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# Predation and Moral Decay

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*Abstract*

*This paper extends the framework of general economic equilibrium by allowing people to choose whether to be producers or predators. We analyse both the determination of the ratio of predators to producers within a generation as well as the evolution of the ratio of predators to producers over generations. Our analysis assumes that some people, whom we denote as "moral", always choose to be producers, whereas other people, whom we denote as "amoral", choose to be either producers or predators depending on whether production or predation yields higher consumption.*

*To determine the ratio of predators to producers within a generation we focus on the interaction between the choice of amoral people to be producers or predators and the choice of producers of the fraction of their resources to allocate to guarding against predation. We find that, with either individual choice or collective choice of the fraction of resources allocated to guarding against predation, as long as the ratio of amoral people to moral people is not too large, all of the amoral people choose to be predators, and amoral people consume more than moral people. We also find that, if the ratio of amoral people to moral people were sufficiently large, then collective choice of the fraction of resources allocated to guarding against predation, by allowing predation to be deterred, would increase the consumption of moral people.*

*To analyse the evolution of the ratio of predators to producers over generations, we develop theories of moral decay and moral revival. Our theory of moral decay implies that, as long as amoral people consume more than moral people, the ratio of amoral people to moral people and the ratio of predators to producers increase from generation to generation. Collective choice of the fraction of resources allocated to guarding against predation would limit the potential extent of moral decay, but it would not prevent moral decay. Our theory of moral revival implies that this steady increase over generations in the ratio of amoral people to moral people can eventually cause the difference between the consumption of moral and amoral people to become small enough to make a moral revival feasible. This analysis accounts for the apparent historical pattern of intergenerational moral decay interrupted and reversed by periodic moral revivals.*

We have benefited from discussing earlier versions of this paper in seminars at the Hong Kong University of Science and Technology, Koç University, the Hebrew University of Jerusalem, Ben Gurion University, the Federal Reserve Bank of Philadelphia, the University of Western Ontario, and IGIER-Bocconi University.

This paper extends the framework of general economic equilibrium by allowing people to choose whether to be producers or predators. Predators are people who produce nothing, but live by appropriating the product of the producers. We analyse both the determination of the ratio of predators to producers within a generation as well as the evolution of the ratio of predators to producers over generations.[1]

Our analysis assumes that society is composed of two types of people, who are distinguished by what we denote as their "moral" dispositions. One type of person is "moral". Moral people always choose to be producers. By definition, a moral person would not choose to be a predator, no matter how lucrative predation is relative to production.

The other type of person is "amoral". Amoral people are potential predators. By definition, amoral people choose to be either predators or producers depending on whether production or predation yields more consumption.[2]

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[1] This abstract analysis assumes that all activities can be classified either as being predatory, or as being directly productive, or as being a way to guard against predation. In fact, although some activities, such as burglary and robbery, are unambiguously predatory, and some activities, such as college teaching, are unambiguously productive, and some activities, such as installing locks, are unambiguously ways to guard against predation, there are activities, such as litigating, that are not easily classified. We leave the reader free to classify specific activities according to his or her own inclination. But, we point out that predation is not synonymous with crime. Although many predatory activities, like burglary and robbery, are criminal, many criminal activities, like illegal gambling and drug dealing, are productive and not predatory. Also, some predatory activities, like the collection of taxes to support a parasitic ruling class, are not criminal.

We could generalize the model without changing the main implications by assuming that an amoral person chooses to be a predator only if predation increases his or her consumption by a finite amount, which also might differ among the amoral people. More importantly, our setup accords with the popular perception, which we think is correct, that people exist who are moral by our definition, and that people who choose to be predators lack the disposition of these moral people. Another possibility, often advanced by economists, is that all people are amoral, in the sense that anybody would choose to be a predator if predation were sufficiently lucrative relative to production, and that some people actually choose to be predators only because they do not have the productive opportunities that people who choose to be producers

To determine the ratio of predators to producers within a generation we focus on the interaction between the choice of amoral people to be producers or predators and the choice of producers of the fraction of their resources to allocate to guarding against predation.[3] We consider both Cournot and Stackelberg versions of the model. In the Cournot version each producer individually chooses the fraction of his or her resources to allocate to guarding, taking the ratio of predators to producers as given. In the Stackelberg version the moral

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Chin Richard Wong (1995) contains a brief review of some of the relevant literature. In fact, a combination of these views could be correct. People who choose to be predators might lack both the moral disposition and the productive opportunities that other people have. In other papers — Grossman and Kim (1996b, 1997) — we analyse models in which everybody is amoral, but in which some people are endowed with more productive resources than other people. In these models the poor can find predation more attractive than the rich.

[3]The analysis of choices about resource allocation distinguishes economic models of predation from biological models of predation. In an economic model a potential predator can choose not to be a predator if production would be a more lucrative activity than predation. In contrast, a biological predator does not have the alternative of being a producer. In addition, in an economic model a potential prey can decide how much resources to allocate to guarding against predation.

Dan Usher (1987) and Boaz Moselle and Ben Polak (1995) analyse pioneering general-equilibrium models in which people decide whether to be producers or predators. Also, in Usher's model producers decide how much effort to put into guarding against predation. In these models each person takes as given the decisions of other people to be producers or predators. Neither of these papers considers the possibility of a strategy of deterring predation. Also, neither of these papers considers the evolution of the ratio of predators to producers over time.

In two previous papers – Grossman and Kim (1995, 1996a) – we developed general-equilibrium models of appropriative interaction between a pair of unitary agents in which a prey can act to deter a potential predator. The first of these papers, however, abstracted from the possibility that an agent would choose to specialize in predation. The second of these papers allowed a potential predator to choose to specialize in either predation or production. But, the role of the prey was preassigned. By choosing to specialize in production, the potential predator did not become a prey. In contrast, in the present paper, as in Grossman and Kim (1996b, 1997), every potential predator is also a potential prey.

people choose collectively the amount of guarding by each producer, taking into account the effect of the amount of guarding on the ratio of predators to producers. The Stackelberg version of the model becomes relevant if it is possible to enforce the collective choice of the amount of guarding and to prevent producers from free-riding on the efforts of others to guard against predation.

We find that with individual choice of the amount of guarding either all or, at least, some of the amoral people choose to be predators. In contrast, with collective choice of the amount of guarding, if the ratio of amoral people to moral people were sufficiently large, then the moral people would choose a large enough amount of guarding to deter the amoral people from being predators. In this event, collective choice of the amount of guarding would increase the consumption of moral people.

Most importantly, we find that with either individual choice or collective choice of the fraction of resources allocated to guarding, as long as the ratio of amoral people to moral people is not too large, amoral people consume more than moral people.[4] This result is crucial for the subsequent analysis of the evolution of the ratio of predators to producers over generations.

To analyse this evolution we develop theories of moral decay and moral revival. Our theory of moral decay builds on the ideas of Geoffrey Brennan and Alan Hamlin (1995) about how and why people acquire moral dispositions. The theory accords with the observation that in almost all ages and societies contemporary observers bemoan steady moral decay.

As long as amoral people consume more than moral people, adopting a disposition to be moral is privately costly. Our theory of moral decay implies that, as a result of the higher consumption of amoral people, the ratio of amoral people to moral people and the ratio

[4] Although a moral person cannot choose to be amoral, a moral person can dislike the fact that his or her moral disposition prevents him or her from having more consumption. In this case, as Gary Becker (1992) puts it, "a rational person can meaningfully state that [he or] she does not 'like' [his or] her preferences..."

of predators to producers increase from generation to generation.[5] Collective choice of the amount of guarding would limit the potential extent of this moral decay. But, as long as amoral people consume more than moral people, collective choice of the amount of guarding would not prevent moral decay.

By increasing the ratio of amoral people to moral people, moral decay decreases the difference between the consumption of amoral and moral people. But, we rarely, if ever, seem to observe societies in which the ratio of amoral people to moral people is so large that amoral people do not consume more than moral people who are otherwise identical. Our theory of moral revival reconciles the apparent phenomenon of steady moral decay with the failure of societies to reach a long-run equilibrium in which the consumption of amoral people and moral people is equalized.

The theory of moral revival implies that, as a result of a steady increase over generations in the ratio of amoral people to moral people, the difference between the consumption of moral and amoral people eventually can become small enough to make a moral revival feasible. A moral revival decreases the ratio of amoral people to moral people. As a result, a moral revival reverses the decrease in the difference between the consumption of amoral people and moral people that resulted from the preceding moral decay. Consequently, a moral revival also restores the previous impetus for moral decay. This analysis accounts for the apparent historical pattern of intergenerational moral decay interrupted and reversed by periodic moral revivals.[6]



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[5] A disposition to be moral exemplifies what Assar Lindbeck (1995) describes as a desirable social norm that has been internalized. Lindbeck develops a related analysis of how economic incentives both interact with and influence the evolution of adherence to social norms over generations. See also Lindbeck, Sten Nyberg, and Jörgen Weibull (1996).

[6] It is beyond the scope of this paper, as well as beyond the scope of our professional expertise, to develop a catalog of historical events that fit the theoretical definition of a moral revival. Historians, of course, have written about the phenomena of moral decay and moral revival. For example, Robert Fogel (1996) claims that America is currently experiencing its fourth Great Awakening. Fogel makes it clear that these Great

## 1. Analytical Framework

Assume that of the total adult population in the present generation the positive fraction $1-m$ is moral and the positive fraction $m$ is amoral. Let $M \equiv \frac{m}{1-m}$ denote the ratio of amoral people to moral people. Aside from their moral dispositions, people are otherwise identical.

Let $1-r$ denote the fraction of people in the present generation who choose to be producers, let $r$ denote the fraction of people who choose to be predators, and let $R \equiv \frac{r}{1-r}$ denote the ratio of predators to producers. Because all moral people choose to be producers, whereas amoral people can choose to be either producers or predators, we have $R \leq M$.[7]

Each person has an exogenous endowment of $Y$ units of resources. Each unit of resources can produce one unit of consumables. The number of units of consumables that a person actually produces equals the product of $Y$ and the fraction of his or her resources allocated to production.[8]

Let $g$ denote the nonnegative fraction of his or her resources that a producer allocates to guarding against predation.[9] Thus, $1-g$ denotes the nonnegative fraction of his or her

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Awakenings encompass what we call a moral revival. He describes a Great Awakening as, among other things, "a rebellion against preoccupation with material acquisition...against financial greed and against all other forms of self indulgence..." Fogel points out that "the leaders of the revival are attempting to win their hearers...to an ethic that stresses...hard work."

[7]For simplicity, we assume that amoral people must specialize in either production or predation. If amoral people were able to divide their time between production and predation, then we would have to analyse the fraction of their time that they allocate to predation.

[8]To focus on the effects of predation, we assume that individual productive activities are independent, and we abstract from trade in either productive inputs or consumables. Skaperdas and Syropoulos (1996) develop a model of predation with trade involving the interactions between two unitary agents.

[9]Examples of ways of guarding against predation include the installation of locks and the hiring of police guards. Guarding against predation generally includes all actions that are costly but have the effect of decreasing the fraction of production lost to predation.

resources that a producer allocates to production. Let $G \equiv \frac{g}{1-g}$ denote the ratio of the resources that a producer allocates to guarding against predation to the resources that he or she allocates to the production of consumables.

A producer retains the nonnegative fraction $p$ of the consumables that he or she produces, while losing the nonnegative fraction $1-p$ to predation. We assume that the fraction $p$ depends negatively on $R$ and positively on $G$. Specifically,

$$p = \frac{1}{1 + \theta R/G}, \quad \theta \geq 0. \tag{1}$$

In equation (1) the parameter $\theta$, which embodies the technology of predation, determines the effectiveness of predators in appropriating consumables for given values of $R$ and $G$.[10]

After allowing for the fraction of resources allocated to guarding against predation and for the fraction of consumables lost to predation, a producer consumes $C$, where

$$C = p(1-g)Y, \tag{2}$$

and a predator consumes $D$, where

$$D = \frac{(1-p)(1-g)Y}{R}. \tag{3}$$

Equation (3) assumes that each predator obtains an equal share of the total amount of consumables appropriated from the producers.

Because predators produce nothing, the resource endowments of predators are wasted. These wasted resources plus the resources allocated to guarding against predation compose the social cost of predation.[11]

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[10] Equation (1) assumes, for simplicity, that for each producer $p$ depends only on $R$ and on his or her own amount of guarding. More generally, $p$ also could depend either positively or negatively on the amount of resources that other producers allocate to guarding.

[11] For simplicity, the model assumes that predators only prey on producers. Predators do not prey on other predators. The model also abstracts from possible destruction of a some consumables as the result

In the Cournot version of this model each person chooses simultaneously whether to be a producer or a predator and, if he or she chooses to be a producer, decides individually the fraction of his or her resources to allocate to guarding against predation. In making these choices, each person takes the choices of other people to be producers or predators as given. In contrast, in the Stackelberg version the moral people decide collectively the fraction of his or her resources that each producer will devote to guarding against predation. In making this collective choice, the moral people take into account both the effect of $G$ on $p$ for a given ratio of predators to producers and the effect of $G$ on the choice of amoral people to be predators.

## 2. Cournot Version: The Ratio of Predators to Producers

Because all people are identical, except for their moral dispositions, each person who chooses to be a producer solves the same problem, which is to choose the ratio $G$ to maximize $C$, taking $R$ as given. To analyse this choice problem we substitute equation (1) into equation (2), and we find that the value of $G$ that satisfies the condition $dC/dg = 0$ is

$$G = \sqrt{\theta R}. \tag{4}$$

Equation (4) implies that the chosen ratio $G$ is an increasing concave unbounded function of $R$.

To decide whether to be a producer or a predator, each amoral person compares the values of $C$ and $D$, taking $G$, as given. By substituting equation (1) into equations (2) and (3), we can calculate that $C$ is larger than, equal to, or smaller than $D$ as $G$ is

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of predation. The models in Grossman and Kim (1995, 1996a) show how destruction is easily incorporated into the analysis. In addition, we could modify the model to allow the activity of guarding against predation to include the apprehension and punishment of predators. The apprehension and punishment of predators would not directly affect $p$, but would reduce the expected utility of predators.

larger than, equal to, or smaller than $\theta$.[12] Thus, the choices of the amoral people are such that

$$R = \begin{cases} M & \text{for } G < \theta \\ [0, M] & \text{for } G = \theta \\ 0 & \text{for } G > \theta. \end{cases} \tag{5}$$

Solving equations (4) and (5) simultaneously, we see that the equilibrium configuration of choices is

$$G = min\{\sqrt{\theta M}, \theta\} \tag{6}$$

and

$$R = min\{M, \theta\}. \tag{7}$$

Figure 1 depicts the Cournot equilibrium for the case in which $M$ is smaller than $\theta$. In this case the equilibrium is $G = \sqrt{\theta M}$ and $R = M$. All amoral people choose to be predators, and the producers allocate the optimal fraction of their resources to guarding against predation given that all amoral people are predators.

Figure 2 depicts the Cournot equilibrium for the case in which $M$ is larger than $\theta$. In this case the equilibrium is $G = \theta$ and $R = \theta$. A ratio of predators to producers equal to $\theta$ is just sufficient to cause producers to choose $G$ equal to $\theta$, which leaves each

[12] In this model the value of $G$ for which $C$ equals $D$ does not depend on $M$, the ratio of amoral people to moral people, because the consumption of a predator relative to the consumption of a producer does not depend on $R$, the ratio of predators to producers. With a larger ratio of predators to producers the fraction of consumables that predators appropriate would be larger relative to the fraction of consumables that producers retain, but each predator's share of the total amount appropriated from producers would be smaller. Because we do not have any reason to think that one effect would dominate the other or that the dominance of one effect would reverse itself as the ratio of predators to producers changes, we set up the model such that the two effects are exactly offsetting.

amoral person indifferent between being a producer and a predator. (Note that in this case, although the model can determine the ratio of predators to producers, it cannot determine which amoral people choose to be predators.)

Equation (6) says that $G$ is a smooth increasing function of $M$ for all values of $M$ less than $\theta$. But, $G$ reaches a maximum of $\theta$ at $M$ equal to $\theta$. See the solid locus in Figure 3.

Equation (7) says that $R$ is equal to $M$ for all values of $M$ smaller than or equal to $\theta$. Given that a positive fraction of people are amoral, individual choice of the fraction of resources allocated to guarding against predation results in a positive fraction of people choosing to be predators. But, $\theta$ is also the maximum value of $R$. See the solid locus in Figure 4.

Substituting equations (6) and (7) into equation (1), we find that the fraction of consumables that producers retain, $p$, is

$$p = max\{\frac{1}{1+\sqrt{\theta M}}, \frac{1}{1+\theta}\}. \tag{8}$$

Equation (8) says that $p$ equals one for $M$ equal to zero, and that $p$ is a smooth decreasing function of $M$ for all values of $M$ smaller than $\theta$. At $M$ equal to $\theta$, $p$ reaches its minimum value, which is $\frac{1}{1+\theta}$. For values of $M$ larger than $\theta$, $p$ remains constant at its minimum value independently of $M$. See the solid locus in Figure 5.

## 3. Cournot Version: The Consumption of Moral People and Amoral People

Because moral people always choose to be producers, the consumption of a moral person is identical to the consumption of a producer, $C$. Substituting for $p$ from equation (8) and for $G$ from equation (6) into equation (2), we obtain

$$C = max\{\frac{Y}{(1+\sqrt{\theta M})^2}, \frac{Y}{(1+\theta)^2}\}. \tag{9}$$

Equation (9) implies that $C$ is a decreasing function of the ratio of amoral people to moral people, $M$, for all values of $M$ smaller than $\theta$. At $M$ equal to $\theta$, $C$ reaches its

minimum value, which is $\frac{Y}{(1+\theta)^2}$. For values of $M$ larger than $\theta$, $C$ remains constant at its minimum value independently of $M$. See the solid locus in Figure 6.

With $M$ smaller than $\theta$, the consumption of a predator, $D$, is larger than the consumption of a producer, $C$. In this case, all of the amoral people choose to be predators, and the consumption of each amoral person equals $D$. Substituting equations (6), (7), and (8) into equation (3), we find that, for $M$ smaller than or equal to $\theta$,

$$D = \frac{\sqrt{\theta/M}}{(1+\sqrt{\theta M})^2}\, Y. \tag{10}$$

Equation (10) implies that, for $M$ smaller than $\theta$, $D$ is negatively related to $M$. See the solid locus in Figure 7.

If $M$ were as large as $\theta$, then the consumption of a predator would be equal to the consumption of a producer. In this case, the amoral people would be indifferent between being predators or producers, and the consumption of each amoral person would be the same as the consumption of a moral person.

These results also imply a Pareto ranking of equilibria in situations in which $M$ is larger or smaller than $\theta$. With $M > \theta$ everyone consumes $\frac{Y}{(1+\theta)^2}$, whereas with $M < \theta$ everyone consumes more than $\frac{Y}{(1+\theta)^2}$. More consumption for everyone is possible with $M < \theta$ because there are fewer predators with $M < \theta$, and predators produce nothing, and because a smaller fraction of resources is allocated to guarding against predation with $M < \theta$.[13]

In addition, as the fraction of people who are moral approaches one, the social cost of predation approaches zero. Thus, the moral people behave in such as way that, if everyone

[13]In inferring a Pareto ranking of equilibria from this ordering of consumption we are assuming that a moral disposition affects welfare only by affecting consumption. In other words, we are ignoring any direct effect on welfare associated with being moral or amoral. We do not have a similar Pareto ranking among values of $M$ that are smaller than $\theta$ because someone who is moral and, hence, a producer for a small value of $M$ but who is amoral and, hence, a predator for a larger value of $M$ can have more consumption with the larger value of $M$.

were to behave that way, then aggregrate consumption would be maximized. In this sense, the behavior of moral people is Kantian.

## 4. Stackelberg Version: The Ratio of Predators to Producers

In the Cournot version of the model each producer in choosing the fraction of his or her resources to allocate to guarding against predation took the choices of other people to be producers or predators as given. We now analyse the alternative Stackelberg version of the model. As we have already indicated, the Stackelberg version of the model becomes relevant if it is possible for the moral people to enforce their collective choice of $G$ on each producer and to prevent producers from free-riding on the efforts of others to guard against predation.[14] The choice of $G$ also must be irreversible.

We will see that, if the ratio of amoral people to moral people were sufficiently large, then the moral people would be able to increase their consumption by deciding collectively that each producer should allocate a large enough fraction of his or her resources to guarding against predation to deter the amoral people from being predators. This collective choice of $G$ would take into account both the effect of $G$ on $p$ for a given ratio of predators to producers, as given by equation (1), and the effect of $G$ on the choice of amoral people to be predators, as given by equation (5).[15]

Because moral people always choose to be producers, the objective of the moral people is to maximize $C$, the consumption of each producer. Substituting equations (1) and (5)

[14]To avoid pursuing a tangential line of analysis, we do not explicitly model an enforcement mechanism. One can imagine a rudimentary government that acts as an agent of the moral people in implementing their collective choice of $g$. In modern societies some forms of guarding, like the installation of locks, are typically chosen individually, whereas other forms of guarding, like the hiring of police, are chosen collectively.

[15]Because the model assumes that for each producer $p$ depends only on $R$ and on his or her own amount of guarding, the potential gain from collective choice of the amount of guarding involves only the strategic advantage from taking into account the effect of $G$ on $R$. If $p$ also depended either positively or negatively on the amount of resources that other producers allocate to guarding, then collective choice of the amount of guarding also would allow producers to take these technological externalities into account.

into equation (2), we find that $C$ has a local maximum at $G = \theta + \epsilon$, where $\epsilon$ is an infinitesimal positive number. From equation (5), $\theta + \epsilon$ is the minimum value of $G$ that would deter the amoral people from being predators.

We also find that $C$ can have another local maximum at $G = \sqrt{\theta M}$, which is the solution to the first-order condition for a maximum, $dC/dg = 0$, given $R = M$. If $\sqrt{\theta M} \leq \theta$, then $\sqrt{\theta M}$ and $\theta + \epsilon$ are both local maxima. Otherwise, $\theta + \epsilon$ is the unique local maximum.

To determine the global maximum, we compare the value of $C$ associated with $G$ equal to $\theta + \epsilon$, denoted as $C(\theta + \epsilon)$, with the value of $C$ associated with $G$ equal to $\sqrt{\theta M}$, denoted as $C(\sqrt{\theta M})$. Substituting $G = \sqrt{\theta M}$, together with equations (1) and (5), into equation (2), we obtain

$$C(\sqrt{\theta M}) = \frac{Y}{(1 + \sqrt{\theta M})^2} \tag{11}$$

and

$$C(\theta + \epsilon) = \frac{Y}{1 + \theta + \epsilon}. \tag{12}$$

Equations (11) and (12) imply that, for small values of $M$, $C(\sqrt{\theta M})$ is larger than $C(\theta + \epsilon)$ and that, for large values of $M$, $C(\sqrt{\theta M})$ is smaller than $C(\theta + \epsilon)$. Moreover, as $M$ increases, $C(\sqrt{\theta M})$ decreases monotonically relative to $C(\theta + \epsilon)$. Thus, the moral people's collective choice of $G$ is

$$G = \begin{cases} \sqrt{\theta M} & \text{for} \quad M \leq \mu \\ \\ \theta + \epsilon & \text{for} \quad M > \mu, \end{cases} \tag{13}$$

where $\mu$ is the value of $M$ that would make $C(\sqrt{\theta M}) = C(\theta + \epsilon)$.[16] Note that $M < \mu$ also implies that $\sqrt{\theta M} < \theta$.

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[16]The derivation of equation (13) is transparent because $C(\theta + \epsilon)$ does not depend on $M$. But, this result can be generalized. For example, if the value of $C$ associated with $R$ equal to zero were negatively

By equating equations (11) and (12), we can easily show that $\mu$ is smaller than $\theta$. The importance of this inequality will become clear presently.

Equation (13) implies that with $G$ chosen collectively $G$ is a smooth increasing function of $M$ for all values of $M$ less than $\mu$. But, $G$ jumps discretely from $\sqrt{\theta M}$ to $\theta + \epsilon$ at $M = \mu$. See the dashed locus in Figure 3.

Combining equation (13) with equation (5), we see that, with $G$ chosen collectively, the fraction of people who choose to be predators is such that

$$R = \begin{cases} M & \text{for} \quad M \leq \mu \\ \\ 0 & \text{for} \quad M > \mu. \end{cases} \tag{14}$$

Equations (13) and (14) say that, if the ratio of amoral people to moral people is not larger than $\mu$, then the moral people maximize their consumption by tolerating predation by the amoral people, while mitigating the effects of predation by setting $G$ equal to $\sqrt{\theta M}$. Thus, $R$ is equal to $M$ for all values of $M$ less than or equal to $\mu$. But, $\mu$ is the maximum value of $R$. If the ratio of amoral people to moral people were larger than $\mu$, then the moral people would maximize their consumption by allocating a large enough fraction of their resources to guarding against predation to deter the amoral people from predation. Thus, for values of $M$ larger than $\mu$, $R$ equals zero. See the dashed locus in Figure 4.

Substituting equations (13) and (14) into equation (1), we see that, with $g$ chosen collectively, the fraction of consumables that producers retain, $p$, is

$$p = \begin{cases} \frac{1}{1+\sqrt{\theta M}} & \text{for} \quad M \leq \mu \\ \\ 1 & \text{for} \quad M > \mu. \end{cases} \tag{15}$$

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related to $M$, but the derivative of this value of $C$ were smaller in absolute value than the derivative of $C(\sqrt{\theta M})$ with respect to $M$, then a small value of $M$ would still induce the moral people to tolerate predation.

Equation (15) says that $p$ equals one for $M$ equal to zero, and that $p$ is a smooth decreasing function of $M$ for all values of $M$ less than or equal to $\mu$. But, $p$ jumps discretely back to one for $M$ larger than $\mu$. See the dashed locus in Figure 5.

In sum, comparing the dashed and solid loci in Figures 3, 4, and 5 we see that, as long as $M$ is not larger than $\mu$, collective choice of $G$ and individual choice of $G$ would result in the same fraction of resources allocated to guarding against predation, the same ratio of predators to producers, and the same fraction of consumables retained by producers. But, if $M$ were larger than $\mu$, then collective choice of $G$, by allowing the moral people to deter predation, would have radically different implications for the values of $G$, $R$, and $p$.

## 5. Stackelberg Version: The Consumption of Moral People and Amoral People

Again, because moral people always choose to be producers, the consumption of a moral person is identical to the consumption of a producer, $C$. Equation (13) implies that, with $G$ chosen collectively,

$$C = \begin{cases} C(\sqrt{\theta M}) & \text{for} \quad M \leq \mu \\ C(\theta + \epsilon) & \text{for} \quad M > \mu. \end{cases} \tag{16}$$

Substituting equations (11) and (12) into equation (16), we see that $C$ is a decreasing function of the ratio of amoral people to moral people, $M$, for all values of $M$ smaller than or equal to $\mu$. For values of $M$ larger than $\mu$, $C$ remains constant at its minimum value, which is $\frac{Y}{1+\theta+\epsilon}$, independently of $M$. See the dashed locus in Figure 6.

Comparison of equations (14) and (15) with equation (16) yields the following interesting result: With $G$ chosen collectively, the consumption of a producer, which is the consumption of a moral person, is negatively related both to the ratio of predators to producers and to the fraction of consumables taken by predators only if the ratio of amoral people to moral people, $M$, is not larger than $\mu$. If $M$ were larger than $\mu$, then the moral people would choose to deter the amoral people from predation. With deterrence the consumption of a

producer would stabilize at its minimum level independently of $M$, although there would be no predators. Thus, with $G$ chosen collectively, a moral person would consume more if $M$ were smaller than $\mu$ rather than larger than $\mu$, even though predation is tolerated with $M$ smaller than $\mu$, whereas predation would be deterred with $M$ larger than $\mu$. The explanation for this result, of course, is that deterrence is costly.

Comparing the dashed and solid loci in Figure 6 we see that, as long as $M$ is not larger than $\mu$, collective choice of $G$ and individual choice of $G$ would result in the same value of $C$. But, if $M$ were larger than $\mu$, then collective choice of $G$ would result in a higher value of $C$.

Turning to the consumption of amoral people, with $G$ chosen collectively, as long as $M$ is not larger than $\mu$, amoral people choose to be predators. Thus, with $G$ chosen collectively, equation (10) gives the consumption of an amoral person for values of $M$ smaller than or equal to $\mu$. In contrast, if $M$ were larger than $\mu$, then amoral people would be deterred from predation and would choose to be producers. In this case, the consumption of an amoral person would be the same as the consumption of a producer, $\frac{Y}{1+\theta+\epsilon}$, and would be equal to the consumption of a moral person. See the dashed locus in Figure 7.

Comparing the dashed and solid loci in Figure 7 we see that, as long as $M$ is not larger than $\mu$, collective choice of $G$ and individual choice of $G$ would result in the same consumption for amoral people. But, if $M$ were larger, but not too much larger, than $\mu$, then collective choice of $G$ would result in less consumption for amoral people, whereas, if $M$ were much larger than $\mu$, then collective choice of $G$ would result in more consumption for amoral people. With collective choice of $G$, the consumption of each amoral person jumps discretely down to $\frac{Y}{1+\theta+\epsilon}$ for $M$ larger than $\mu$, but does not decrease below $\frac{Y}{1+\theta+\epsilon}$.

The dashed loci in Figures 6 and 7 also imply a Pareto ranking of equilibria in situations in which $M$ is larger or smaller than $\mu$. With $G$ chosen collectively and with $M > \mu$ everyone consumes $\frac{Y}{1+\theta+\epsilon}$, whereas with $M < \mu$ everyone consumes more than $\frac{Y}{1+\theta+\epsilon}$. More consumption for everyone is possible with $M < \mu$ because the fraction of resources

that would be allocated to guarding against predation with $M > \mu$ in order to deter predation would be larger than the production of the amoral people who would be deterred from predation.[17]

Turning to relative economic rewards, comparing the dashed lines in Figures 6 and 7 we find that with either individual choice or collective choice of the fraction of resources allocated to guarding, as long as $M$ is not too large, amoral people consume more than moral people. Collective choice of the fraction of resources allocated to guarding, however, would decrease the range of values of $M$ for which amoral people have more consumption. With individual choice of the fraction of resources allocated to guarding "not too large" means $M$ not larger than $0$, whereas with collective choice of the fraction of resources allocated to guarding "not too large" means $M$ not larger than $\mu$, where $\mu$ is smaller than $0$.

## 6. Moral Decay

Thus far, we have analysed static equilibria with given fractions of people who are moral and amoral. As we have just seen, this analysis has the apparently realistic implication that, as long as the ratio of amoral people to moral people is not too large, amoral people consume more than moral people. This implication, together with the observation that in almost all ages and societies contemporary observers bemoan steady moral decay, leads us to speculate about the evolution over generations of the ratio of amoral people to moral people.

We begin by suggesting a theory of moral decay. This theory builds on the ideas of Brennan and Hamlin (1995) about how and why people acquire moral dispositions. Brennan and Hamlin suggest that a person can choose to be moral by deliberately adopting a disposition or a mind-set that henceforth requires him or her to behave morally. They also suggest that parents can choose whether or not to try to inculcate their children with such a disposition

[17]Production as measured by national income accounts would be maximized if predation were deterred. Thus, our results illustrate one of the ways in which national income accounts can be misleading indicators of welfare. See William Nordhaus and James Tobin (1972) for a seminal treatment of this issue.

to be moral.

We assume that all parents who are themselves moral, but only those parents who are themselves moral, try to inculcate their sons and daughters with a disposition to be moral.[18] But, as we commonly observe, this effort to transmit moral values to children is not always successful. Accordingly, we also assume that, if adopting a disposition to be moral is privately costly, then some of the sons and daughters of moral parents do not heed the lessons of their parents. Given these assumptions, as long as adopting a disposition to be moral is privately costly, a smaller fraction of people adopt a disposition to be moral in each succeeding generation, and over generations $M$, the ratio of amoral people to moral people, increases. In this theory, if $M$ is small enough that amoral people consume more than moral people, then economic rewards, to use the terminology of Brennan and Hamlin, "inhibit the generation of virtue".

Our preceding analysis implies that, as $M$ increases, $R$, the resulting ratio of predators to producers, also increases, and the difference between the consumption of a moral person and the consumption of an amoral person decreases. If not interrupted and reversed, these trends would continue until $M$ either equalled $\theta$, if the fraction of resources allocated to guarding against predation is chosen individually, or became larger than $\mu$, if the fraction of resources allocated to guarding were chosen collectively. With $M$ either equal to $\theta$ or larger than $\mu$ in the respective versions of the model, the consumption of moral people and amoral people would be equalized at their minimum values.

Casual observation suggests that societies are rarely, if ever, so unfortunate as to reach such a long-run equilibrium, which, as we have seen, would be Pareto inferior. We do not seem to observe societies in which the ratio of amoral people to moral people is so large that amoral people do not consume more than moral people who are otherwise identical. In every society with which we are familiar, a disposition to be moral seems to reduce a

[18]See Becker (1992) for a general discussion of motivations for parents to try to shape the preferences of their children.

person's economic reward.

But, casual observation also is consistent with the prediction that the effect of a person's moral disposition on his or her consumption produces a steady increase over generations in the ratio of amoral people to moral people. As we have mentioned, in almost all ages and societies contemporary observers bemoan steady moral decay. How can we reconcile this observation with the previous observation that societies rarely reach a long-run equilibrium in which the consumption of moral people and amoral people are equalized?

## 7. Moral Revivals

History suggests that we can find the answer to this question in a theory of moral revivals. We define a moral revival to be an event in which a finite number of amoral people simultaneously decide to adopt a disposition to be moral. If a moral revival occurs, then the ratio of amoral people to moral people decreases by a finite amount within a single generation. This section considers the possibility that the steady increase in the ratio of predators to producers that results from a steadily increasing ratio of amoral people to moral people eventually provokes a moral revival.

Any amoral people who have decided to join a moral revival and to adopt a disposition to be moral have acted in opposition to their pecuniary interest. To rationalize this behavior we must presume that these previously amoral people received a nonpecuniary reward from joining the moral revival. We refer to this reward, which can take a variety of objective or subjective forms, as the joy of participating in a moral revival. For an amoral person to want to join a moral revival, this joy must be sufficient to compensate for the difference between the consumption of an amoral person and the consumption of a moral person.

Let $J$ denote the value in units of consumption of the joy received by each participant in a moral revival. From observing the behavior of people who participate in moral revivals, it seems realistic to assume that $J$ is positively related to the number of participants in

the moral revival.[19] Specifically, we assume that

$$J = \rho(M_0 - M_1) \quad \text{for} \quad M_0 > M_1, \quad \rho > 0, \tag{17}$$

where $M_0$ is the ratio of amoral people to moral people before the moral revival and $M_1$ is the ratio of amoral people to moral people after the moral revival. The difference, $M_0 - M_1$, is the decrease in the ratio of amoral people to moral people as a result of the moral revival and is an increasing function of the number of participants in the moral revival. In equation (17), the parameter $\rho$ determines how much joy a moral revival gives to each participant for a given decrease in $M$.

We are interested in the possible existence of pairs $(M_0, M_1)$ such that a moral revival is feasible. Define $W(M_1) \equiv D|_{M=M_1} - C|_{M=M_1}$. The function $W(M_1)$ gives the difference between the consumption of an amoral person and the consumption of a moral person after a hypothetical moral revival that reduces the ratio of amoral people to moral people to $M_1$. This function determines the value of $J$ that is necessary for each participant to want to join a moral revival that reduces the ratio of amoral people to moral people to $M_1$.

In Figure 8 the thick locus depicts the function $W(M_1)$, given individual choice of the fraction of resources allocated to guarding against predation. Equations (9) and (10) together imply that $W(M_1)$ is a decreasing function of $M_1$, that $W(M_1)$ is convex, at least for small values of $M_1$, and that $\lim_{M_1 \to 0} W(M_1) = \infty$. The family of thin loci depict for various possible values of $M_0$ how the value of $J$ depends on $M_1$. In Figure 8, any thin locus associated with a value of $M_0$ smaller than $M_0^*$ lies below the thick locus, the thin locus associated with $M_0^*$ is just tangent to the thick locus, and any thin locus associated with a value of $M_0$ larger than $M_0^*$ intersects the thick locus. Thus, given the form of $W(M_1)$ and given that $J$ is an increasing function of $M_0 - M_1$, and assuming that $\rho$ is sufficiently large, Figure 8 shows that there exists a nonempty set of pairs $(M_0, M_1)$ with

[19] This feature of a moral revival exemplifies what Laurence Iannaccone (1992) refers as "positive benefits from 'participatory crowding' ". Iannaccone focuses on ways of internalizing the associated externality.

$0 < M_0^- \leq M_0 \leq 0$ and $M_1 < M_0$ such that $J = \rho(M_0 - M_1) \geq W(M_1)$. In other words, for values of $M$ equal to or larger than $M_0^-$, there exist values of $M_1$ such that the joy received by each participant in a moral revival would compensate for the difference between the consumption of an amoral person and the consumption of a moral person after the moral revival. Note that $M_0^*$ is positive but, given that $\rho$ is sufficiently large, less than $0$.

This analysis implies that, if $M$ is less than $M_0^-$, then a moral revival is not feasible. But, as $M$ steadily increases over generations, when $M$ reaches or exceeds $M_0^*$, a moral revival becomes feasible. Figure 8 indicates that, if a moral revival occurs when the ratio of amoral people to moral people is $M_0^*$, then the ratio of amoral people to moral people after the moral revival must be $M_1^*$. But, if a moral revival does not occur until the ratio of amoral people to moral people is larger than $M_0^-$, then the ratio of amoral people to moral people after the moral revival can be either somewhat smaller or somewhat larger than $M_1^-$. Nevertheless, although as $M_0$ increases the range of values of $M_0 - M_1$ associated with a feasible moral revival also increases, for a moral revival to be feasible the number of participants must never be either too small or too large.

Given $M \geq M_0^*$, the actual occurrence of a moral revival requires two additional conditions. First, someone (a leader) has to recognize that a moral revival is feasible. Second, that person has to be able to coordinate the participation of amoral people in the moral revival to make $M_0 - M_1$ just large enough to achieve an actual pair $(M_0, M_1)$ that satisfies $J = \rho(M_0 - M_1) \geq W(M_1)$. Figure 8 also shows that, given $M \geq M_0^*$, the minimum value of $M_0 - M_1$ that would satisfy $J = \rho(M_0 - M_1) \geq W(M_1)$ decreases as $M_0$ increases, at least locally. Thus, the longer that a moral revival is delayed, the smaller is the minimum number of participants that a feasible moral revival requires and, hence, that the leader has to coordinate.

With collective choice of the fraction of resources allocated to guarding against predation the analysis would be similar, except that the function $W(M_1)$ would jump down to zero at $M$ equal to $\mu$. Although $\mu$ is smaller than $0$, if $\mu$ were at least as large as $M_0^*$, then

a moral revival still would be feasible before moral decay ended with the equalization of the consumption of moral and amoral people. But, if $\mu$ were smaller than $M_0^*$, then collective choice of the fraction of resources allocated to guarding would cause the consumption of moral and amoral people to be equalized and moral decay to end before a moral revival became feasible. Thus, by limiting the potential extent of moral decay, collective choice of the fraction of resources allocated to guarding also might prevent the ratio of amoral people to moral people from becoming large enough to make a moral revival feasible.

Following a moral revival, because the fraction of people who are amoral has decreased, the consumption of an amoral person is much larger relative to the consumption of a moral person than before the moral revival. As a result of this reversion to a previous pattern of rewards to productive and predatory activities, the previous trend of moral decay resumes. The ratio of amoral people to moral people and the ratio of predators to producers again increase from generation to generation. In sum, this theory suggests that steady moral decay is normal, but that periodic moral revivals prevent the ratio of amoral people to moral people from reaching a long-run equilibrium.

## 8. Summary

We began by analysing the determination of the ratio of predators to producers and the consumption of moral and amoral people within a generation, taking the ratio of amoral people to moral people as given. This analysis focused on the interaction between the choice of amoral people to be producers or predators and the choice of producers of the fraction of their resources to allocate to guarding against predation. We found that, with either individual choice or collective choice of the fraction of resources allocated to guarding, as long as the ratio of amoral people to moral people is not too large, all of the amoral people choose to be predators, and amoral people consume more moral people. This last implication is apparently realistic, and it provided the basis for our subsequent analysis of the evolution of the ratio of predators to producers over generations.

We also saw how, if the ratio of amoral people to moral people were sufficiently large, collective choice of the fraction of resources allocated to guarding against predation, by allowing predation to be deterred, would increase the consumption of moral people. In addition, we found that with amoral people consuming more than moral people, everyone consumes more than he or she would have if the ratio of amoral people to moral people were large enough to equalize the consumption of moral and amoral people. This result obtains even though with collective choice of the fraction of resources allocated to guarding against predation equalization of the consumption of moral and amoral people would be associated with predation being deterred.

We then analysed the evolution of the ratio of predators to producers over generations. For this purpose we developed theories of moral decay and moral revival. As long as amoral people consume more than moral people, adopting a disposition to be moral is privately costly. According to our theory of moral decay, although moral parents try to inculcate their sons and daughters with a disposition to be moral, because a decision to adopt a disposition to be moral is privately costly, the fraction of people who choose to adopt a disposition to be moral decreases over generations. Consequently, as a result of the higher consumption of amoral people, the ratio of amoral people to moral people and the ratio of predators to producers increase from generation to generation. We also found that collective choice of the fraction of resources allocated to guarding would limit the potential extent of this moral decay. But, as long as amoral people consume more than moral people, collective choice of the fraction of resources allocated to guarding would not prevent moral decay.

By increasing the ratio of amoral people to moral people, moral decay decreases the difference between the consumption of amoral and moral people. But, although in almost all ages and societies contemporary observers bemoan steady moral decay, we rarely, if ever, seem to observe societies in which the ratio of amoral people to moral people is so large that the consumption of amoral people and moral people who are otherwise identical is equalized. This observation led us to develop a theory that allows the possibility of periodic

moral revivals.

In a moral revival a finite number of previously amoral people simultaneously adopt a disposition to be moral. According to our theory of moral revival, each participant in a moral revival receives an amount of joy from participating that is positively related to the number of participants. The theory implies that a steady increase over generations in the ratio of amoral people to moral people eventually causes the difference between the consumption of an amoral person and the consumption of a moral person to become small enough relative to the potential joy from joining a moral revival to make a moral revival feasible. Importantly, however, for a moral revival to be feasible the number of participants cannot be either too small or too large. This suggested pattern of steady moral decay interrupted and reversed by periodic moral revivals explains why, although the ratio of amoral people to moral people and the resulting ratio of predators to producers typically increase from generation to generation, societies rarely, if ever, are unfortunate enough to reach a Pareto inferior equilibrium in which the consumption of amoral people and moral people is equalized.

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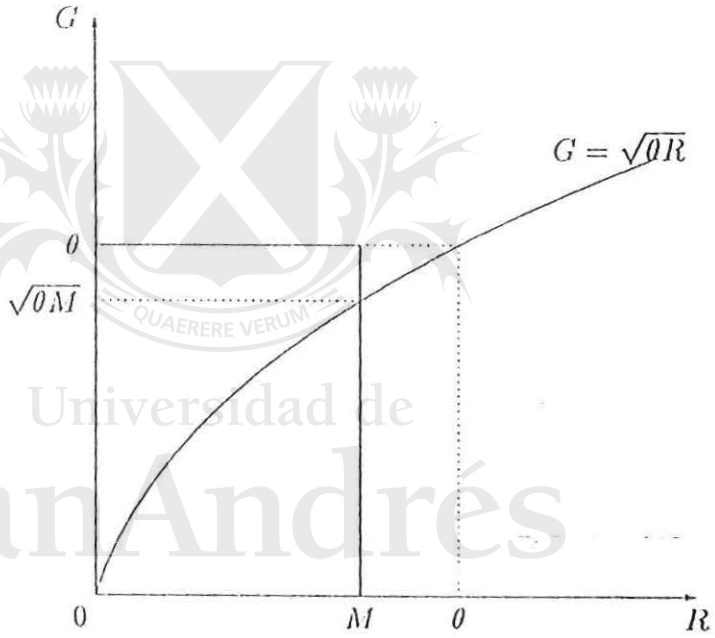


Figure 1: Cournot Equilibrium for $M < 0$

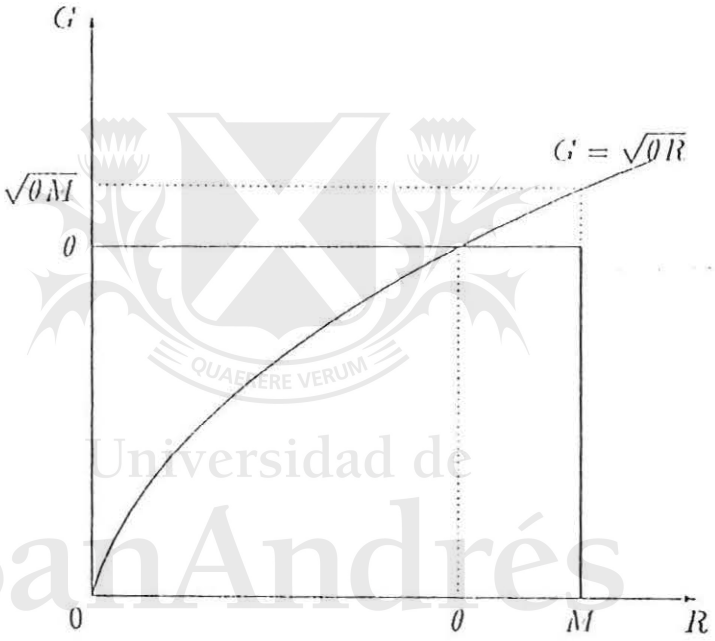


Figure 2: Cournot Equilibrium for $M > \theta$

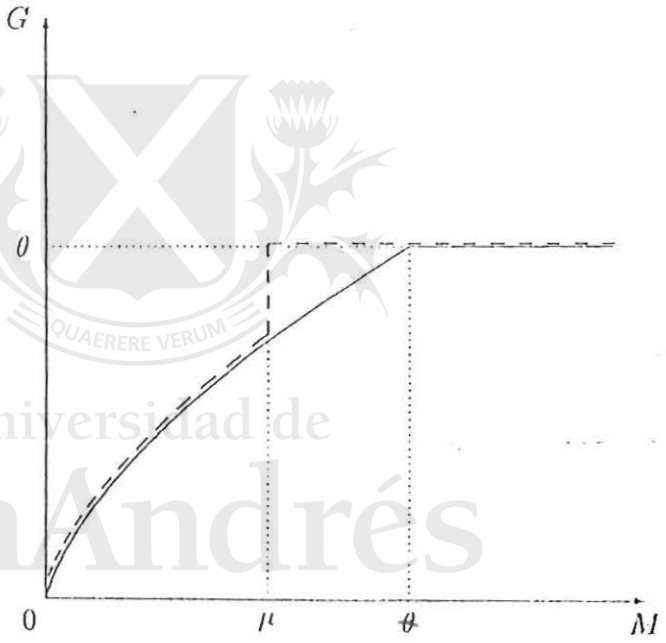


Figure 3: Guarding Against Predation

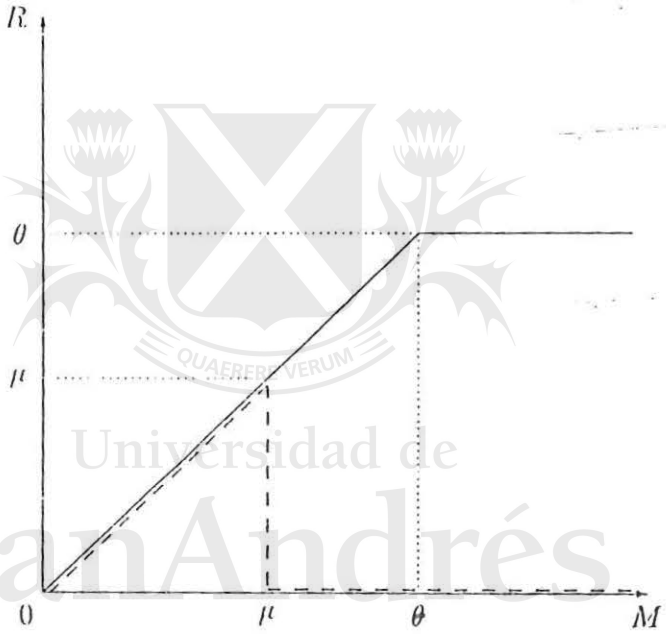


Figure 4: Ratio of Predators to Producers

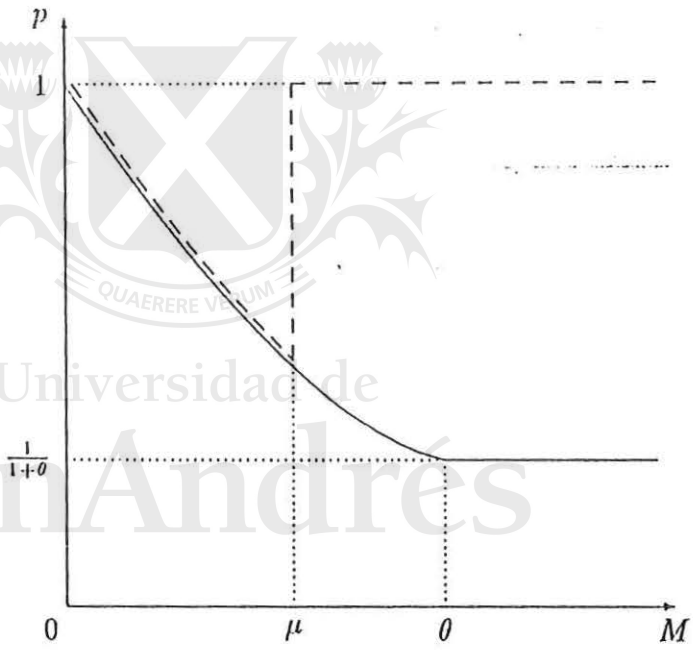


Figure 5: Fraction of Consumables Retained by Producers

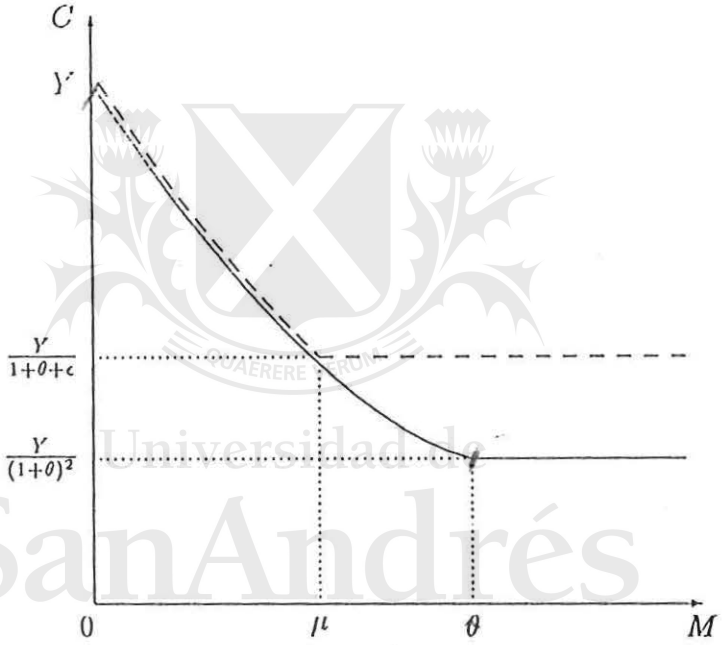


Figure 6: Consumption of a Moral Person

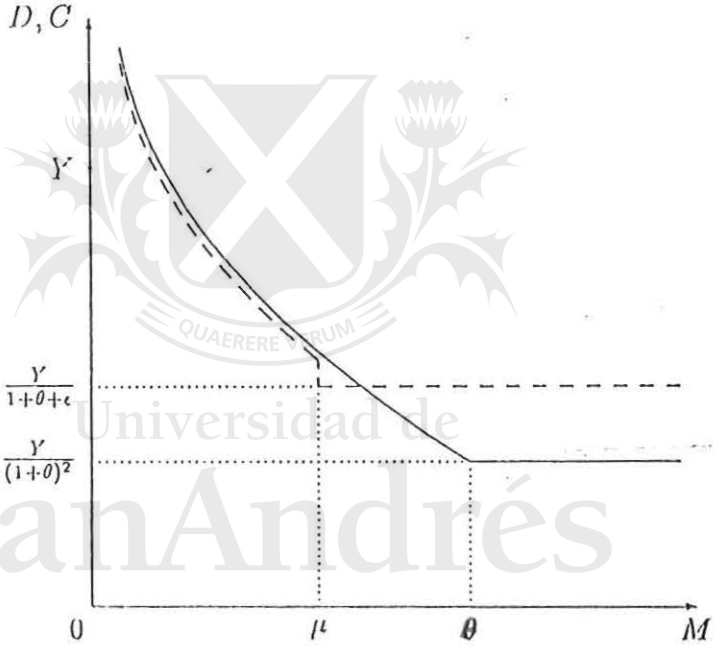


Figure 7: Consumption of an Amoral Person

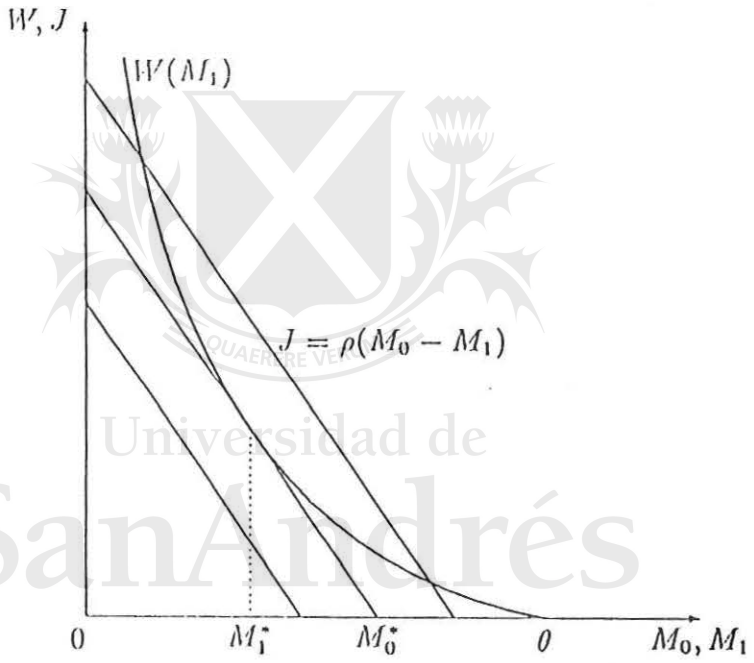


Figure 8: Is a Moral Revival Feasible?