characteristic allows us to ask under what conditions we may expect cooperative frameworks to persist.

A *non-empty* core is one that is stable. It exists only when the game is balanced (Osborne & Rubinstein 1994)—that is, when there is a set of coalitions $T = \{S\}$ with non-negative weights ∂_s for each T so that for each i

$$\sum_{\substack{s \in T \\ S \to \{i\}}} \partial_s .$$

Moreover, for the core to be non-empty, the above sum of balanced payouts for all coalitions must be less than or equal to the all-inclusive group of *N* individuals:

$$\sum_{s \in T} \partial_s v(S) \leq v(N).$$

If that condition is not met, there is the *possibility* (though, it is important to note, not a certainty) of constant unrest unless enforcement mechanisms can be brought to bear. Aivazian and Callen (1981) point out the major implication: when three or more agents interact in the presence of two or more externalities, the Coase Theorem (1960) may fail and no bargain can be struck. This suggests that in a complex environment, even zero transactions costs are not a sufficient criterion to guarantee stability. Note, however, that "stability" does not mean that everyone is included in the society-wide coalition; indeed, exclusion is one stable outcome, so long as the excluded group is either happy with its situation or unable to change it by offering an attractive alternative coalition to one or more of the standing coalition. "Stability," in other words, might be achieved by marginalizing one or more groups in society, essentially akin to forming minimum winning coalitions in non-cooperative game theory (see, e.g., Hardin 1976; Riker 1962; Riker & Ordeshook 1973). This observation reinforces the idea that "stability" as defined in a cooperative game theory model implies neither a "positive peace" (the presence of conditions that eliminate the causes of violence) nor a "negative peace" (the absence of direct violence) (Galtung 1969). Instead, "stability" refers here to the formation of cooperative coalitions.

An example may help to illustrate these points. Let's say that a particular economy consists only of three parties: two farmers and one industrialist. One farmer owns a lot of land, so we will call him the landowner. Working alone, the farmer and the industrialist each earn US$500, while the landowner earns US$1,000. Moreover, each party can form a coalition with another to reap economies of scale—in other words, benefits that would not accrue to any party acting independently. The farmer may provide cheap labor to the industrialists, for a total of US$1,400 (in which case, the landowner would still earn US$1,000). Alternatively, the farmer may provide cheap labor to the landowner, for a total of US$1,900 (leaving the industrialist to earn his usual US$500). Then again, the industrialist could team up with the landowner to produce US$1,900 (leaving the farmer to earn his usual US$500). Finally, an all-inclusive coalition would produce US$2,500.

Note first that the all-inclusive coalition represents the optimal solution. That is, economy-wide cooperation produces more revenue than any other possible configuration of coalitions. And yet, it is unstable: say the landowner is paying just over US$500 in wages to each of his partners. In that case, the farmer and the industrialist will choose to defect, earning up to US$700 apiece. But subsequently, the landowner (earning just US$1,000 now) will offer a coalition to one of them, peeling them off to earn, say US$800, and boosting his own revenues to US$1,100. It turns out that there may be no stable equilibrium when the payout of economy-wide cooperation is low enough, even if it is the optimal solution for that society. In the absence of external coercion, the coalitions will perpetually disintegrate, reform, and disintegrate again.

The Model

We now formalize these ideas using a 2-sector economy in which there is one industrialist, M, and two farmers, F_1 and F_2. The choice to model a 2-sector economy is not only convenient for this model's structure because returns to scale in each sector provide the necessary two externalities mentioned above. It is also important insofar as the switch from an agricultural to an industrial economy has figured in the development economics literature as the single most important historical process in generating high-paying jobs on a society-wide scale. This can be seen in the work of Lewis (1954), in the analyses of Dependency Theorists and Import Substitution Industrialization proponents (Arndt 1987; Bacha 1978; Frank 1978; Prebisch 1950, 1959), in Export-Oriented Industrialization, and in the thinking of heterodox economists (Amsden 2001; Chang 2002).

Individually, the industrialist can produce manufactured goods based on raw materials found in the land, while the farmers can farm their land. Raw materials are evenly distributed across all lands. If one or both farmers choose, they may form a coalition with the industrialist such that their lands' raw materials feed the industrialists' processes. Alternatively, the two farmers may form a coalition and farm their lands collectively. The production functions of each sector are such that manufacturing has a productivity coefficient, C, and farming, L. Returns to scale vary by sector, with α representing manufacturing and β farming. Moreover, the farmers' land, R, is split between the farmers such that F_1's allotment is pR and F_2's is $(1-p)R$, where $p \in [0,1]$. The industrialist has his own additional allocation of land at his disposal, aR.

We are now ready to put the pieces together. The values of the singleton "coalitions" are then:

$$V\left[\{F_1\}\right] = L\left(pR\right)^{\beta} \tag{1a}$$

$$V\left[\{F_2\}\right] = L\left(\left(1-p\right)R\right)^{\beta} \tag{1b}$$

$$V\left[\{M\}\right] = C\left(aR\right)^{\alpha} \tag{1c}$$

The values of the three 2-party coalitions are:

$$V\left[\{M,F_1\}\right] = C\left(aR + pR\right)^{\alpha} = C\left(R\left(a+p\right)\right)^{\alpha} \tag{2a}$$

$$V\left[\{M,F_2\}\right] = C\left(aR + \left(1-p\right)R\right)^{\alpha} = C\left(R\left(a+1-p\right)\right)^{\alpha} \tag{2b}$$

$$V\left[\{F_1,F_2\}\right]=L(R)^{\beta} \tag{2c}$$

Note that we have assumed that a farmer-industrialist coalition will operate with the technological coefficient and return to scale of the industrial sector. This implies, wrongly in some hypothetical cases, that $C(R(a+1-p))^{\alpha} > L(R(a+1-p))^{\beta}$. The assumption is herein justified solely on the grounds that it simplifies the analysis.

The all-inclusive coalition must be geared either toward farming or toward manufacturing, taking on the higher of the two values:

$$V\left[\{F_1,F_2,M\}\right]=\max\begin{cases}C\left(R(a+1)\right)^{\alpha}\\ L\left(R(a+1)\right)^{\beta}\end{cases} \tag{3}$$

Recalling the requirement for a non-empty core, and if we denote payouts to the two farmers and the industrialist under the grant coalition as f_1, f_2, and m respectively, then we may state that such payouts must meet or exceed the payouts for singleton "coalitions," such that

$$f_1 \geq V\left[\{F_1\}\right], \tag{4}$$

$$f_2 \geq V\left[\{F_2\}\right], \text{ and} \tag{5}$$

$$m \geq V\left[\{M\}\right]. \tag{6}$$

Moreover, the payout for any two actors under the grand coalition must meet or exceed their payout as a couplet coalition, such that

$$f_1 \geq V\left[\{F_1\}\right]. \tag{7}$$

We can now say that the possibility for instability will exist if

$$V\left[\{F_1,F_2,M\}\right]<\frac{1}{3}\Big(V\left[\{F_1\}\right]+V\left[\{F_2\}\right]+ C(aR)^{\alpha}+V\left[\{F_1,M\}\right]+ V\left[\{F_2,M\}\right]+V\left[\{F_1,F_2\}\right]\Big). \tag{8}$$

The condition for an empty core is then:

$$C\left(R(a+1)\right)^{\alpha}<\frac{1}{3}\Big[C\left(R(a+p)\right)^{\alpha}+ C\left(R(a+1-p)\right)^{\alpha}+L(R)^{\beta}\Big],$$
given $C\left(R(a+1)\right)^{\alpha} > L\left(R(a+1)\right)^{\beta}$, and (9a)

$$L\left(R(a+1)\right)^{\beta}<\frac{1}{3}\Big[C\left(R(a+p)\right)^{\alpha}+ C\left(R(a+1-p)\right)^{\alpha}+L(R)^{\beta}\Big],$$
given $L\left(R(a+1)\right)^{\beta} > C\left(R(a+1)\right)^{\alpha}$. (9b)

Graphically, the condition is represented below by three functions: (a) the manufacturing payout (blue), (b) the agricultural payout (green), and (c) the empty core benchmark (red, given by the right hand side of Equations (9a) and (9b). The empty core will obtain whenever the red line exceeds both the blue and the green.

Implications

This section is broken into four parts, in which the model's predictions for instability are analyzed given: (1) rising technological efficiency in the industrial sector; (2) rising levels of industrial asset ownership; (3) a varying distribution of assets between farmers; and, (4) increasing societal resources. The latter might be interpreted, for instance, as raising the amount of international aid a country receives. Each of these dynamics will be examined under three assumptions: (A) increasing returns to scale for industry, and positive decreasing returns to agriculture (i.e., $\alpha > 1 > \beta$)[6]; (B) decreasing returns to both industry and agriculture (the standard microeconomic assumption), and (C) negative returns to scale for both industry and agriculture[7]. For the sake of comparability, it is assumed in all cases that $\alpha > \beta$ (except in **Figure 3C**).

Rising Industrial Efficiency

In the case of positive mixed returns to scale (increasing for industry, decreasing for agriculture), rising industrial efficiency is predicted to produce a switch from an economy dominated by agriculturalists to one dominated by industrialists. Moreover, there is a brief period in the transition during which time no stable equilibrium exists, and the possibility for societal chaos looms (see **Figure 1**). In the more typical case of decreasing returns to scale in both sectors, that period of possible instability is more protracted, stretching out longer (see **Figure 2**). Finally,

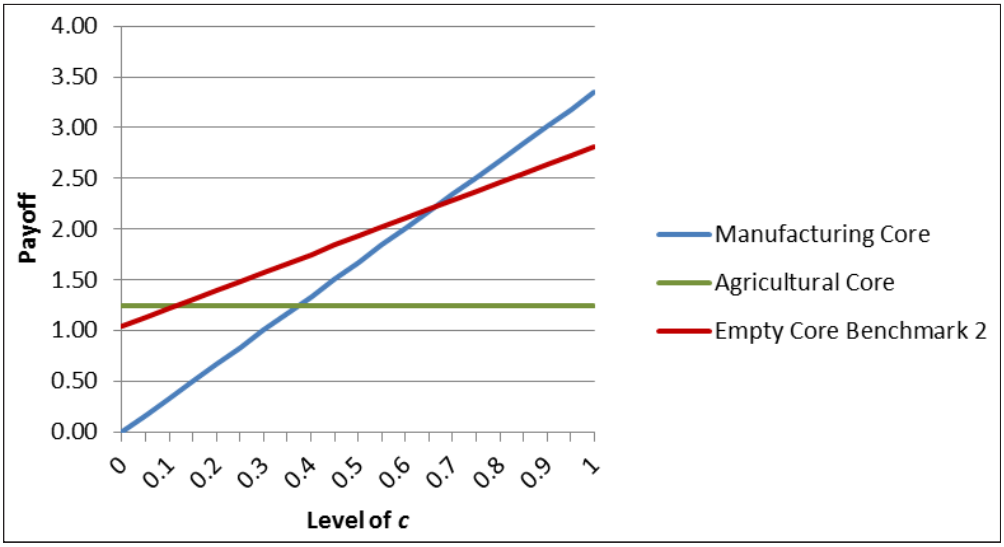

Figure 1: Stable and unstable economies as a function of rising industrial efficiency under mixed (increasing for industry, decreasing for agriculture) returns to scale. $L = 1$, $R = 2$, $a = 0.5$, $p = 0.5$, $\alpha = 1.1$, $\beta = 0.2$.

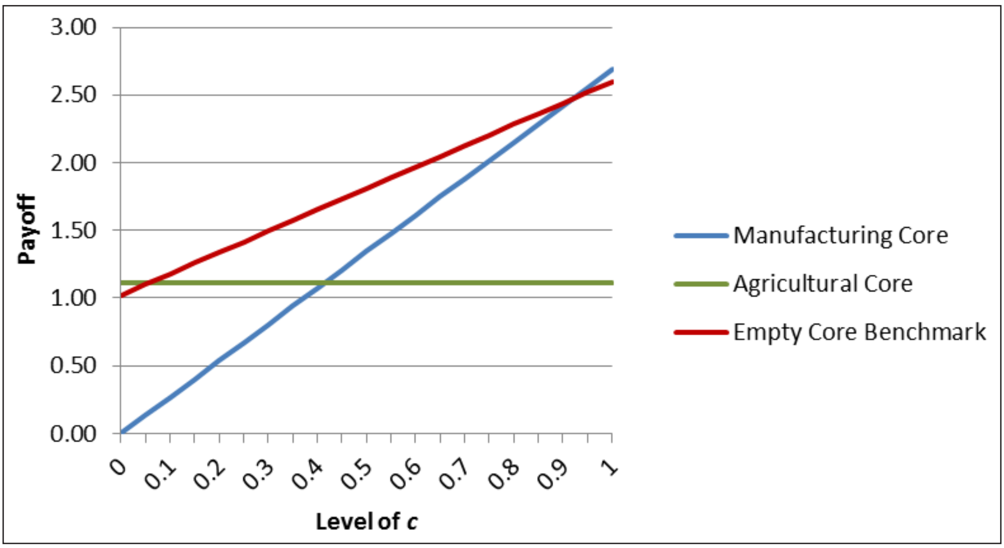

Figure 2: Stable and unstable economies as a function of rising industrial efficiency under decreasing returns to scale. $L = 1$, $R = 2$, $a = 0.5$, $p = 0.5$, $\alpha = 0.9$, $\beta = 0.1$.

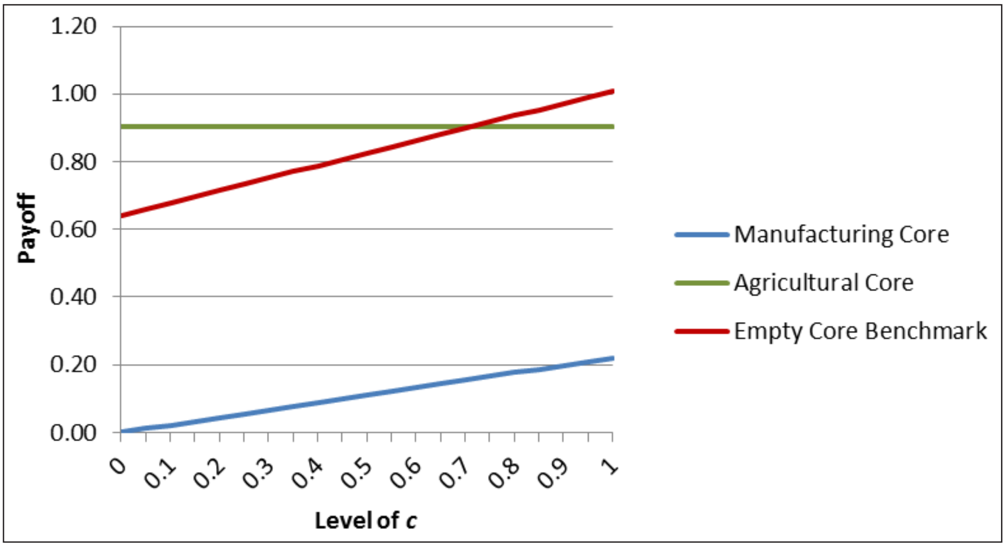

Figure 3: Stable and unstable economies as a function of rising industrial efficiency under negative returns to scale. $L = 1$, $R = 5$, $a = 0.5$, $p = 0.5$, $\alpha = -0.75$, $\beta = -0.05$.

in the case of negative returns to scale in both sectors, the period is infinite, with the industrial economy never coming to the rescue, and "stability" only assured at low levels of industrial technology in an agricultural society (see **Figure 3**).

As these hypothetical histories are highly stylized, it is foolish to attempt to map real historical episodes, with all of their attendant complexities, onto them. But the idea that an increase in productive efficiency would lead to instability, even in countries with strong national governments, does find some historical corroboration. The prototypical increase in production efficiency occurred during the English Industrial Revolution, generally dated from around 1760 to around 1832. This period coincided almost perfectly with the peak of the enclosure movement, which precipitated dramatic declines in peasant livelihoods and the consequent urbanization that fed industrial labor pools (see, e.g., Polanyi 2001 [1945]). Prior to the beginning of the Industrial Revolution, English Prime Ministers since at least 1721, and going back even to 1715 when the post of Lord High Treasurer was permanently created, came exclusively from the Whig party, broadly associated with constitutional monarchy, classical liberalism, trade, and industry. The enclosure movement and Inclosure Acts, however, saw a slow realignment of economic interests, such that the landed gentry and increasingly powerful bourgeoisie were induced to cooperate, simultaneously boosting the productivity of arable land and manning factories. The politics of England gave way to a "period of uncertainty," dominated by a factionalizing Tory party and characterized increasingly by discontent of the agriculturalist classes. This trend manifested itself both in the Tories' reluctant support under the 2nd Earl of Liverpool's Prime Ministry for the Corn Laws of 1815, as well as in the Luddite uprising and spates of "machine breaking." The state's harsh crackdown on the latter came to dominate public opinion of the Tory party, which was dissolved in 1834 (Morgan 2010, Ch. 7,8). This historical period is fraught with wars and other historical complications, making any direct causal link between increased productive capacity and political instability impossible to establish. Moreover, previous periods in English history are not immune from turmoil, either. However, the proposition that industrial productivity gains are always stabilizing does not seem to find support in this particular episode.

Growing Industrial Asset Ownership

Let us now turn our attention now to the total assets owned by the industrialist. Under positive, mixed returns to scale (increasing for industry, decreasing for agriculture—see **Figure 4**), society transitions smoothly from an agricultural to an industrial economic base without any intervening period of instability. In the case of universally decreasing returns, however, lower levels of industrial asset ownership are the only stable option (see **Figure 5**). Interestingly, this holds true both in the case in which the agricultural sector is more efficient than industry (in which an agricultural economy is favored), and in the reverse case, when an industrial economy is preferred. The same can be said of a shrinking economy, though in that case, agriculture must, of necessity, be the more efficient of the two sectors, while industrialists benefit from restricted ownership (see **Figure 6**). If either one or the other of those two requirements goes unmet, there is no stable societal coalition.

Varying Asset Distribution between Farmers

The relationship between inequality and economic growth has been the subject of intense scrutiny in economic and development literature since the classic article by Kuznets (1955). That piece famously suggested that income inequality could be expected to rise in the early stages of industrial development, declining again as the economy matured. More recently, many scholars have focused on the causal reverse of that relationship—assessing the effect of inequality, and particularly land and asset inequality, on economic growth. Fort and Ruben (2006) used panel data with land Gini coefficients to show that land inequality negatively impacts growth, both directly and, interestingly, by degrading the positive effects of educational programs.

Another body of literature has focused on the link between inequality and conflict. Cramer (2005) summarizes the bewildering array of arguments for and against such a link, including proponents of both linear (Muller, Seligson, & Fu 1989; Nafziger & Auvinen 2002) and nonlinear relationships. In terms of nonlinear theories, it is pertinent to our discussion that there are proponents for both

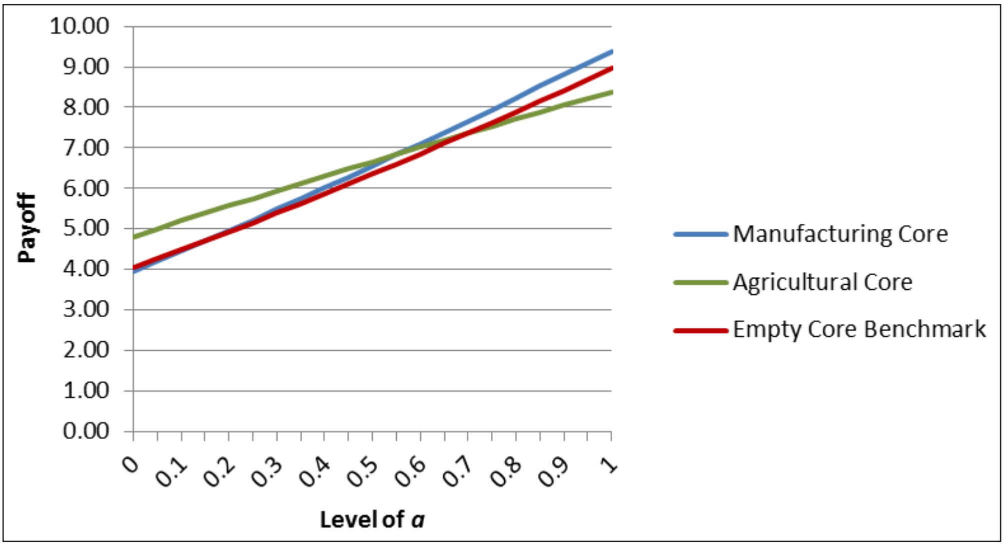

Figure 4: Stable and unstable economies as a function of growing industrial assets under mixed (increasing for industry, decreasing for agriculture) returns to scale. $C = 1$, $L = 2$, $R = 3$, $p = 0.5$, $\alpha = 1.25$, $\beta = 0.75$.

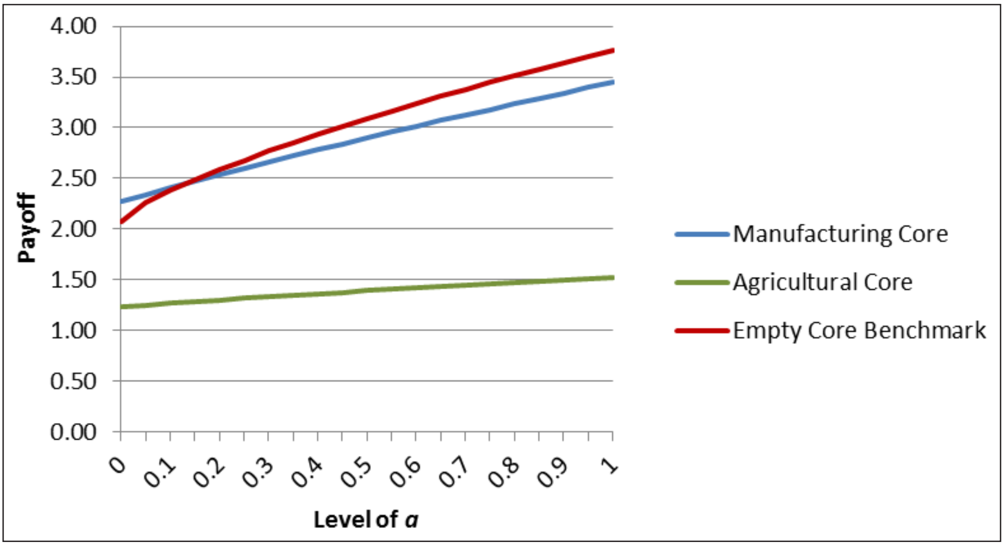

Figure 5: Stable and unstable economies as a function of growing industrial assets under decreasing, and returns to scale. $C = 1.5$, $L = 1$, $R = 2$, $p = 0.5$, $\alpha = 0.6$, $\beta = 0.3$.

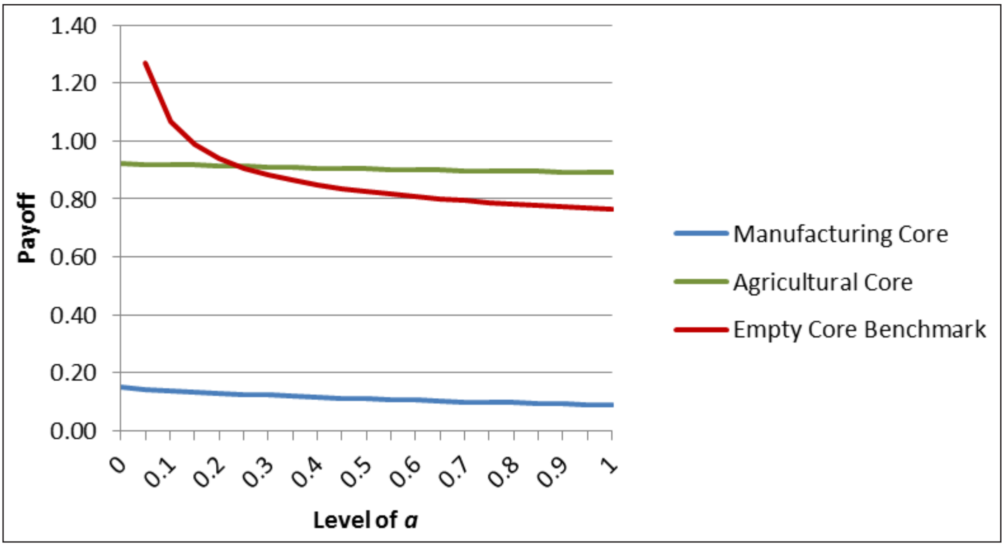

Figure 6: Stable and unstable economies as a function of growing industrial assets under negative returns to scale. $C = 0.5$, $L = 1$, $R = 5$, $p = 0.5$, $\alpha = -0.75$, $\beta = -.05$.

U-shaped and inverted-U-shaped relationships between the two phenomena. Cramer places Hirschman (1981) in the U-shaped camp, as he describes a "tolerance for inequality": when inequality rises, the majority of people cease to feel solidarity with the economic elite, and may attempt to usurp their wealth by violent means; when it drops, many cease to believe that socioeconomic mobility is a possibility, and unrest grows. Cramer places in the second camp those who believe that radical inequality so disempowers the poorest that they are prevented from agitating, but that perfect equality removes any incentive for predatory violence (e.g., Nagel 1974). In the middle, then, a region for potential unrest exists.

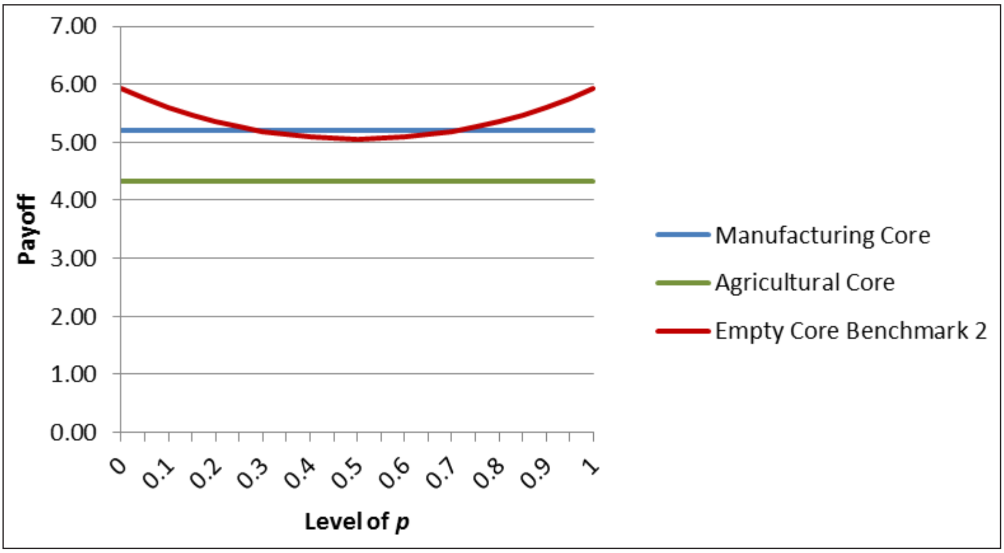

Figure 7: Stable and unstable economies as a function of farmer inequality under mixed (increasing for industry, decreasing for agriculture) returns to scale. Perfect equality is denoted by $p = 0.5$. $C = 1$, $L = 2.5$, $R = 2$, $a = 0.5$, $\alpha = 2$, $\beta = 0.5$.

None of these studies has sought to place land or asset inequality in conversation with economic growth to predict conflict or instability. In this section, we show that inequality can be associated with both increased *and* decreased likelihoods of instability, depending upon the returns to scale exhibited by our two economic sectors. To that end, we now turn to the distribution of assets between the two farmers, p, where $p = 0.5$ signifies perfect equality and $p = 0$ and $p = 1$ signify perfect inequality.

Under mixed returns to scale (increasing for industry, decreasing for agriculture), the benchmark level for instability (i.e., the "empty core") is a convex function of the distribution of agricultural assets (see **Figure 7**). It may intersect the payout functions for stable industrial or agricultural coalitions. In fact, the convexity of the function is increased with greater returns to industry. This seems to imply that, when industry—or cities, if we wish to interpret the sector as an essentially urban one—is experiencing rapid economic growth, the importance of maintaining relative distributional equality in rural areas is heightened. (If one unrealistically assumes that both sectors exhibit increasing returns, there is no possibility for instability; a universally accelerating economy appears, in this model, to be an inherently stable one.)

By contrast, in the scenario of decreasing returns to scale in both sectors, the benchmark curve for an empty core becomes convex (see **Figure 8**). Accordingly, the likelihood for societal instability becomes greatest when rural inequality is lowest. The intuition behind this is simply that, in the absence of an all-inclusive economy yielding high enough rewards to guarantee self-enforcement of contracts among its participants, neither farmer is able to offer the other farmer or the industrialist a deal that effectively marginalizes the excluded party.

As predicted in Section III, the curvature of the empty core benchmark with respect to rural land distribution changes again when the returns to scale dip into negative territory: it becomes convex (see **Figure 9**). This finding suggests that, in a shrinking economy, maintaining rural land equality is crucial. This conclusion accords with André and Platteau's (1998) assessment of the salience land inequality in the context of stagnant agricultural productivity and a growing population.

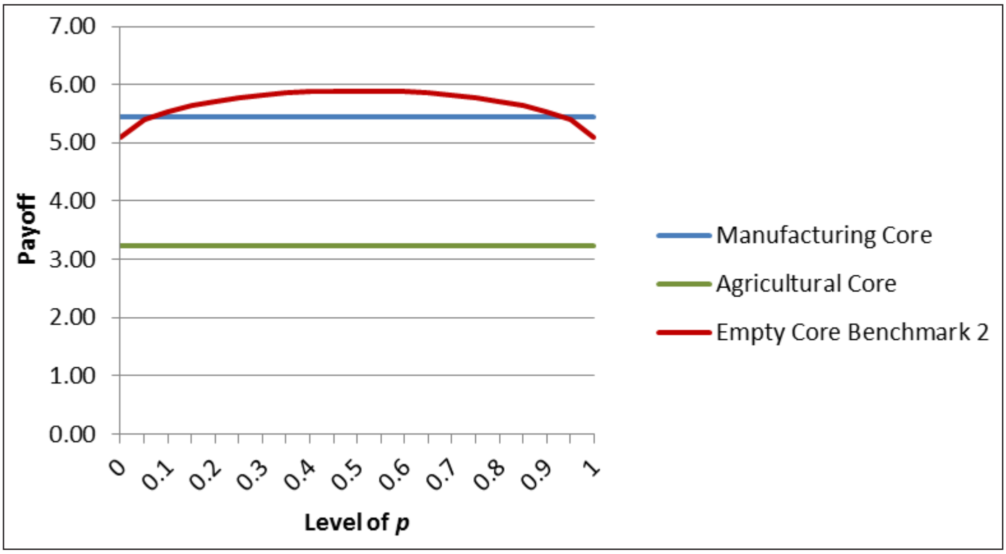

Figure 8: Stable and unstable economies as a function of farmer inequality under decreasing returns to scale. Perfect equality is denoted by $p = 0.5$. $C = 3$, $L = 2$, $R = 3$, $a = 0.1$, $\alpha = 0.5$, $\beta = 0.4$.

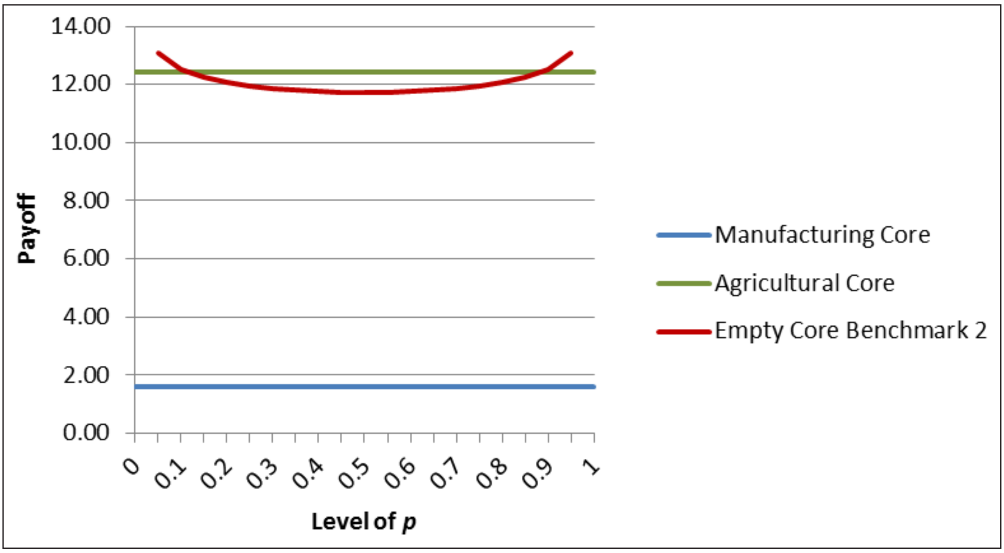

Figure 9: Stable and unstable economies as a function of farmer inequality under negative returns to scale. Perfect equality is denoted by $p = 0.5$. $C = 1$, $L = 3$, $R = 0.1$, $a = 0.5$, $\alpha = -0.25$, $\beta = -0.75$.

How can we make sense of the importance of rural equality in rapidly industrializing nations? One possibility is to consider the import-substitution industrialization (ISI) policies adopted in many Asian and Latin American countries during the 1960s and 1970s. Davis (2004) argues that rural land equality in the former enabled the farming classes to cohere as a political force, thereby pressuring the government to hold industrial firms accountable to production standards and paving the way for export-led industrialization and enhanced political stability in the 1980s and 1990s. In Latin America, by contrast, Davis argues that radical land inequalities disenfranchised rural peasants vis-à-vis rural landholders, setting the stage for the failure of "2nd-stage" ISI, the proliferation of debt crises, and generally contested and unstable political regimes continuing to the present day.

Increasing Societal Resources

Can cooperative game theory shed any light on aid policy, in addition to distributional policy? Simplistically, this question suggests varying the resources available to the economy under various returns to scale. I skip the case of increasing returns to industry, as we have determined that it is always defined by a non-empty core. In the scenarios of mixed increasing / decreasing returns for industry and agriculture respectively, and of universally decreasing returns, however, an interesting picture emerges: at low resource levels, a cooperative societal framework coheres around agriculture, and at high levels, around manufacturing. At middling resources levels, however, an empty core—and thus the possibility for instability—emerges (see **Figure 10** and **Figure 11**).

One very imperfect historical analog to this pattern is that of the 19th century United States, when the country was based around a largely agricultural economy. The 13 original colonies experienced a rapid rise in per capita real product from around US$68 in 1800, to US$111 in 1840, to US$170 in 1860 (Lindert & Williamson), at which point the American Civil War commenced. This example is problematic for a number of reasons, including the fact that agricultural and industrial technology was advancing in the lead-up to the Civil War, and that these endogenous dynamics likely represent a large part of the cause of the rise in societal resource levels in the first place. To that extent, then, the example may more aptly exemplify the pattern of stability as the level of *C* rises, as detailed in a previous subsection. In either case, the Civil War did seem to mark a definitive shift from a largely agricultural economy to a largely industrial one in which machinery (albeit largely animal-powered at the time) increasingly played a large role in boosting agricultural production (Rasmussen 1965). The model suggests more broadly that aid policy might theoretically then be used to

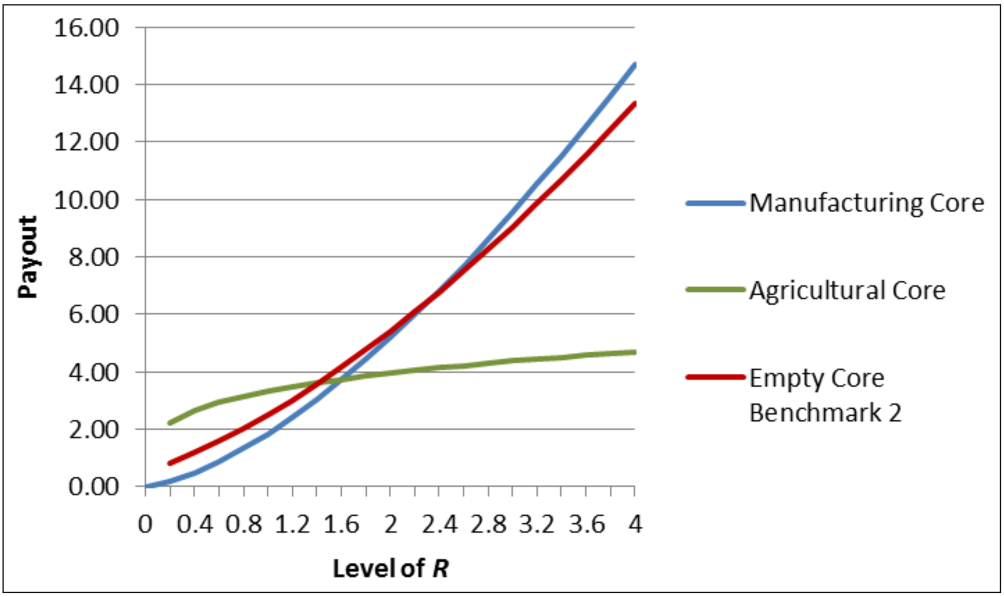

Figure 10: Stable and unstable economies as a function of resource levels (R) under mixed (increasing for industry, decreasing for agriculture) returns to scale. Perfect equality is denoted by $p = 0.5$. $C = 1$, $L = 3$, $a = 0.5$, $p = 0.5$, $\alpha = 1.5$, $\beta = 0.25$.

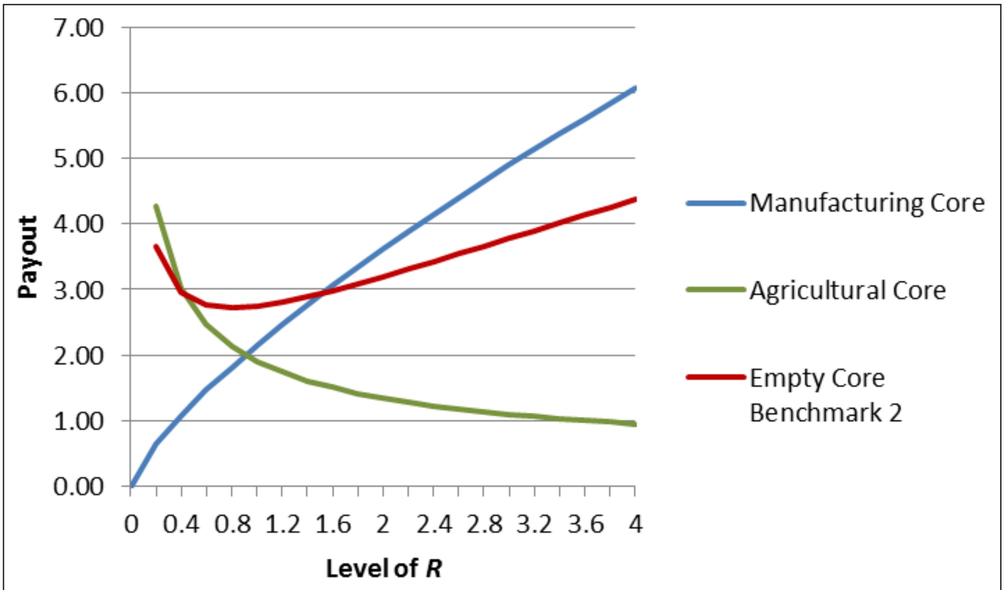

Figure 11: Stable and unstable economies as a function of resource levels (R) under decreasing returns to scale. Perfect equality is denoted by $p = 0.5$. $C = 2$, $L = 2$, $a = 0.1$, $p = 0.3$, $\alpha = 0.9$, $\beta = 0.3$.

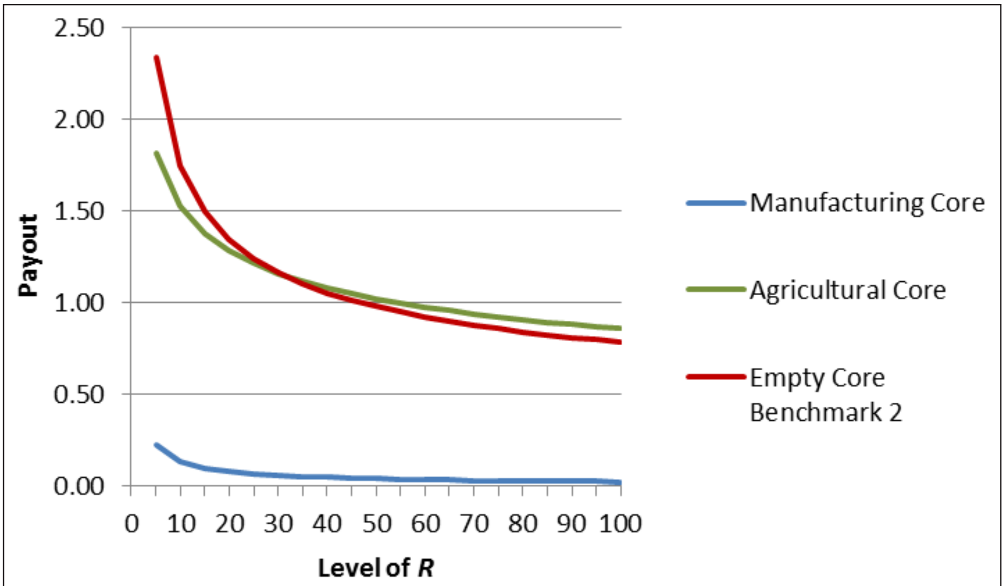

Figure 12: Stable and unstable economies as a function of resource levels (R) under negative returns to scale. Perfect equality is denoted by $p = 0.5$. $C = 1$, $L = 3$, $a = 0.5$, $p = 0.5$, $\alpha = -0.75$, $\beta = -0.25$.

hasten the transition from an agricultural to an industrial economy in these situations.

Assuming all negative returns to scale, however a more intuitive picture—that of the classic poverty trap (Collier et al. 2003)—forms (see **Figure 12**). Low resource levels are associated with an empty core and thus heightened likelihood of instability. At higher resource levels, cooperation becomes possible for an agricultural society, but interestingly, this is not possible for an industrial society under negative returns. This is because the industrialist, as a monopolist in this model, must cooperate with at least one agriculturalist, which subordinates the payout of an industrial society to the empty core benchmark—a phenomenon that does not affect agriculturalists. Of course, the fact of negative returns to scale implies that societal resources will, in the long run, be declining, eventually precipitating a return of stability.

Conclusion

In the distributional policy analysis, I suggested that maintaining equitable assets amongst agriculturalists is only undesirable under the assumption that the manufacturing sector exhibits positive and decreasing returns to scale. If increasing[8] or negative returns are the case with the manufacturing sector, however, agricultural equality then becomes an important policy goal in ensuring stability in the cooperative model. In the particular case of a shrinking economy, stability can be preserved given (a) fairly equitable land distribution, and (b) a healthy industrial sector serving agriculture.

In terms of aid policy, I suggested that, under decreasing industrial returns, more resources available to an economy can promote cooperative frameworks, but that such boosts will entail a switch to economies structured around the industrial sector. This is an important point because, while many of development "success stories" have linked agricultural production to urban industry (Brazil, India, and China, for instance) and a large body of literature views such "rural-urban linkages" favorably (see, e.g., ESCAP/UN-Habitat 2002; Evans 1992, 2001; Kammeier 2002; Momen 2006; Tacoli 1998), aid policy in general has tended to shy away from the active promotion of industrialization.[9] I also discussed how, under negative industrial returns, an increase in resources would promote a cooperative framework based around agriculture. Taken together, then, the model suggests that aid policy should be informed by an empirical assessment of sectoral returns to scale when peacebuilding is a critical goal.

The cooperative model comes with several important caveats. For one, as previously noted, while a non-empty core ensures cooperation, the reverse is not true: an empty core does not *guarantee* instability. For another, the model in no way attempts to describe the effects of state enforcement in the form, for instance, of police. In fact, the state does not figure at all here. In this respect, the model is perhaps most applicable to countries or areas in which state governments are weak and ineffective, or in which state interests are highly tied to one of the sectors modeled. For the current purposes, however, these failings may not matter much, as we are more concerned with guaranteeing stability than predicting instability.

More pertinent to the field of Peace Studies, though, is the consideration that the model describes stability, and not negative or positive peace.[10] That is, a stable arrangement may exist in which no profitable deviations exist, but which is not objectively tolerable, or humanely desirable, for one or more of the participants. Underlying this model, then, is a rational-choice view of stability that clashes with "grievance"-based views, such the idea that peasants rebel not when there is a "better deal" to be gained, but when their subsistence livelihoods are threatened with destruction (e.g., Scott 1976). Moreover, it does not necessarily follow that a model designed to predict the actions of individuals is applicable on a macroeconomic basis.

A final caveat is that the diagrams presented herein are simply exercises in comparative statics. There is no ineluctable logic that would draw the level of, say, societal resources, up. And as the example of 19th century America highlighted, these factors are not independent of one another. Moreover, there may easily be circular causation at work, insofar as instability may decrease levels of resources, technological coefficients, or returns to scale, in ways that are not modeled here.

However, there is value in the consideration of these sorts of models. At the most basic level, they draw out implications of a specific definition of economic stability. This definition differs markedly from the standard implicit one, which diagnoses instability symptomatically by way of reference to recurrent conflict. By contrast, the definition adopted here posits that conflict may, itself, be economically stable, even while providing one possible mechanism that could weaken social and political institutions to the point where recurrent conflict is more likely. In some ways, this definition of stability resonates with the current discursive context in which conflict management is preferred to keeping or building "peace" (Mac Ginty 2012: 23–25). Moreover, this type of model is highly adaptable, and may easily be refined in ways that improve believability (see, e.g., McDougal & Ferguson 2012).

In closing, I note that the model is possibly testable. One strategy for doing so involves the somewhat neglected dataset by Crego, Larson, Butzer, and Mundlak (1998), which enables dual-sector estimation of production coefficients and returns to scale across 41 developing and developed countries for the period 1962–1992. Paired with the Uppsala (2009) conflict dataset and additional data on land distribution and control variables as yet unidentified, the Crego et al. dataset might allow for a test of association between an empty core and political volatility. Rearranging Equations (9a) and (9b), we might construct a dependent variable x_{it} measuring the difference between the empty core benchmark and the all-inclusive coalitions:

$$x_{it} \equiv \frac{1}{2}\left(C\left(R\left(a+p\right)\right)^{\alpha} + C\left(R\left(a+1-p\right)\right)^{\alpha} + L\left(R\right)^{\beta}\right) - C\left(R\left(a+1\right)\right)^{\alpha},$$
$$\text{given } C\left(R\left(a+1\right)\right)^{\alpha} > L\left(R\left(a+1\right)\right)^{\beta}, \text{ and} \tag{10a}$$

$$x_{it} \equiv \frac{1}{2}\left(C\left(R\left(a+p\right)\right)^{\alpha} + C\left(R\left(a+1-p\right)\right)^{\alpha} + L\left(R\right)^{\beta}\right) - L\left(R\left(a+1\right)\right)^{\beta},$$
$$\text{given } L\left(R\left(a+1\right)\right)^{\beta} > C\left(R\left(a+1\right)\right)^{\alpha}, \tag{10b}$$

for inclusion in a standard fixed time effects logistic regression equation.

Notes

1 I gratefully acknowledge the insights of Nicholai Lidow, who first brought this idea to my attention, as well as the significant suggestions of two anonymous reviewers. I am also grateful to Neil T. Ferguson for his work subsequent to the writing of this piece, which renders the basic model elaborated herein more realistic and sophisticated.

2 A "growing pie" is an economist's metaphor for a growing set of shared resources. If one wants to increase the size of her "piece of the pie," the two fundamental ways of doing this are to make others' pieces smaller (i.e., redistribute the resources in one's favor) or to grow the shared resources such that one's proportion of the total remains constant but now implies a larger amount.

3 Hirshleifer's (1988) seminal conflict model essentially implied a very endorsement of economic growth.

4 The eponymous example of a prisoner's dilemma is that of two would-be criminal accomplices who have committed a serious crime. The two have been imprisoned and the police have evidence to convict each of them on lesser charges (say, breaking and entering), but not the principal charge. The accomplices are interrogated separately and have no way of communicating. The police attempt to entice each into inculpating the other by commuting their sentence. Thus, if both accomplices cooperate by not snitching, each will do a small amount of time in

jail. If one snitches, he will get out immediately, while the other will be held for life. And if both snitch, they will both be held for a long time. An example of deadlock might be the Israel-Palestine conflict. As in the prisoner's dilemma, the best outcome for either player (taken to be Israel's Likud political party and the Palestinian Liberation Organisation in this case) would be for the other side to accommodate its demands. Unlike in the prisonner's dilemma, though, the next best option is not to cooperate, but rather mutual non-cooperation, since accommodation by either party in that context could be seen as a sign of weakness leading to the party's ouster from power. An example of chicken might be that of the Cold War. As in the prisoner's dilemma, the best outcome for either player would be for the other side to cooperate (say, by unilaterally disarming) and thereby allow for its domination. However, unlike in the prisoner's dilemma, the consequence of mutual non-cooperation (both sides arming, possibly resulting in nuclear war) is far worse than being the one suckered, making it rational to cooperate if the other side seems committed to non-cooperation.

5 See, e.g., Tsebelis (1990).

6 While it is unusual to assume increasing returns to scale in an economic model, a body of economic literature has demonstrated that industrial cities can and do exhibit increasing returns (Arthur 1989; Fujita, Krugman, & Venables 1999; Krugman 1991a, 1991b, 1998).

7 Again, it is unusual to assume negative returns to scale in economic models, as rational actors are assumed not to invest at all when returns to them are less than what they invest. However, it might be postulated that, for whatever reason, non-investment is not possible, precipitating a poverty trap (Duflo & Banerjee 2011). Negative returns to industry may be somewhat similar to what Hoselitz (1955) termed a "parasitic" city—one which destroys wealth, or at least sucks it out of the country in question.

8 Romer (1994), Arthur (1989) and Krugman (1991b) were among the first to model increasing returns to scale in urban industrial areas. Increasing returns to scale can be explained solely as a function of pecuniary agglomeration economies resulting from the presence of specialized intermediary industries in the presence of transportation costs (see, e.g., Fujita et al. 1999; Krugman 1998), but may also arise due to pecuniary recruitment economies in the labor market, as well as non-pecuniary economies associated with technological innovation—all mechanisms originally discussed by Alfred Marshall (1920 [1890], Ch. 10).

9 For example, while the World Bank has a dizzying array of agricultural extension, crop, forestry, animal husbandry, irrigation, and fishery projects across the developing world, few projects deal with the promotion of industry in such a "hands on" way. Rather, World Bank industry projects tend to promote good "investment climates" through public sector reform, infrastructure provision, and institutional capacity-building. Historically, critiques have been leveled against the World Bank to the effect that it systematically misrepresents the needs of developing countries to push rural development agendas (see, e.g., Ferguson 1994 [1990]). Amsden (2001, 2007, 2012 (manuscript)) alleges that the aid industry as a whole has managed to ignore the fact that industrialization is the only economic process that has historically managed to provide high-paying jobs (and therefore a means of pulling oneself out of poverty) to large portions of society.

10 For the seminal discussion of positive versus negative peace, see Galtung (1969).

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