Savings and Predation

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Abstract

We contrast the relationship between predation and savings in two different simple models. In the first model, predation is an exogenous event in which savings are expropriated with some fixed probability. In such a setting, the higher the probability of expropriation the lower are savings. In the second model, we endow the predatory agent with a decision whether to expropriate or to devote his efforts to some productive endeavor. In this second model, the (endogenous) probability of expropriation can easily be positively correlated with savings. In addition, we show that predation is more damaging to the savings and utility of the victim in the second model.

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1 Introduction

It has long been recognized that the absence of secure property rights can severely affect economic decisions. A particular emphasis has been put in the effects of weak property rights on investment and, as a consequence, on economic growth.[1] At a fundamental level, the mechanism that relates weak property rights and intertemporal economic decisions is quite obvious. If an agent is not sure that she will enjoy tomorrow the returns from her investments today, she is likely to reduce investment and increase her current consumption.

In this paper we consider the equivalent problem with respect to a savings decision. We consider a simple setting in which an agent possesses a fixed amount of a storable good and must decide how much to consume and how much to save for the future. In the absence of predation, it makes sense to save because future income is stochastic and marginal utility is strictly decreasing.

We introduce to this basic setting the posibility of predation. A simple way of capturing weak property rights is simply to allow for an exogenous positive probability that savings be expropriated.[2] Obviously, this possibility reduces the returns to savings. As a consequence, such a model naturally generates a negative correlation between expropriation risk and savings.[3]

We contrast this exogenous model of predation with a framework in which we model the incentives a predatory agent. More specifically, we consider a predatory agent that has two mutually excludable options. Either he devotes his time and effort to some productive economic activity, or he devotes his effort to expropriate savings.[4]

This model of endogenous expropriation generates a very different relationship between savings and the (endogenous) probability of predation. In particular, we show that there are several sources of exogenous variation in parameters of the model that induce a *positive* correlation between savings and expropriation. The intuition behind this result is simple. The larger the savings, the higher are the incentives to predate. Any exogenous change that, say, increases returns to savings, will both increase equilibrium savings and equilibrium expropriation.

In addition, we show that it is possible that savings are constrained (i.e. savings are lower than they would be in the absence of the probability of expropriating) even if there is no positive probability of observing predation in equilibrium. This happens in situations where the agent that decides on savings prefers to keep a small level of savings in order not to make expropriation profitable for the predator.

[1] For models based on societal conflict, see, for instance, Tornell (1997) and Tornell and Lane (1999). In other models, the state itself can be the predator. See, for instance, Grossman and Noh (1994), Acemoglu (2005) or Padró i Miquel (2007). For a recent overview of the relationship between property rights and development, see Besley and Ghatak (2009).

[2] Because our agent is risk-averse, it makes a difference whether expropriation is probabilistic. The equivalence with taxation in Besley and Ghatak (2009) is thus formally lost. The qualitative insights do, however, remain.

[3] The same mechanism is invoked to generate a negative correlation between expropriation risk and income growth. For empirical evidence on such correlation see for instance Acemoglu, Johnson and Robinson (2001) and the many studies cited in Besley and Ghatak (2009).

[4] Hence, we introduce simplified version of the guns vs butter dilemma that is at the heart of the economic conflict literature. See for instance Skaperdas (1992) and Garfinkel and Skaperdas (2007).

In the endogenous expropriation model that we solve, we focus on the case in which the predator's productive income is highly correlated with the income of his victim.[5] This situation is particularly damaging to savings. If predation is exogenous, whether savings are expropriated does not depend on the realized income in the second period. This implies that the agent saving will, with positive probability, be able to enjoy her savings when she needs them (i.e. when income in the second period is low). In contrast, in the endogenous predation model, the predator decides to expropriate when the income derived from his economic activity is low. As a consequence, he expropriates savings precisely when they are most useful to the saving agent.[6] This implies that, for a given equilibrium probability of expropriation, utility and savings are lower in the endogenous predation model.

2 The Model

Consider an economy with two agents, denoted a and p. Agent a lives for two periods. She owns K units of a storable good and needs to decide how much of it to consume in the first period, and how much of it to save for the second period. Denote by $s \in [0, K]$ the amount saved. In the second period, the agent has access to a stochastic flow of income $A\theta$ from her economic activity. θ is distributed according to cdf $F(\theta)$ with support on $(0, \infty)$. For instance, agent a might be a member of a sedentary tribe that is specialized on rainfed agriculture. Parameter θ in this case captures the inherent randomness in weather patterns. Agent a might also be an entrepreneur, and in this case θ simply captures random market conditions in the second period.

Agent a values consumption every period according to the utility function $U(.)$, with $U' > 0$, and $U'' < 0$.

Property rights in this economy are not secure. More specifically, assume that agent p can appropriate the savings of agent a. In the case of the agricultural example, agent p could be a pastoralist group that can choose to raid the homestead of agent a. Agent p can also be corrupt officials or more generally any agent that has coercive power.

We assume that, because of the possible violence involved in the interaction, when savings are expropriated agent a suffers a non-monetary cost $c \geq 0$.

We consider two different ways of modeling expropriation. First, we assume that agent p is able to grab agent a's savings with exogenous probability $\Pi < 1$. We call this the *exogenous predation* model.

Second, we endow agent p with a productive economic activity whose returns are correlated with a's economic activity. To capture this correlation in a simple way, we simply assume that b's economic activity yields $P\theta$ – and thus we will examine the case of perfect correlation. For instance, the returns to the pastoralist cattle-herding of agent p would also depend on the

[5] This is naturally the case in situations such as the relationship between pastoralist nomads and agricultural settlers. Both groups' incomes are correlated due to the effect of rainfall. For instance, Flint and de Waal (2005) suggest that the persistent drought could be an important cause for the violence in Darfur.

[6] Chassang and Padró i Miquel (2009) solve a model of conflict in which predation also occurs during bad economic circumstances.

rainfall that feeds a's plots. Therefore, in the secod model agent p faces an opportunity cost to his predatory activities. It can either work on her economic activity, or raid agent a's savings.

We assume that agent p also values consumption according to $U(.)$ and, when he expropriates, pays a utility cost $C \geq 0$. C can simply capture the probability that he is caught ex-post by the relevant authorities, multiplied by the punishment imposed. We call this second model the *endogenous predation* model.

3 Exogenous Predation

In the first model, the only economic decision to be determined is the level of savings that agent a decides to hold in order to increase second period consumption. The problem is easily set up as

$$\max_{s\in[0,K]} V^{EX}(s) = U(K-s) + \Pi\left(\int U\left(A\theta\right)dF(\theta) - c\right) + (1-\Pi)\int U\left(A\theta + s\right)dF(\theta). \qquad (1)$$

For K high enough this problem has an interior solution s^* that can be implicitly expressed as[7]

$$U'(K-s^*) = (1-\Pi)\int U'\left(A\theta + s^*\right)dF(\theta). \qquad (2)$$

It is immediate from (2) that s^* is decreasing in Π, which is very intuitive. An increase in Π reduces the probability that savings will be available in the second period. As a consequence, the agent decides to consume up front. This discussion establishes the following result.

Remark 1 *In the exogenous predation model, savings are negatively correlated with the observed probability of expropriation.*

4 Endogenous Predation

Because agent p is active in this formulation, it is important to specify the timing of the model.

1. Agent a first decides her level of savings s

2. The state of the world θ is realized and observed by p

3. Agent p decides whether to work on his economic activity or to steal agent a's savings.

We solve for the subgame perfect equilibrium of this model.

First, consider p's decision whether to expropriate or to work on his productive activity. Given the timing in the model, agent p takes this decision knowing both s and θ. It follows that

[7] Formally, we consider K large enough such that $U'(K) < (1-\Pi)\int U'\left(\theta\right)dF(\theta)$.

he will expropriate if and only if $\theta < \tilde{\theta}$, where[8]

$$\tilde{\theta} = \begin{cases} 0 & \text{if } U(s) < C \\ \frac{1}{P} U^{-1}\left[U(s) - C\right] & \text{otherwise} \end{cases} \tag{3}$$

It is clear from this expression that as long as $U(s) < C$, a's savings are secure.[9] This is because in this case the costs associated to expropriating, C, are larger than what can be expropriated. Obviously, in this circumstance, it is always better for p to devote his energies to his economic activity. For $U(s) > C$, however, there are realizations of θ bad enough that p prefers to forego his economic activity and raid a's savings. According to the reaction function (3), ceteris paribus, the larger are a's savings, the higher is the probability that p decides to expropriate.

Knowing this reaction function, agent a must consider how much to save for the second period. Given (3), her problem is stated as

$$\max_{s \in [0,K]} V^{END}(s) = U(K - s) + \int^{\tilde{\theta}} \left(U(A\theta) - c\right) dF(\theta) + \int_{\tilde{\theta}} U(A\theta + s) dF(\theta). \tag{4}$$

This problem can be prone to corner solutions.[10] To restrict our attention to the interesting cases, we assume that C is small enough such that the threat of expropriation is binding.[11] Define s^C such that $U(s^C) = C$. The following condition

$$U'(K - s^C) > \int U'(A\theta + s^C) dF(\theta) + \frac{U'(s^C)}{PU'(0)} f(0) \left[U(0) - c - U(0 + s^C)\right] \tag{5}$$

distinguishes between two interesting cases.

Lemma 1 *Denote by $\tilde{s}$ the optimal level of savings with endogenous predation. We have two possibilities.*

1. *If condition (5) holds, $\tilde{s} = s^C$*

2. *If condition (5) does not hold, $\tilde{s}$ is implicitly defined by*

$$U'(K - \tilde{s}) = \int_{\tilde{\theta}} U'(A\theta + \tilde{s}) dF(\theta) + \frac{U'(\tilde{s})}{PU'(P\tilde{\theta})} f\left(\tilde{\theta}\right) \left[U(A\tilde{\theta}) - c - U(A\tilde{\theta} + \tilde{s})\right] \tag{6}$$

[8] If he expropriates he obtains $U(s) - C$, while his productive economic activity yields $U(P\theta)$

[9] Recall that θ cannot yield negative realizations.

[10] As above, we assume that K is large enough such that $U'(K) < \int U'(A\theta) dF(\theta)$ so that some positive level of savings is always first best.

[11] Formally, we assume that K and C are such that $U'(K - s^C) < \int U'(A\theta + s^C) dF(\theta)$.

It follows from this lemma that the relationship between equilibrium savings and equilibrium probability of expropriation is quite nuanced and different from the exogenous predation scenario. Abusing notation, denote by $\tilde{\Pi} = F(\tilde{\theta})$, the endogenous equilibrium probability of expropriation. We consider the two subcases above separately.

Remark 2 *When condition (5) holds, we have* $\tilde{\Pi} = 0$ *and yet savings are constrained.*

This situation is more likely the larger are c and C and the smaller is P.[12] As discussed above, when $s = s^C$ it is never worth it for p to expropriate. As soon as s exceeds s^C, however, a faces expropriation with positive probability. This involves a first order loss given by the last additive term in (5). This loss consists of two different elements. First, c, the non-monetary cost associated with suffering predation; second, $U(s^C)$, which is the utility associated to the monetary cost of predation. If these costs are large, weighted by $f(0)$ and the slope of the reaction function (3), a decides that it is not worth it to save above s^C. In this case, we might observe the coexistence of very low savings rates, together with very few instances of expropriation.

Remark 3 *When condition (5) does not hold, exogenous changes in* c *and* A *induce a positive correlation between* $\tilde{s}$ *and* $\tilde{\Pi}$.

This result follows from observing the first order condition in Lemma 1. As c increases, the costs associated with expropriation increase and a reduces savings $\tilde{s}$ in order to reduce the occurrence of predation. When A increases, second period consumption looks better which reduces the need to save. This reduces $\tilde{s}$ which again diminishes $\tilde{\Pi}$. It is clear that the reason for this positive correlation lies in the endogenous motivation of expropriation, as could already be seen in the reaction function (3). Note, on the other hand, that exogenous changes in C and in P, because they enter directly in $\tilde{\theta}$, might generate positive or negative correlations between savings and observed expropriation.

The combination of remarks 1 and 3 paints a confusing picture on the relationship between observed expropriation and savings. This might be particularly concerning for studies trying to identify empirically the effect of expropriation on savings (or, equivalently, investment). Not only the observed correlation might be positive or negative as a function of how the incentives of the predatory agent are modeled, but the sign might also depend on the source of variation. In addition, remark 2 shows that the threat of expropriation might severely constrain savings even when its empirical frequency is very low.

5 Savings and Welfare

It is clear in the formulation of program (4) that savings are not enjoyed uniformly across all realizations of θ. Rather, because of the endogenous expropriation incentives of agent p, there

[12] Of course, if C is too large expropriation might cease to be binding altogether. In this assertion we are assuming that U'' is not too large in absolute value.

are two very different posibilities. For low realizations of θ, savings are fully expropriated. Conversely, for higher realizations of θ, savings can be fully consumed by a. This stands in contrast with program (1), where the probability of losing the savings, Π, is orthogonal to θ.

To formally examine the consequences of the correlation between θ and expropriation, fix any interior level of savings $\hat{s}$ and denote by $\hat{\Pi} = F(\hat{\theta})$, the associated probability of expropriation, where $\hat{\theta} = \frac{1}{P}U^{-1}\left[U\left(\hat{s}\right) - C\right]$. Using strict concavity of U and the Mean Value Theorem, it can be shown that

$$V^{EX}(\hat{s}) - V^{END}(\hat{s}) =$$
$$\int^{\hat{\theta}} \left(1 - \hat{\Pi}\right)\left[U\left(A\theta + \hat{s}\right) - U(A\theta)\right] dF(\theta) + \int_{\hat{\theta}} \hat{\Pi}\left[U\left(A\theta\right) - U\left(A\theta + \hat{s}\right)\right] dF(\theta) > 0.$$

It follows from this inequality that any given level of savings provides higher utility in the case of exogenous expropriation. The reason is quite intuitive. In the two models the agent faces the same total probability of expropriation, but in the endogenous model this loss is concentrated in cases where the marginal utility of consumption is high.[13]

Remark 4 *At the same overall probability of expropriation, savings provide strictly larger second period utility with exogenous expropriation than with endogenous expropriation.*

This result suggests that agent a saves more when facing exogenous expropriation. To verify this intuition it is necessary to compare the first order conditions of the two programs. Take $\tilde{s}$ to be the solution to (6), and $\tilde{\Pi}$ the associated probability of expropriation. We obtain

$$\frac{\partial V^{EX}}{\partial s}(\tilde{s};\tilde{\Pi}) - \frac{\partial V^{END}}{\partial s}(\tilde{s}) =$$
$$\frac{U'(\tilde{s})}{PU'(P\tilde{\theta})} f\left(\tilde{\theta}\right)\left[c + U(A\tilde{\theta} + \tilde{s}) - U(A\tilde{\theta})\right] + \tag{7}$$
$$+\left(1 - \tilde{\Pi}\right)\int U'\left(A\theta + \tilde{s}\right) dF(\theta) - \int_{\tilde{\theta}} U'(A\theta + \tilde{s}) dF(\theta) > 0 \tag{8}$$

This decomposition shows that the incentives to save in the two models differ for two reasons.

The first additive term, (7), corresponds to the marginal increase in expropriation that an increase in savings entails. As discussed above, this is because higher savings induce a higher temptation to predate on agent p. Of course, this effect is only present in the endogenous model, as the probability of expropriation is fixed in the exogenous predation setting. Hence, this effect reduces the marginal incentive to save in the endogenous model which is formally shown in (7) being strictly positive.

[13] By prodiving low economic yields, these are the realizations that make the opportunity cost to the predator smallest.

In addition, the second and third elements in the expression, in line (8) also add up to a strictly positive quantity.[14] Hence, this is a second force pushing a to save less in the endogenous model. This second difference across models is a direct consequence of the fact that, under endogenous predation, savings are stolen with probability 1 when marginal utility is high. As shown above, this means that returns to savings are smaller in the exogenous model which again depresses savings. We thus have the following result.

Remark 5 *For a given observed probability of expropriation, equilibrium savings are strictly higher under exogenous expropriation than under endogenous expropriation.*

These two results suggest that if the endogenous model is a better depiction of reality than the exogenous model, the effects of predation on savings are worse than traditionaly considered.[15] For a given observed frequency of predation, the victim saves less and her welfare is strictly lower under the endogenous expropriation model.

6 Uncorrelated Economic Activities

Consider a small variation in the endogenous predation model in which the economic activity of agent p yields returns $P\phi$ where ϕ is distributed identically and independently from θ. As before, p observes s, ϕ and θ before deciding whether to expropriate or not. This problem induces the following program on agent a.

$$\max_{s\in[0,K]} U(K-s) + \Pi(s)\left(\int U\left(A\theta\right)dF(\theta) - c\right) + (1-\Pi(s))\int U\left(A\theta + s\right)dF(\theta). \tag{9}$$

where $\Pi(s) = F\left(\frac{1}{P}U^{-1}\left[U(s) - C\right]\right)$.

This problem mixes characteristics of the two models considered above. On the one hand, (9) shows that predation occurs with the same probability $\Pi(s)$ for any realization of θ. In this way, the problem is similar to exogenous model. On the other hand, the probability of predation $\Pi(s)$ is an increasing function of s, a property of the endogenous model.

It can be shown that remarks 2 and 3 apply to this model. Hence, the fact that savings can be constrained in the absence of actual instances of predation, and that savings and predation can be positively correlated in equilibrium does not depend on the correlation between predator's opportunity cost and the income of the victim. Rather, it depends on $\Pi(s)$ being a strictly increasing function of savings.

With respect to welfare and savings, it can be readily seen that remark 5 applies. There is however a caveat. In particular, the equivalent to (8) is equal to 0. In other words, incentives to safe are higher in the exogenous model than in this variation of the model, but this is only due to (7), the effect of increased savings on the probability to suffer from predation.

[14] This is again a direct consequence of the Mean Value Theorem, together with strict concavity.

[15] See, for instance, the benchmark model in Besley and Ghatak (2009).

The main difference between this model and the endogenous model considered above is the fact that remark 4 does not apply. In this section, because income activities are uncorrelated, given a probability of expropriation, savings provide the same level of welfare as in the exogenous model. This suggests that the effects of endogenous predation on the welfare of its victims are worse the more correlated economic activities are.

7 Discussion

We have presented a simple model of endogenous predation and compared its effects on savings to a benchmark model where expropriation occurs exogenously. In the endogenous model, savings might be constrained even if predation is seldom observed in equilibrium. In addition, many sources of exogenous variation might generate a positive correlation between the level of savings and the equilibrium probability of predation.

We have also shown that the welfare impact of endogenous predation is particularly damaging if the opportunity cost of the predatory agent is correlated with the economic returns of the victim.

These conclusions might be important to keep in mind, particularly in instances where the state might be the coercive agent engaged in expropriation, as most probably its alternative sources of income (such as formal taxation) are highly correlated with the economic shocks that its subjects receive.

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