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A TENTATIVE MODEL OF CONFLICT, APPROPRIATION AND PRODUCTION IN A TWO-SECTOR ECONOMY

Raul Caruso*

ABSTRACT

This paper presents a model of conflict in an economy characterized by two sectors. In a first sector labelled as contested sector two agents struggle in order to appropriate the maximum possible fraction of a contestable output. In a second sector, the uncontested sector, each agent holds secure property rights over the production of some goods. Both agents maximize an income function which can be described as a function of contributions of both sectors. Results show that the degree of returns in the uncontested sector is a powerful force which countervails the impact of destructive and unproductive interaction in the contested sector.

KEYWORDS: Conflict, Productive and Unproductive Activities, Butter and Guns, Crime, Warlords, Civil War.

JEL CLASSIFICATION: D74, D20, F51, H56,O17.

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Introduction

This note is intended to be a contribution to the theoretical economic analysis of conflict. A conflict can be described as *« a destructive interaction which involves strategic interdependent decisions in the presence of coercion and anarchy ».*In many general equilibrium models following Hirshleifer (1988),[1] a contestable output falls into a common pool available for seizure and appropriation. However, in reality, agents involved in a conflict have some income and wealth secure from appropriation. This should imply that there is a relationship between the choice of resources to be allocated to conflict and the choice of resources to be allocate in the secure production.

Take the existence of crime organizations.[2] In reality, crime organizations do not devote all their efforts and resources to the exploitation and protection of 'dirty' businesses as illegal drugs trafficking, arms smuggling or illegal gambling. These businesses require massive collateral investments in 'military equipment' in order to protect them from state-led policing and other potential criminal competitors. In the mean time, crime organizations are also commonly involved in many legal activities. This is a common phenomenon in Italian southern regions where Sicilian Mafia and Neapolitan Camorra[3] are supposed to allocate a huge amount of resources in some traditional sectors as building, construction and real estate.

A very similar phenomenon is also predictable in many developing regions where different warlords (or states and rebel groups) fight over the appropriation and the control of a territory or resources. On one hand they fight and expend

[1] In more recent years several studies extended Hirshleifer's basic model. See among others: Grossman (1991), Grossman and Kim (1995), Skaperdas (1992), Neary (1997), Anderton et al. (1999), Garfinkel and Skaperdas (2000), Dixit (2004), Spolaore (2004), Caruso (2006a). The literature on the economics of conflict has been recently surveyed and deeply expounded in Garfinkel and Skaperdas (2007).

[2] The interaction between the state and crime organizations has been already analysed as a conflict between two groups (Skaperdas and Syropoulos, 1995).

[3] Surprisingly, there are few economic studies of italian crime organizations. A first empirical evidence is in Marselli and Vannini (1997). See also different theoretical contributions in Zamagni (1993).

resources to appropriate a contested resource or a fraction of a future income. On the other hand, they can be involved in productive activities on the fraction of territory whose govern is completely secure. This appears to be the case in countries as – for examples among others - Afghanistan, Colombia, Angola or Nigeria where some groups hold the power in some regions and continuously send (or face) threats of aggression and predation to (from) the recognized state government.

Then, in an extremely simplified economy, it would be possible to consider two sectors. In a first sector each agent holds secure property rights over the production of some goods. Such secure property rights assure the holder of a secure level of production and then of income stream. In the second sector, agents struggle in order to appropriate the maximum possible fraction of a contestable output. In the continuation of this work, I shall label the first sector as *uncontested sector* and to the latter as *contested sector*. The purpose of this paper is to analyse the type of resource allocation in an economy characterized by these two sectors.

There are some specific features for this economy. First, a world modelled as a contested economy involves necessarily strategic behaviour between agents. This recalls a point expounded in Bowles and Gintis (1988/1993) who underlined the impact of power in market interactions through the expression 'contested exchange'. In fact, the exploitation of coercion through brutal violence is nothing but a tool to establish a power relationship shaping the existence and persistence of market institutions. The existence of coercion also has a significant impact on the overall distribution of resources between productive and unproductive activities

Then, secondly, the final allocation of resources will depend upon exploitation of force. In particular, the relative strength is one of crucial factor in determining the final outcome of interaction. Third, there is a productive asymmetry between the two sectors. In particular, the economy is modelled as having a traditional uncontested sector characterized by decreasing returns to scale (DRS) and a contested sector characterized by constant returns to scale (CRS). This is a key assumption for this work.

To my knowledge, there are very few papers analysing two sectors with three activities as two kinds of productive activities (secure production, contested production) and unproductive activities. Only Garfinkel and Skaperdas (2007) introduces briefly the argument in a section of their survey on economics of conflict, but their model allows only for two types of equilibria. In a first equilibrium agents only produce ‘margarine’ thus implying no allocation of resources to both ‘butter’ and ‘guns’. In a second kind of equilibrium, both parties produce positive quantities of guns and butter but no margarine. Different equilibria emerge in the presence of particular combination of a degree of decisiveness of the conflict and a production parameter. More attention has been paid to economies characterized by two kinds of unproductive activities (defence and offence) and productive activities. This is the case of Grossman and Kim (1995), Rider (1999) and Panagariya and Shibata (2000) among others. The latter, models an arms rivalry between two small countries facing a constant probability of war. Countries produce arms and a consumption good that can be traded internationally whilst a defense good interpreted as a public good is non-traded. The main result of the article is that a subsidy flowing from one country to another can boost consumption and then increase total welfare. Rider (1999) develops a model with two goods and three activities (production, predation and defense) to show the impossibility of pure and uncontested exchange. In such a framework each agent is assumed to produce only one good. However, the first work implying a distinction between two types of unproductive activities is Grossman and Kim (1995).

This brief paper is simply designed. In a first section, the model is presented and optimal choices at the equilibrium are computed. In a second section, the impact of different variables and parameters upon total production and total welfare are studied. In a last section, some conclusions and discussions based upon the results are presented as well as some insight for future research.

The Model

The world is made of two risk-neutral agents indexed by $i = 1,2$. They interact simultaneously. Both agents has a positive resources endowment denoted by $R_i \in (0, \infty), i = 1,2$. It can be divided into 'guns', 'butter' and 'ice-creams'. By 'guns' I indicate any positive investments in unproductive activities of fighting. By 'butter' I indicate any positive investment in productive activities in the contested sector, whilst by 'ice-creams' I indicate any positive investments in productive activities in the uncontested sector. The interaction between the two agents generates an equilibrium allocation of resources endowment among 'guns', 'butter' and 'ice-creams'.

To summarise formally it is possible to write the resources constraint as:

$$R_i = y_i + x_i + G_i, i = 1,2 \tag{1}$$

where G_i denotes the level of 'guns', and y and x denote 'seed' and 'butter' respectively. They are all assumed to be positive: $y_i \in (0, \infty), x_i \in (0, \infty), i = 1,2$.

In the contested sector, the contested joint product – indicated by CY - can be described as a simple linear additive function:

$$\begin{aligned} CY &= x_1 + x_2 = \\ &= TR - G_1 - y_1 - G_2 - y_2 \end{aligned} \tag{2}$$

where $TR = R_1 + R_2$. This aggregate production function is characterized by constant returns to scale and constant elasticity of substitution. The outcome of the struggle is determined by means of an ordinary Contest success function[4] (henceforth CFS for brevity) in its ratio form:

$$p_i(G_1, G_2) = \frac{G_i}{G_1 + G_2}, i = 1,2 \tag{3}$$

[4]Selective seminal contributions on CSF are by Tullock (1980), O'Keeffe et al. (1984), Rosen (1986) and Dixit (1987). See then Skaperdas (1996) and Clark and Riis (1998) for a basic axiomatization. See also Amegashie (2006) and Peng (2006).

The functional form adopted for CSF implies that the conflict is not decisive, namely it could be said that it exhibits constant returns to fighting. Equation (3) is differentiable and follows the conditions below:

$$\begin{cases} p_1 + p_2 = 1 \\ p_i = .5 \text{ at } G_1 = G_2 \\ \partial p_i / \partial G_i > 0 \quad \partial p_i / \partial G_j < 0 \\ \partial^2 p_i / \partial G_i < 0 \quad \partial^2 p_i / \partial G_j > 0 \end{cases} \tag{3.1}$$

and then the outcome in the contested sector is given by:

$$S_i = p_i(G_1, G_2)\theta CY \tag{4}$$

Where $\theta \in (0,1)$ denotes a physical destruction parameter. It can be interpreted as an ex-ante perception of destructiveness of conflict. That is, a conflict is twice costly. On one hand the amount resources allocated to 'guns' do constitute a deadweight loss for society because the same amount of resources could be allocated to more productive activities. On the other hand, in the case of actual violent conflicts there is a fraction of resources physically destroyed. Take the gravest case of a war and consider for simplicity a potential labour supply. All the potential labourers could become either soldiers or farmers. On one hand all the men involved in soldiering do constitute a deadweight loss because they could be employed as farmers. On the other hand, if an actual war breaks out many of them will be killed. The ex-ante perception on the percentage of killed soldiers (that is the fraction of human capital) do constitute an example of θ. At this stage, given the sharp analytical complexity I shall assume for sake of simplicity that it is equal for both agents. As θ increases, the conflict is perceived less and less destructive. Given conditions (3.1) the fraction of contestable output accruing to agent i is increasing in its own level of guns whereas it is decreasing in the opponent's level of guns. Equation (4) is the cornerstone of the classical Hirshleifer's model of continuing conflict featuring two risk-neutral agents.

The uncontested sector is modelled as a traditional sector exhibiting decreasing returns to scale. Therefore, the production function is a standard intensive production function which exhibits decreasing returns to scale:

$$Y_1(y_1) = y_1^a ; Y_2(y_2) = y_2^b \quad (5)$$

where y_i denotes the level of resources devoted to the uncontested production by agent i and $a \in (0,1)$ and $b \in (0,1)$ are the parameters capturing the degree of returns of scale for agent 1 and agent 2 respectively. Trivial to say that $Y(0) = 0$, $Y(\infty) = \infty$, $\partial Y / \partial y > 0$, $\partial^2 Y / \partial^2 y_i < 0$, $\partial Y_1 / \partial a > 0 \Leftrightarrow y_1 > 1, \partial Y_2 / \partial b > 0 \Leftrightarrow y_2 > 1$. The level of production in the uncontested sector can be simply denoted through $UY = Y_1 + Y_2$.

Therefore, the final income of each agent can be described as a function of contributions of both sector as $W_i = f(Y_i, S_i)$. Eventually each agent maximizes an objective function as:

$$W_i(Y_i, S_i) = Y_i + S_i, i = 1,2 \quad (6)$$

This kind of function can lead to ambiguous results. On one hand, an increase in the amount of 'guns' lower the level of production. On the other hand, final wealth of each agent could be raised through positive investments in appropriative activities. Agents are assumed to be rational and to interact simultaneously à la Nash-Cournot. Under an ordinary process of maximization the optimal choices[5] of 'ice-creams' are:

[5] Studying the second order condintions it is possibile to show that the critical points $(G_1^*, G_2^*, y_1^*, y_2^*)$ do require a sufficiently high level of TR to be an equilibrium.

$$y_1^* = \left(\frac{2a}{\theta}\right)^{1/(1-a)} \quad (7.1)$$

$$y_2^* = \left(\frac{2b}{\theta}\right)^{1/(1-b)} \quad (7.2)$$

The optimal level of 'ice-creams' is unambiguously larger than zero ($y_i^* > 0, i = 1,2$) for both agents and it is increasing in the degree of returns to scale, $\partial y_1^* / \partial a > 0, \partial y_2^* / \partial b > 0$. Note also that the level of 'ice-creams' is decreasing in the degree of destructiveness $\partial y_i^* / \partial \theta < 0$. The optimal level of 'guns' is given by:

$$G_1^* = G_2^* = G^* = \frac{TR}{4} - 2^{(2a-1)/(1-a)}\left(\frac{a}{\theta}\right)^{1/(1-a)} - 2^{(2b-1)/(1-b)}\left(\frac{b}{\theta}\right)^{1/(1-b)} \quad (8)$$

The level of 'guns' is larger than zero if and only if $TR > -y_1^* - y_2^*$. Given (7.1) and (7.2) the latter condition always hold. Note that the optimal level of guns is increasing in the degree of destructiveness, $\partial G^* / \partial \theta > 0$. Namely, the higher is the perceived potential destruction the higher is the willingness to avoid it by a massive investments in arms. Moreover it is clear that $\partial G_1^* / \partial a < 0, \partial G_1^* / \partial b < 0, \partial G_2^* / \partial \alpha < 0, \partial G_2^* / \partial b < 0$. It is possible to compute the optimal level of 'butter' simply as:

$$\begin{aligned} x_1^* &= R_1 - y_1^* - G_1^* = \\ &= \frac{3R_1 - R_2}{4} - 3 \times \left(2^{(2a-1)/(1-a)}\left(\frac{a}{\theta}\right)^{1/(1-a)}\right) + 2^{(2b-1)/(1-b)}\left(\frac{b}{\theta}\right)^{1/(1-b)} \end{aligned} \quad (9.1)$$

$$\begin{aligned} x_2^* &= R_2 - y_2^* - G_2^* = \\ &= \frac{3R_2 - R_1}{4} - 3 \times \left(2^{(2b-1)/(1-b)}\left(\frac{b}{\theta}\right)^{1/(1-b)}\right) + 2^{(2a-1)/(1-a)}\left(\frac{a}{\theta}\right)^{1/(1-a)} \end{aligned} \quad (9.2)$$

And it is possible to show that the level of butter of each agent is decreasing in its degree of returns to scale and increasing in rival's degree of return to scale, namely $\partial x_1 / \partial a < 0$, $\partial x_1 / \partial b > 0$, $\partial x_2 / \partial b < 0$, $\partial x_2 / \partial a > 0$. This means that as the degree of returns to scale increases each agent will prefer to allocate resources to the uncontested sector. That is, as the secure and uncontested sector becomes more productive (albeit still in the range of the DRS) the level of contested 'butter' decreases.

Of course, the optimal level of butter of agent i is increasing in its own initial endowment and decreasing in the endowment of the opponent, namely $\partial x_i / \partial R_i > 0, \partial x_i / \partial R_j < 0, i = 1,2, i \neq j$. Final incomes of both agents are then given by:

$$W_1^* = \frac{\theta}{4} TR + 2^{(2a-1)/(1-a)} (2-a) \left(\frac{a}{\theta} \right)^{a/(1-a)} - 2^{(2b-1)/(1-b)} b^{1/(1-b)} \theta^{b/(b-1)} \tag{10.1}$$

$$W_2^* = \frac{\theta}{4} TR + 2^{(2b-1)/(1-b)} (2-b) \left(\frac{b}{\theta} \right)^{b/(1-b)} - 2^{(2a-1)/(1-a)} a^{1/(1-a)} \theta^{a/(a-1)} \tag{10.2}$$

Final incomes are positive if and only some conditions are satisfied

$$W_1^* > 0 \Leftrightarrow TR > \left(2 \frac{b}{\theta} \right)^{1/(1-b)}$$

whereas

$$W_2^* > 0 \Leftrightarrow TR > (\theta / 2)^{1/(a-1)}.$$

Eventually, note that incomes of both agents are decreasing in both degrees of returns to scale under some conditions. Verify that $\partial W_1^* / \partial a < 0 \Leftrightarrow (a-2)\ln(2a/\theta) + a - 1 > 0, \partial W_2^* / \partial b < 0 \Leftrightarrow (b-2)\ln(2b/\theta) + b - 1 > 0$, and $\partial W_1^* / \partial b < 0, \partial W_2^* / \partial a < 0$.

Then, there is a combination of a and θ that makes the income of each agent decreasing in its own degree of returns to scale. In particular, the first condition states that as $\theta \to 1$(namely, the conflict is perceived less and less destructive) there are positive values for a allowing for a negative impact of the degree of returns upon the level of income. For example if $\theta = .75$, then $\partial W_1^* / \partial a < 0 \Leftrightarrow 0 < a < .24$. The intuition behind appears to be simple. In other words, when agent 1 does not retain a high degree of returns in the uncontested sector and interprets the conflict as non-destructive, it will have less incentives to invest in the secure and uncontested sector.

To sum up it is possible to write the following proposition:

PROPOSITION 1: *when agents are identical in their fighting abilities and asymmetric in their degrees of returns to scale in the uncontested sector a combination of the destruction parameter and the degree of returns affect the optimal allocation of resources. In particular it is clear that: (a) as the degree of returns to scale increases each agent will prefer to allocate more resources to the uncontested sector; (b)when the conflict is perceived to be non-destructive each agent has less incentives to invest in the uncontested sector.*

Production and Welfare

As tools for 'measurement' I analyse hereafter the level of production and the total welfare. I shall consider the impact of the different variables and parameters on them. First, Using (5), (7.1) and (7.2) it is possible to compute the level of production emerging in the uncontested sector. Then we have:

$$UY = \left(2\frac{a}{\theta}\right)^{a/(1-a)} + \left(2\frac{b}{\theta}\right)^{b/(1-b)} \tag{11}$$

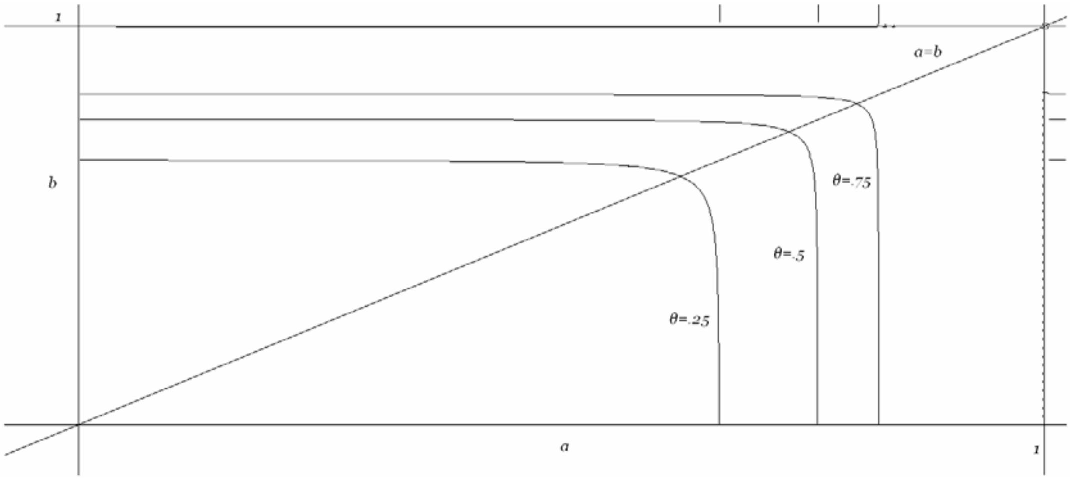
First, the level of uncontested production is unambiguously larger than zero. Eventually it is worth noting that $\partial UY / \partial a > 0 \Leftrightarrow \ln(2a/\theta) - a + 1 > 0$ and $\partial UY / \partial b > 0 \Leftrightarrow \ln(2b/\theta) - b + 1 > 0$. That is, as the conflict is perceived to be less and less destructive the degree of returns in the uncontested sector must be sufficiently high. Otherwise, in the presence of low returns to scale both agents would be better off by allocating resources into the contested sector. In such a case, the level of production in the uncontested sector would decrease. In other words, when the returns in the uncontested sector are extremely low the level of uncontested production would decrease. For instance, set arbitrary $\theta = .75$, in order to have a level of UY increasing in a and b it is necessary to have $a, b > .16$. By contrast, as $\theta \to 0$ a very low degree of returns would even suffice to satisfy the positive relationship between total production in the uncontested sector and degree of returns.

Using (9.1) and (9.2) the level of production in the contested sector – namely the contested output - is given by:

$$CY = x_1^* + x_2^* = \frac{TR}{2} - 2^{a/(1-a)} \left(\frac{a}{\theta} \right)^{1/(1-a)} - 2^{b/(1-b)} \left(\frac{b}{\theta} \right)^{1/(1-b)} \tag{12}$$

It is trivial to say that CY is increasing in the level of resources $\partial CY / \partial TR > 0$ and decreasing in the destruction parameter $\partial CY / \partial \theta < 0$. At the same time it is unambiguously decreasing in both a and b, $\partial CY / \partial a < 0, \partial CY / \partial b < 0$. The higher are the returns in the uncontested sector the lower would be the level of production in the contested sector. It is worth noting that there are combinations of a and b, both being between zero and unity, that allows for $CY = UY$. The plot below reports the curves denoting the locus $CY = UY$ for $TR = 200$ and three different values for θ. As it is simply shown as the conflict becomes less destructive the combination of a and b allowing for $CY = UY$ requires higher values for both a and b. All the points above the curves allow for $UY > CY$. Then, to have the desirable scenario of $UY > CY$ both a and b must be sufficiently high. This is depicted in Figure 1.

FIGURE 1 – UNCONTESTED AND CONTESTED PRODUCTION



The total production in the economy is simply given by the sum of (9.1) and (9.2)

$$
\begin{aligned}
TY &= CY + UY = \\
&= \frac{TR}{2} + \theta^{1/(a-1)}(\theta - a)2a^{a/(1-a)} + \theta^{1/(b-1)}(\theta - b)2b^{b/(1-b)}
\end{aligned} \tag{13}
$$

Also in this case it is clear that $\partial TY / \partial \theta < 0, \partial TY / \partial TR > 0$. Given the results presented above it appears to be predictable that the degree of returns can have an ambiguous impact on the level of total production. In particular the partial derivatives with respect to a and b show that the total production is largely decreasing in the degrees of returns to scale. More formally, we have:

$$\partial TY / \partial a < 0 \Leftrightarrow (a - \theta)\ln(2a/\theta) + (a-1)(\theta - 1) > 0 \tag{13.a}$$

and

$$\partial TY / \partial b < 0 \Leftrightarrow (b - \theta)\ln(2b/\theta) + (b-1)(\theta - 1) > 0 . \tag{13.b}$$

In fact, when the conflict is perceived to be destructive both agents allocate more resources in the uncontested sector. This can decrease the level of production in the contested sector. Then, although it can appear paradoxical, this can also decrease the level of total production. This would depend upon specific combinations of a,b and θ.

It is possible to compute the total welfare as the sum of incomes. Then :

$$TW = W_1^* + W_2^* = \\ = \theta\frac{TR}{2} + (1-a)\left(\frac{2a}{\theta}\right)^{a/(1-a)} + (1-b)\left(\frac{2b}{\theta}\right)^{b/(1-b)} \tag{14}$$

The level of total welfare is increasing in the level of resources $\partial TW / \partial TR > 0$. Note also that $\partial TW / \partial a > 0 \Leftrightarrow \ln(2a/\theta) > 0$ and $\partial TW / \partial b > 0 \Leftrightarrow \ln(2b/\theta) > 0$. Therefore, as the conflict becomes less destructive the degree of returns in the uncontested sector must be sufficiently high. The level of total welfare is decreasing in θ if and only if the following condition is satisfied:

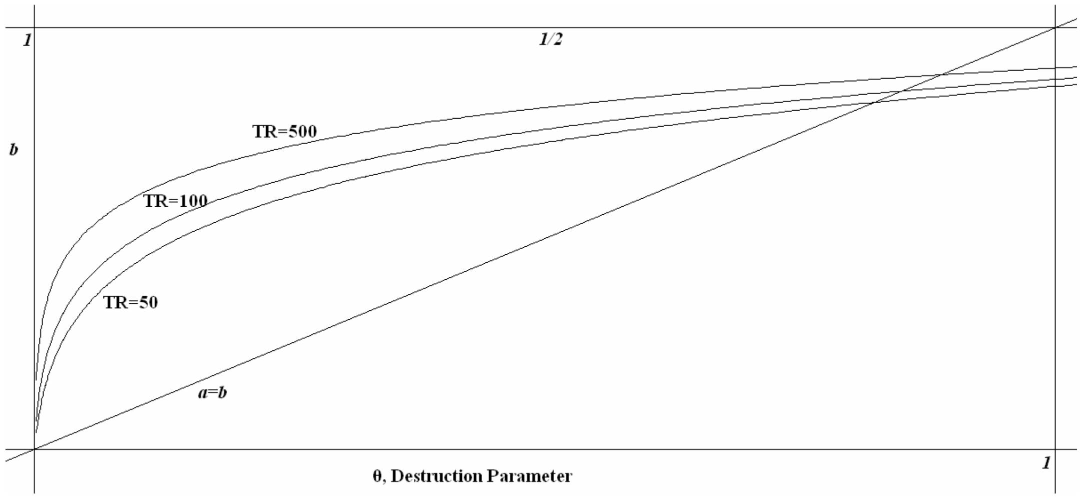
$$\left(TR(2b)^{1/(b-1)} - \theta^{1/(b-1)}\right)(2a)^{1/(a-1)} - \theta^{1/(a-1)}(2b)^{1/(b-1)} < 0 \tag{15}$$

which after some manipulations can be reduced to:

$$TR(2b)^{1/(b-1)} - \theta^{1/(b-1)} < 0 \tag{16}$$

Setting an arbitrary value for TR it is possible to plot a parameter space (b,θ). All the points below the curves represent all the combinations of b and θ that satisfy condition (16).

FIGURE 2 – WHEN TOTAL WELFARE IS DECREASING IN θ



The plot simply shows that when the degree of returns to scale for agent 2 is sufficiently high total welfare is decreasing in the destruction parameter even if the latter is very close to unity (namely when the conflict appears to be almost non-destructive). However, by contrast, it is clear that when the total resources endowment is sufficiently high, the level of total welfare is increasing in the destruction parameter.

The latter result states that in the presence of one agent sufficiently productive in the uncontested sector production total welfare is no longer increasing in θ . Put differently, even if the conflict is perceived to be non-destructive investing in the contested sector does not increase total welfare. This confirms the idea that the existence of conflict does not constitute a socially optimal incentive scheme. This is particularly relevant when considering that the contested sector has been assumed to be characterized by constant returns to scale, whilst the uncontested sector has been assumed to exhibit decreasing returns to scale. That is, even if the contested sector seems to ensure higher returns

To sum up it is possible to write:

PROPOSITION 2: *when agents are identical in their fighting abilities and asymmetric in their degrees of returns to scale in the uncontested sector then (a) when the returns in the uncontested sector are extremely low the level of uncontested* *production decreases. Put differently, as the conflict is perceived to be less and less destructive the degree of returns in the uncontested sector must be sufficiently high; (b) The higher are the returns in the uncontested sector the lower would be the level of production in the contested sector; (c) there are combinations of the degrees of returns in the uncontested sector that equals the level of production in the two sectors; (d) even if the conflict is perceived to be non-destructive and the contested sector exhibits constant returns to scale, investing in the contested sector does not increase total welfare. In the presence of one agent sufficiently productive in the uncontested sector production total welfare is not increasing in the destruction parameter.*

Conclusion

The analysis of this paper highlights the interaction between two risk-neutral agents that can allocate their own resources both into a contested sector and an uncontested sector. The main results I would claim for this preliminary work is that even if the conflict is perceived to be non-destructive and the contested sector exhibits constant returns to scale investing in the contested sector does not increase total welfare. That is, although the contested sector appears to be guarantee higher returns than the uncontested sector, total welfare is no longer increasing in the destruction parameter.

This suggests that the level of productivity in the uncontested sector can be a powerful factor inducing a higher allocation of resources in ordinary entrepreneurial activity. This recalls the famous discussion posed by Baumol (1990) that suggested how entrepreneurs allocate their resources depending on the relative returns of productive and unproductive activities. According the model of this work, a major positive investment in the uncontested sector would follow a superior productivity in the contested sector. This would move resources in the uncontested and also lower socially investments in unproductive 'guns'. However, there could be many other factors affecting this process. Tornell and Lane (1999) for example, analysing an economy with an efficient formal sector and a less efficient informal sector state that a productivity improvement in the efficient sector does not lead to an increase in welfare when there are powerful groups demanding for discretionary redistribution. By contrast, when groups are powerless or when there recognized barriers to redistribution a productivity improvement can raise welfare.

Moreover, a further point to be investigated is related to the measurement and evaluation of resulting equilibria. Recall that, since also the investments in 'butter' do constitute investments in productive activities, it is possible to have resulting equilibria which cannot be ranked by pareto criterion. Therefore, allocation of resources to 'butter' do also improve both total production and total welfare. Under a different protocol of interaction a negotiated settlement could move a huge amount of resources into the contested sector, namely in 'butter'. In such a case, a decrease in the investments in 'ice-creams' may not be necessarily detrimental for welfare. Or at least, this kind of result should not be excluded from the beginning.

In terms of economic and public policies the results of the paper suggest that deterrence does not appear to be the only viable way to eradicate violent struggles for predation and appropriation. Higher returns in the uncontested sector would lower the level of 'guns' in the society as it is clear when analysing equation (8). In this respect, the model presented is nothing but an exciting first step. The model would be enriched when considering some specific policy measures as for example taxation, redistribution and public funded transfers. In particular, the tax burden imposed upon a fraction of population by a ruling elite has been interpreted as a crucial factor moving the this is the basic idea surrounding some brilliant works as Grossman (1991) and Acemoglu and Robinson (2006). In the first, the author shows that a too high tax rate imposed by the ruler would increase the probability of a successful insurrection. Albeit with a different technical approach and with no distinction between 'butter' and 'guns', in the latter, the authors – under different scenarios - interpret the tax rate as instrument of redistributive policies used by the governing elite in favour of the citizens so determining a revolution constraint. In fact, fearing a revolution the elite can make concessions and set a tax rate that redistribute some of the resources to the citizen. In such a framework, the revolution constraint is strongly affected by existing income inequality which can be modified through redistributive policies.

Eventually, this paper can be enriched while considering exactly a market interaction involving the goods produced in the uncontested sectors. In this model, the interaction is intrinsically only conflictual. At this point, there is no clear modelling of actual exchange interaction between agents.

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