NBER WORKING PAPER SERIES

INVENTORS AND PIRATES:
CREATIVE ACTIVITY AND INTELLECTUAL PROPERTY RIGHTS

Herschel I. Grossman

Working Paper 7898
http://www.nber.org/papers/w7898

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 2000

I thank Andrew Gruber for useful information and my colleagues in the Brown Workshop in Macroeconomics and Growth for valuable modeling suggestions. The views expressed herein are those of the author and not necessarily those of the National Bureau of Economic Research.

Inventors and Pirates: Creative Activity and Intellectual Property Rights
Herschel I. Grossman
NBER Working Paper No. 7898
September 2000
JEL No. O31, O34

ABSTRACT

This paper analyzes how both the value of ideas created as well as the security of intellectual property rights result from the choices of potentially creative people either to engage in creative activity or to be pirates, and from decisions of people who are engaged in creative activity to allocate time and effort to the guarding of ideas from pirating. An important result is that, although the existence of a small number of geniuses causes a larger fraction of potentially creative people to choose to be pirates and, consequently, makes intellectual property rights less secure, the existence of a small number of geniuses, holding fixed the average level of talent, can result in a larger value of ideas being created. The paper also recognizes the difference between the private value and the social value of the security of intellectual property rights.

Herschel I. Grossman
Department of Economics
Box B
Brown University
Providence, RI 02912
and NBER
herschel_grossman@brown.edu

It is a commonplace observation that the incentive to engage in creative activity depends on the security of intellectual property rights. This observation, and the extensive literature that analyses this dependence, presumes that the security of intellectual property rights is largely a matter of public policy. This presumption justifies a modeling strategy that takes the security of intellectual property rights to be exogenous with respect to creative activity. The standard model abstracts from the decisions that people make to pirate ideas and to guard ideas from pirating.

The present paper focuses on these decisions. In so doing it develops a model in which, in contrast to the standard model, creative activity and the security of intellectual property rights are jointly determined and the security of intellectual property rights is endogenous. In this model potentially creative people choose either to engage in creative activity or to be pirates, and people who are engaged in creative activity allocate their time and effort between creating ideas and guarding their ideas from pirating. The paper analyzes how these choices are made and how both the value of ideas created as well as the security of intellectual property rights that result from these choices depend on what I call the environment for pirating.[1] This environment reflects both the technology of pirating and social institutions, such as patent law, copyright law, and their administration, that either impede or facilitate pirating. The paper takes the environment for pirating as given.

This analysis defines pirating to include any appropriation of the value of ideas created by others, whether such appropriation involves the violation of patents and copyrights, as in the case of pirated editions of books, or merely the creation of unauthorized imitations of ideas, as in the case of "knock-offs" of original designs. For simplicity, the analysis abstracts

[1]Dan Usher (1987) developed a seminal model in which people decide whether to be producers or predators and in which producers also decide how much time and effort to put into guarding against predators. The present analysis uses the basic structure of the models of producers and predators developed by Minseong Kim and myself and summarized in Grossman (1998). For other examples of uses of this modeling structure, see Grossman and Kim (2000[a], 2000[b]).

from differences among scientists, authors, composers, and artists, using the generic term "inventors" to denote people who engage in creative activity. The analysis assumes that each potentially creative person's choice to be either an inventor or a pirate depends on whether being an inventor or a pirate would yield more wealth for him (or her).

The guarding of ideas from pirating includes any costly activity that decreases the net value of the ideas that inventors create, but also decreases the ability of pirates to appropriate the value of these ideas. Ways of guarding ideas include everything from physically securing the premises at which either creative activity takes place or ideas are implemented, to filing patents, to hiring lawyers to enforce patents and copyrights, to directing creative activity to ideas that are intrinsically less readily pirated, even if these ideas are less valuable than alternative ideas, to developing and implementing strategies, like encryption, that make ideas harder to pirate. Each of these ways of guarding ideas requires either the direct use of an inventor's time and effort or the spending of part of an inventor's gross income on hiring other people, such as lawyers. For simplicity the analysis abstracts from different ways of guarding ideas, assuming only that inventors allocate a fraction of their time and effort either directly or indirectly to guarding their ideas. With appropriate modifications of the modeling the analysis could be extended to consider specific ways of guarding.

The paper begins by analysing a simple model in which each potentially creative person is equally talented. This analysis shows how the choices made by potentially creative people and the resulting value of ideas created and security of intellectual property rights depend on the environment for pirating. The paper then extends the model by assuming that a small fraction of the potentially creative people, the geniuses, are much more talented than ordinary potentially creative people. The analysis of this extended model shows that, with the existence of a small number of geniuses, a larger fraction of potentially creative people choose to be pirates, and, consequently, intellectual property rights are less secure. But, the analysis also reveals that, holding fixed the average level of talent, the existence of a small number of geniuses can result in a larger value of ideas being created.

The paper concludes by exploring the difference between the private value and the social value of the security of intellectual property rights. This analysis shows that the amount of time and effort that inventors allocate to guarding their ideas results both in intellectual property rights being too secure and in the value of ideas created being too small.

1. Potentially Creative People

Assume initially that each potentially creative person is equally talented. As already explained, each person chooses to be either an inventor or a pirate. Let R denote the ratio of pirates to inventors. The fraction of people who are pirates is $R/(1+R)$.

As also already explained, inventors allocate their time and effort between creating ideas and guarding these ideas. Let Ω denote the value of the ideas that each inventor could create were he (or she) to allocate all of his (or her) time and effort to creating ideas, and let G denote the ratio of the time and effort that an inventor allocates to guarding his ideas to the time and effort that he allocates to creating ideas. Assume further that the net value of the ideas that an inventor creates equals $\Omega/(1+G)$, which is the product of Ω and the fraction of his time and effort that he allocates to creating ideas.

Also, assume that the value of an idea that an inventor creates is independent of whether or not pirates appropriate this idea. Accordingly, the pirating of an inventor's ideas results in a sharing of $\Omega/(1+G)$ between the inventor and the successful pirates. To model this sharing of the value of ideas, let p denote the fraction of the value of his ideas that an inventor retains. Pirates appropriate the fraction $1-p$. In this model p measures the security of intellectual property rights.

Appealing to a random matching story, assume that the larger is the number of pirates relative to the number of inventors the more frequently will each inventor encounter a pirate. Also assume that the more time and effort that an inventor allocates to guarding his ideas relative to time and effort that he allocates to creating ideas the less likely is a pirate to be successful in any encounter. Thus, p depends negatively on R and positively on G. To

incorporate this story into the analysis, assume specifically that

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

In equation (1) the exogenous parameter θ quantifies the environment for pirating. This parameter determines the effectiveness of pirates in appropriating an inventor's ideas for given values of R and G.[2] As mentioned above, the environment for pirating depends both on technology and on social institutions.

The development of MP3 compression technology, which has facilitated the pirating of music, is an example of a technological innovation that increased θ. An improvement in the technology for encryption is an example of a technological innovation that would decrease θ. An increase (or a decrease) in the efficiency of the bureaucracy and the courts that administer the filing and enforcement of patents would be an example of a social innovation that would decrease (or increase) θ.

Let C denote the wealth of an inventor. Allowing for the fraction of the value of an inventor's ideas that pirates appropriate, we have

$$C = \frac{p\,\Omega}{1 + G}. \tag{2}$$

Let D denote the wealth of a pirate. To calculate D, observe that the value of the ideas that pirates appropriate from each inventor is $(1-p)\Omega/(1+G)$. Assuming that each pirate obtains an equal share of the total value of the ideas that pirates appropriate, D equals the product of $(1-p)\Omega/(1+G)$ and the ratio of inventors to pirates. Thus, we have

$$D = \frac{1-p}{R}\,\frac{\Omega}{1+G}. \tag{3}$$

[2]Although equation (1) assumes, for simplicity, that for each inventor p depends only on R and his own choice of G, it would be easy to extend the model to allow p for each inventor to depend either positively or negatively on the values of G chosen by other inventors.

2. Inventors and Pirates

Consider first the decision of each inventor to allocate a fraction of his time and effort to guarding his ideas. Taking R, the ratio of pirates to inventors, as given, each inventor chooses the ratio G to maximize C. To analyse this choice problem we substitute equation (1) into equation (2) and calculate the value of G that satisfies the condition $dC/dG = 0$. This condition implies that each inventor's choice of G is such that

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

Equation (4) says that, the better is the environment for pirating and the larger is the ratio of pirates to inventors, the larger is the fraction of their time and effort that inventors allocate to guarding their ideas. In Figures 1 and 2 the concave locus represents equation (4).

Consider next the decision of a potentially creative person to be an inventor or a pirate. To decide whether to be an inventor or a pirate, each potentially creative person compares the values of C and D. In taking as given his potential wealth as an inventor or as a pirate, each person implicitly takes as given the choices by other people to be inventors or pirates, as reflected in R, and the fraction of their time and effort that other inventors allocate to guarding their ideas, as reflected in G. He knows that, if he chooses to be an inventor, then he will allocate the same fraction of his time and effort to guarding his ideas as do other inventors.

Substituting equation (1) into equations (2) and (3), we find that C is equal to or larger than D as G is equal to or larger than θ. This relation between C and D implies that the choices to be an inventor or a pirate are such that

$$R = \begin{cases} x \in [0, \infty] & \text{for} \quad G = \theta \\ 0 & \text{for} \quad G > \theta. \end{cases} \tag{5}$$

Equation (5) says that, if G were equal to θ, then some fraction of the potentially creative people would choose to be pirates, whereas, if G were larger than θ, then every potentially

creative person would choose to be an inventor. (The ratio of pirates to inventors is undefined for G smaller than θ.) In Figure 1 the L shaped locus represents equation (5).

Solving equations (4) and (5) simultaneously, we find that, with all potentially creative people being equally talented, the equilibrium configuration of choices is

$$R = G = \theta. \tag{6}$$

Figure 1 illustrates this equilibrium. With R equal to θ inventors choose G equal to θ, and with G equal to θ each potentially creative person is indifferent between being an inventor and a pirate.

Equation (6) implies that the fraction $\theta/(1+\theta)$ of potentially creative people chooses to be pirates and that inventors allocate the fraction $\theta/(1+\theta)$ of their time and effort to guarding their ideas.[3] Substituting equation (6) into equation (1), we find that the fraction of the value of his ideas that an inventor retains is

$$p = \frac{1}{1+\theta}. \tag{7}$$

Equation (7) implies that, with all potentially creative people being equally talented, intellectual property rights are less secure the larger is θ.

Finally, let Z denote the net value per capita of ideas created. In equilibrium, Z equals the product of three factors: the fraction of people who choose to be inventors, the fraction of their time and effort that inventors allocate to creating ideas, and Ω. Using equation (6) to calculate this product, we obtain

$$Z = \frac{\Omega}{(1+\theta)^2}. \tag{8}$$

[3]By determining the equilibrium fraction of pirates, this analysis implies a probability with which a potentially creative person chooses to be a pirate. But, the analysis does not tell us which people choose to be pirates. In that sense, with all potentially creative people being equally talented, the model has multiple equilibria.

Equation (8) implies that Z is smaller than Ω and that this shortfall in the value of ideas created is larger the larger is θ.

Taking together, equations (6), (7), and (8) have the following implications:

> *With all potentially creative people being equally talented, the better is the environment for pirating, the smaller is the fraction of potentially creative people who choose to be inventors, rather the pirates, and the larger is the fraction of their time and effort that inventors allocate to guarding their ideas. As a result, the better is the environment for pirating, the smaller is the net value per capita of ideas created. Also, the less secure are intellectual property rights.*

3. Geniuses

This section introduces the assumption that a small fraction of the potentially creative people, the geniuses, correctly perceive themselves to be much more talented than ordinary creative people. Let E denote the ratio of geniuses to ordinary creative people, where E is much smaller than one. The fraction of people who are geniuses is $E/(1+E)$. Let Ω_o denote the value of the ideas that each ordinary creative person could create, and let Ω_e denote the value of the ideas that each genius could create, where Ω_e/Ω_o is much larger than one.[4] Finally, let $\overline{\Omega}$ denote the value of the ideas that the geniuses and the ordinary potentially creative people on average could create, where

$$\overline{\Omega} = \frac{E}{1+E}\,\Omega_e + \frac{1}{1+E}\,\Omega_o. \tag{9}$$

[4]In this formulation the perceived interpersonal distribution of talent has only two realizations, Ω_o and Ω_e. Thus, in this model a potentially creative person has to know only these two numbers and whether or not he is a genius. The analysis that follows would generalize readily to a model in which the perceived interpersonal distribution of talent has a larger, but finite, number of realizations. The alternative of specifying a continuous interpersonal distribution of talent is unappealing because it would require the strong assumption that potentially creative people can finely perceive their talent levels on a continuum.

An important implication of equation (9) is that, for a given value of E, the larger is the ratio Ω_e/Ω_o the larger are both the ratio $\overline{\Omega}/\Omega_o$ and the ratio $\Omega_e/\overline{\Omega}$.

Let v_e denote the fraction of people who are geniuses and who choose to be inventors, where $v_e \leq E/(1+E)$, and let v_o denote the fraction of ordinary creative people who choose to be inventors, where $v_o \leq 1/(1+E)$. Thus, we have $v_e + v_o + R/(1+R) = 1$, where R again denotes the ratio of pirates to inventors.

Assume further that ordinary creative people have a comparative advantage as pirates. To implement this assumption in a simple way, specify the environment for pirating such that geniuses and ordinary creative people are equally effective at pirating.[5] This assumption retains the specification in equation (1) according to which p depends on the ratio R, but not on the identity of the pirates or inventors.

Let C_e denote the wealth of a genius who chooses to be an inventor, and let C_o denote the wealth of an ordinary creative person who chooses to be an inventor. Allowing for the fraction of the value of ideas that pirates appropriate, we have

$$C_e = \frac{p\ \Omega_e}{1+G}, \tag{10}$$

and

$$C_o = \frac{p\ \Omega_o}{1+G}. \tag{11}$$

Let D again denote the wealth of a pirate. Assuming that each pirate obtains an equal share of the total value of the ideas that pirates appropriate, D equals $1-p$ times the value per capita of ideas created divided by the fraction of people who are pirates. Using the result derived in the next paragraph that all inventors would choose the same value of G, the value per capita of ideas created is $(v_e\Omega_e + v_o\Omega_o)/(1+G)$. Thus, we have

$$D = \frac{(1-p)}{R/(1+R)}\ \frac{v_e\Omega_e + v_o\Omega_o}{1+G}. \tag{12}$$

[5]The analysis could be generalized by allowing geniuses to be better pirates than ordinary creative people, as long as a person's talent has a larger effect on his ability to create ideas than on his ability as a pirate.

4. Geniuses and Pirates

Consider again the decision of each inventor to allocate a fraction of his time and effort to guarding his ideas. Taking R as given, each genius who chooses to be an inventor would choose G to maximize C_e, and any ordinary creative person who would choose to be an inventor would choose G to maximize C_o. Accordingly, the choice of G by any inventor again satisfies equation (4), $G = \sqrt{\theta R}$.

Next, consider again the decisions of potentially creative people to be an inventors or pirates. To decide whether to be an inventor or a pirate, each genius compares the values of C_e and D, and each ordinary creative person compares the values of C_o and D. Again, in taking as given his potential wealth as an inventor or as a pirate, each person implicitly takes as given the choices by other people to be inventors or pirates, as reflected in R, and the fraction of their time and effort that other inventors allocate to guarding their ideas, as reflected in G. He knows that, if he chooses to be an inventor, then he will allocate the same fraction of his time and effort to guarding his ideas as do other inventors.

Using equation (1) and equations (10) - (12) we find that the choices of geniuses and ordinary creative people to be inventors or pirates depend on G in the following way:

1. If D was equal to C_e and, hence, was larger than C_o, then geniuses would have the same wealth whether they chose to be inventors or pirates, whereas ordinary creative people would have more wealth if they chose to be pirates. Hence, R would be either equal to or larger than $1/E$. Also, v_o would equal zero, and, hence, v_e would equal $1/(1+R)$. Equations (1), (10), and (12) imply that this case would occur if and only if G was equal to θ.

2. If D was smaller than C_e but still was larger than C_o, then ordinary creative people would have more wealth if they choose to be pirates, whereas geniuses would have more wealth if they choose to be inventors. In this case, R would be equal to $1/E$. Also, again v_o would equal zero, and, hence, v_e would equal $1/(1+R)$.

Equations (1) and (10)-(12) imply that this case could occur only if G was larger than θ, but was smaller than $\theta\Omega_e/\Omega_o$.

3. If D was smaller than C_e but was equal to C_o, then ordinary creative people would have the same wealth whether they choose to be inventors or pirates, whereas geniuses would have more wealth if they choose to be inventors. Equations (1) and (10)-(12) imply that this case could occur only if G was equal to or larger than $\theta\overline{\Omega}/\Omega_o$, but was equal to or smaller than $\theta\Omega_e/\Omega_o$. In this case, the equality between D and C_o would imply that R was equal to $(G/\theta - \overline{\Omega}/\Omega_o)/(\overline{\Omega}/\Omega_o - 1)$. This implied value of R would be equal to or smaller than $1/E$, but larger than or equal to zero.

4. If D was smaller than C_o and, hence, also was smaller than C_e, then every person would have more wealth if he chose to be an inventor. Equations (1), (11), and (12) imply that this case could occur only if G was larger than $\theta\overline{\Omega}/\Omega_o$. In this case, R would equal zero.

Summarizing these results we have

$$R = \begin{cases} x \in [1/E, \infty] & \text{if and only if} \quad G = \theta \\ 1/E & \text{only if} \quad \theta < G < \theta\Omega_e/\Omega_o \\ (G/\theta - \overline{\Omega}/\Omega_o)/(\overline{\Omega}/\Omega_o - 1) & \text{only if} \quad \theta\overline{\Omega}/\Omega_o \le G \le \theta\Omega_e/\Omega_o \\ 0 & \text{only if} \quad G > \theta\overline{\Omega}/\Omega_o. \end{cases} \tag{13}$$

(The ratio of pirates to inventors again is undefined for G smaller than θ.) In Figure 2 the piecewise linear locus represents equation (13).

Solving equations (4) and (13) for R, we obtain

$$R = \begin{cases} \theta & \text{for} \quad 1/E \le \theta \\ 1/E & \text{for} \quad \theta < 1/E \le R_1 \\ R_1 & \text{for} \quad \theta < R_1 < 1/E < R_2 \\ \{R_1, R_2, 1/E\} & \text{for} \quad 1/E \ge R_2 \ge R_1 > \theta, \end{cases} \tag{14}$$

where R_1 and R_2 are the values of R that satisfy both $R = (G/\theta - \overline{\Omega}/\Omega_o)/(\overline{\Omega}/\Omega_o - 1)$, from equation (13), and $G = \sqrt{\theta R}$, from equation (4).

If E is sufficiently small and if Ω_e/Ω_o is sufficiently large, then we can rule out all but one of the possible equilibrium values for R given by equation (14). First, we see that, if E is smaller than $1/\theta$, then the equilibrium value of R cannot be equal to θ and, hence, cannot be larger than $1/E$. This result says that, if the ratio of geniuses to ordinary creative people is sufficiently small, then in equilibrium all of the geniuses choose to be inventors.

Second, inspecting the quadratic equation of which R_1 and R_2 are the roots, we see that, if Ω_e/Ω_o is sufficiently large that $\overline{\Omega}/\Omega_o$ is larger than $\left(1 + \sqrt{1 + 1/\theta}\right)\Big/2$, then R_1 and R_2 do not exist as real numbers. In this case the equilibrium value of R cannot be smaller than $1/E$. This result says that, if the value of the ideas that each genius could create is sufficiently large relative to the value of the ideas that each ordinary creative person could create, then in equilibrium all of the ordinary creative people choose to be pirates.

In sum, the equilibrium configuration of choices has the following property:

> *If the fraction of potentially creative people who are geniuses is sufficiently small, and if geniuses are sufficiently talented relative to ordinary creative people, then all of the geniuses choose to be inventors, and all of the ordinary creative people choose to be pirates.*

Hence, if E is sufficiently small and if Ω_e/Ω_o is sufficiently large, then we have

$$R = 1/E. \tag{15}$$

Furthermore, with R equal to $1/E$, equation (4) implies that we have

$$G = \sqrt{\theta/E}. \tag{16}$$

Figure 2 illustrates this equilibrium.

5. Geniuses and the Net Value of Ideas Created

Comparing equations (15) and (16) with equation (6) we see that, with the existence of a small fraction of geniuses, such that E is smaller than $1/\theta$, a larger fraction of potentially creative people choose to be pirates, and inventors allocate a larger fraction of their time and effort to guarding their ideas. In addition, substituting equations (15) and (16) into equation (1), we find that with a small fraction of geniuses the fraction of the value of his ideas that an inventor retains is

$$p = \frac{1}{1 + \sqrt{\theta / E}} \tag{17}$$

Comparing equation (17) with equation (7) we also see that with a small fraction of geniuses intellectual property rights are less secure than with all potentially creative people being equally talented.

Because geniuses choose to be inventors, and ordinary creative people choose to be pirates, the wealth of every genius is equal to C_e, and the wealth of every ordinary creative person is equal to D. Substituting for p from equation (17) and for R and G from equations (15) and (16) into equations (10) and (12), we obtain

$$C_e = \frac{\Omega_e}{\left(1 + \sqrt{\theta / E}\right)^2} \tag{18}$$

and

$$D = \sqrt{\theta E}\, \frac{\Omega_e}{\left(1 + \sqrt{\theta / E}\right)^2}. \tag{19}$$

Equations (18) and (19) tell us that in equilibrium geniuses are wealthier than ordinary creative people.

More interestingly, in equilibrium, the net value per capita of ideas created, Z, equals the product of the fraction of people who are geniuses, the fraction of their time and effort

that geniuses allocate to creating ideas, and Ω_e. Also, Z equals the average wealth of inventors and pirates. Using equations (18) and (19) we obtain

$$Z = \frac{E}{1+E}\, C_e + \frac{1}{1+E}\, D \;=\; \frac{E}{1+E}\, \frac{\Omega_e}{1+\sqrt{\theta/E}}. \tag{20}$$

Equating $\overline{\Omega}$ to Ω in equation (8), we find that, if Ω_e/Ω_o is sufficiently large that $\Omega_e/\overline{\Omega}$ is larger than $\left(1+\sqrt{\theta/E}\right)\Big/\left[E/(1+E)\right]\left(1+\theta\right)^2$, then the value of Z given by equation (20) is larger than value of Z given by equation (8).

Taken together, equations (17) and (20) have the following implications:

> *Holding fixed the average level of talent, if geniuses are sufficiently talented relative to ordinary creative people, then, although the existence of geniuses results in intellectual property rights being less secure, the existence of geniuses also results in a larger net value per capita of ideas being created.*

To understand this result note that the existence of geniuses concentrates more of a given average level of talent in the hands of people who choose to be inventors. Conversely, with all of the pirates being ordinary creative people, each pirate wastes a smaller amount of talent than with everyone, both pirates and inventors, having the same amount of talent. If Ω_e is sufficiently large relative to Ω_o, then this positive effect outweighs the negative effects of fewer inventors and of the allocation a larger fraction of inventors' time and effort to guarding their ideas.

Equation (20) also has two other interesting implications: First, because the set of pirates coincides with the set of ordinary creative people, for a given value of $[E/(1+E)]\Omega_e$, Z is larger the larger is E, as long as E remains smaller than $1/\theta$. The result obtains because, with a larger fraction of somewhat less talented geniuses and, hence, with a smaller fraction of pirates, the inventors allocate a smaller fraction of their time and effort to guarding their ideas. Second, even though with E smaller than $1/\theta$ the ratio of pirates to inventors does not depend on θ, Z is larger the smaller is θ. This result obtains because the better is

the environment for pirating the larger is the fraction of their time and effort that inventors allocate to guarding their ideas.

6. Are Intellectual Property Rights Too Secure?

In the equilibrium that we have analysed, geniuses choose to be inventors, ordinary creative people choose to be pirates, and each inventor, taking the ratio of pirates to inventors as given, allocates the fraction of his time and effort to guarding his ideas that maximizes his wealth, C_e. The result is that inventors choose G equal to $\sqrt{\theta/E}$, as given by equation (16), and that the net value per capita of ideas created, Z, is given by equation (20).

It is interesting to compare the solution to each inventor's problem of choosing G to maximize C_e to the solution to the hypothetical problem of choosing G to maximize the net value per capita of ideas created. These solutions are not necessarily the same. In fact, we might conjecture that the value of G that each inventor chooses is either larger or smaller than the value of G that, if chosen by all of the inventors, would maximize Z.

First, observe that individual inventors, in taking the ratio of pirates to inventors as given, ignore the fact that, if all of them were to make ideas sufficiently hard to pirate, then ordinary creative people would be deterred from being pirates. This observation suggests that the value of G that each inventor chooses is smaller than the value of G that, if chosen by all of the inventors, would maximize Z. In other words, we might conjecture that the social value of guarding ideas is larger than its private value.

To explore this conjecture, we see from equation (13) and Figure 2 that, if G were sufficiently large — more precisely, if G were larger than $\theta\Omega_e/\Omega_o$ which is a larger value of G than individual inventors choose — then all of the potentially creative people, including the ordinary creative people, would choose to be inventors rather than pirates. Accordingly, suppose that G were equal to $(1+\epsilon)\theta\Omega_e/\Omega_o$, where ϵ is an arbitrarily small number. This value of G is the smallest value for which R would unambiguously equal zero. With R equal to zero, p would equal one, and intellectual property rights would be perfectly

secure.[6] In addition, with R equal to zero, Z would equal the product of the fraction of time and effort that inventors allocate to creating ideas and the value of the ideas that the geniuses and the ordinary creative people on average could create. Thus, with G equal to $(1+\epsilon)\theta\Omega_e/\Omega_o$, we would have

$$Z = \frac{\overline{\Omega}}{1+(1+\epsilon)\theta\Omega_e/\Omega_o}. \tag{21}$$

Comparing equation (21) with equation (20), we see that, if Ω_e/Ω_o is sufficiently large, then the value of Z given by equation (21) is smaller than the value of Z given by equation (20). This result obtains because, with geniuses being much more talented than ordinary creative people, $\overline{\Omega}$ in equation (21) would be only a little larger than $[E/(1+E)]\Omega_e$ in equation (20), whereas $\theta\Omega_e/\Omega_o$ in equation (21) would be much larger than $\sqrt{\theta/E}$ in equation (20). In other words, the increase in the potential value of ideas created from inducing ordinary creative people to be inventors rather than pirates would be small, whereas the fraction of their time and effort that inventors would have to allocate to guarding their ideas would be large. This analysis has the following implication:

> *If geniuses are sufficiently talented relative to ordinary creative people, then the social value of guarding ideas is not larger than its private value. Although, by allocating sufficiently more time and effort to guarding ideas than each inventor chooses, it would be possible to make ideas hard enough to pirate that intellectual property rights would be perfectly secure, such an increase in time and effort allocated to guarding would decrease the net value per capita of ideas created.*

Now consider the alternative possibility that the private value of guarding ideas is larger than its social value. Observe that the wealth of an inventor depends not only on the value

[6] We also could have R equal to zero for values of G as small as $\theta\overline{\Omega}/\Omega_o$. But, values of G not larger than $\theta\Omega_e/\Omega_o$ would not be uniquely associated with R equal to zero. In addition, because $\overline{\Omega}/\Omega_o$ is larger the larger is Ω_e/Ω_o, the implications of Ω_e/Ω_o being large would apply even if we associated R equal to zero with values of G as small as $\theta\overline{\Omega}/\Omega_o$.

of the ideas that he creates but also on the fraction of that value that he retains. This observation suggests that the value of G that each inventor chooses is larger than the value of G that, if chosen by all of the inventors, would maximize Z.

From equation (13) and Figure 2, we see that, for any value of G larger than θ, all of the geniuses would choose to be inventors, just as in the equilibrium in which inventors are maximizing their wealth. Accordingly, suppose that G were equal to $(1+\epsilon)\theta$. If E is smaller than $1/\theta$, then $(1+\epsilon)\theta$ is smaller than $\sqrt{\theta/E}$, which is the value of G that individual inventors choose. Thus, with G equal to $(1+\epsilon)\theta$, p would be smaller, and intellectual property rights would be less secure, than in the equilibrium in which inventors are maximizing their wealth. But, the set of inventors still would coincide with the set of geniuses. Furthermore, each inventor would allocate a larger fraction of his time and effort to creating ideas.

Accordingly, with G equal to $(1+\epsilon)\theta$, the net value per capita of ideas created would be larger than with G equal to what individual inventors choose. Specifically, with G equal to $(1+\epsilon)\theta$, we would have

$$Z = \frac{E}{1+E}\ \frac{\Omega_e}{1+(1+\epsilon)\theta}. \tag{22}$$

The important observation here is that, if E is smaller than $1/\theta$, then the value of Z given by equation (22) is larger than the value of Z given by equation (20). This analysis has the following implication:

> *If the fraction of potentially creative people who are geniuses is sufficiently small, then inventors allocate a larger fraction of their time and effort to guarding their ideas than the fraction that would maximize the net value per capita of ideas created. With less time and effort allocated to guarding ideas, although intellectual property rights would be less secure, the net value per capita of ideas created would be larger than in an equilibrium in which inventors are maximizing their wealth.*

7. Summary

This paper has analysed the interaction between the choices of potentially creative people to be either inventors or pirates and the decisions of inventors to allocate time and effort to guarding their ideas. We have seen how both the net value of ideas created as well as the security of intellectual property rights depend in equilibrium on the environment for pirating and on the interpersonal distribution of talent. The analysis also recognized the difference between the private value and the social value of the security of intellectual property rights.

We can briefly summarize the main results of the analysis as follows:

1. If the fraction of potentially creative people who are geniuses is sufficiently small, and if geniuses are sufficiently talented relative to ordinary creative people, then all of the geniuses choose to be inventors, and all of the ordinary creative people choose to be pirates.

2. The better is the environment for pirating, the smaller is the net value per capita of ideas created. Also, the less secure are intellectual property rights.

3. The existence of geniuses results in intellectual property rights being less secure. But, holding fixed the average level of talent, if geniuses are sufficiently talented relative to ordinary creative people, then the existence of geniuses also results in a larger net value per capita of ideas being created.

4. If the fraction of potentially creative people who are geniuses is sufficiently small, then from a social standpoint each inventor allocates too much of his time and effort to guarding his ideas. The net value per capita of ideas created would be larger in a hypothetical situation in which intellectual property rights were less secure than in an equilibrium in which inventors are maximizing their wealth.

References

Grossman, Herschel I., "Producers and Predators," *Pacific Economic Review*, 3, October 1998, 169-187.

Grossman, Herschel I. and Minseong Kim, "Predation, Efficiency, and Inequality", unpublished manuscript, June 2000[a].

Grossman, Herschel I. and Minseong Kim, "Educational Policy: Egalitarian or Elitist?", unpublished manuscript, July 2000[b].

Usher, Dan, "Theft as a Paradigm for Departures from Efficiency," *Oxford Economic Papers* 39, June 1987, 235-252; reprinted as Chapter III in Dan Usher, *The Welfare Economics of Markets, Voting and Predation*, Ann Arbor: The University of Michigan Press, 1992.

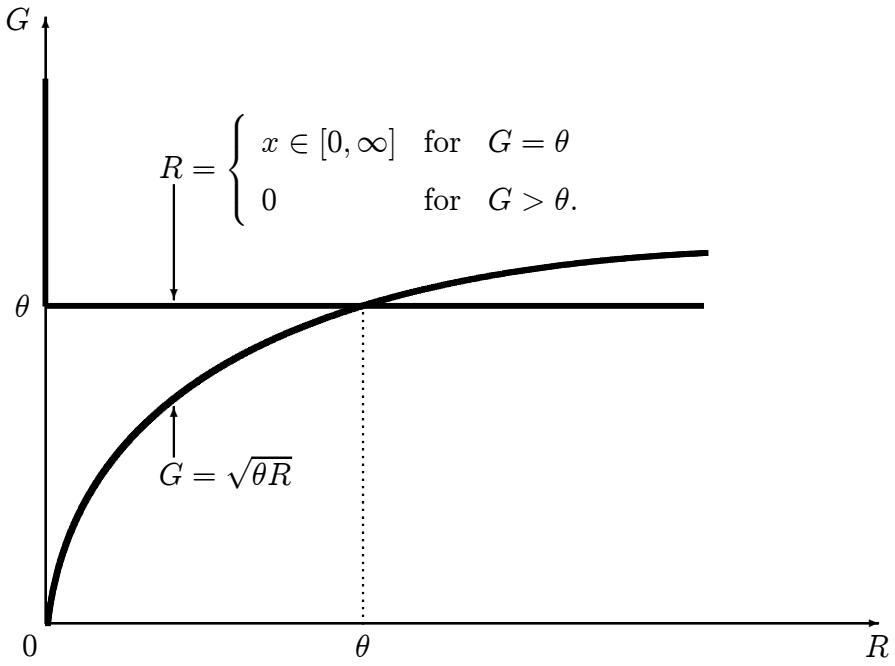

Figure 1: Equally Talented People

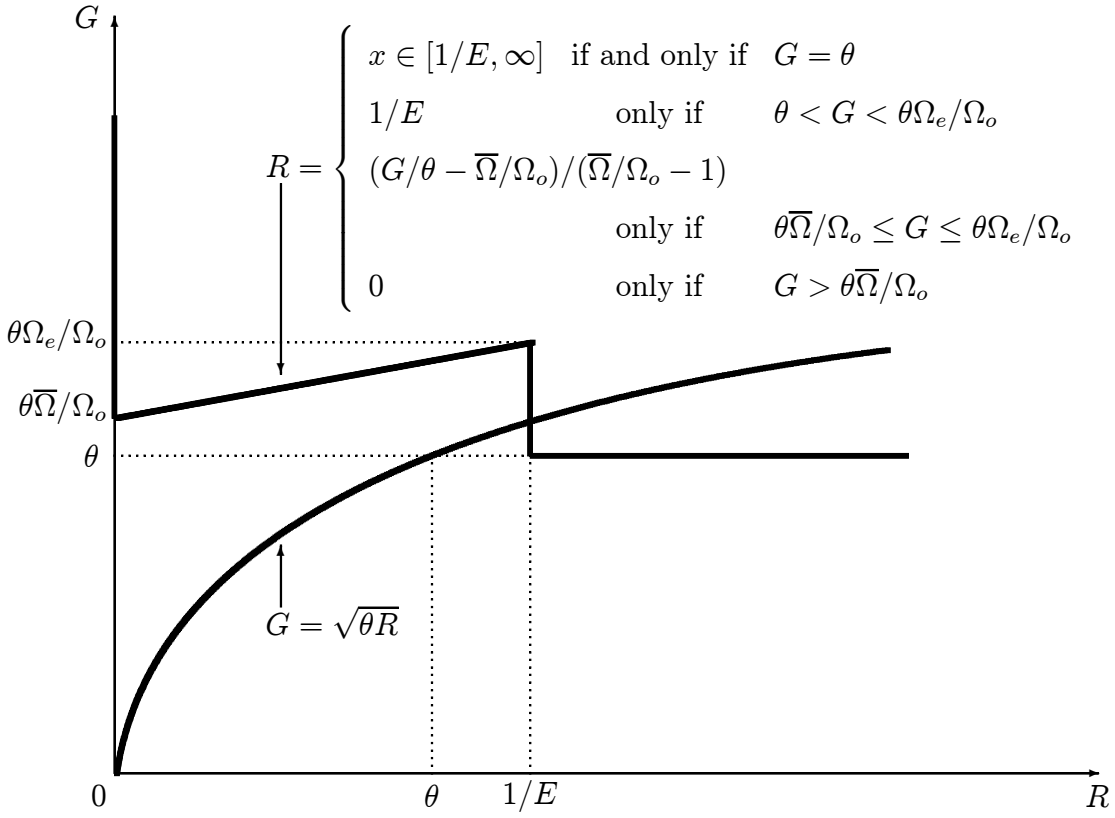

Figure 2: A Few Geniuses