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# Inventors and Pirates: Creative Activity and Intellectual Property Rights

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## *Abstract*

*This paper analyzes a model in which creative activity and the security of intellectual property rights are jointly determined, both depending on the choices made by potentially creative people either to engage in creative activity or to be pirates of the ideas created by others and on the decisions made by people who are engaged in creative activity to allocate resources to guarding the ideas that they create from pirating. The exogenous variables in this model are the environment for pirating, which includes the legal system, and the interpersonal distribution of talent. Among other results, the analysis shows that, holding fixed the average level of talent, the existence of geniuses makes intellectual property rights less secure, but also can result in a larger saleable value of ideas being created. The analysis also shows that intellectual property rights probably are too secure, in that the amount of time and effort allocated to guarding ideas from pirating probably is larger than the amount that would maximize the net saleable value of ideas created.*

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It is a commonplace idea that the incentive to engage in creative activity depends on the security of intellectual property rights. In analyzing this dependence the literature typically takes the security of intellectual property rights to be a direct consequence of the legal system, and, consequently, to be exogenous with respect to creative activity.<sup>1</sup> This exogeneity assumption, however, neglects an essential part of the story, in that it abstracts from the choices that link the legal system to the security of intellectual property rights.

The present paper focuses on these choices. The analysis involves a model in which within a given environment, which includes the legal system, both creative activity and the security of intellectual property rights depend on the decisions made by potentially creative people either to engage in creative activity or to be pirates of the ideas created by others and on the decisions made by people who are engaged in creative activity to allocate resources to guarding the ideas that they create from pirating. In this model, in contrast to the standard analysis, creative activity and the security of intellectual property rights are jointly determined, and the security of intellectual property rights is endogenous.<sup>2</sup>

The exogenous variables in this model are the environment for pirating and the interpersonal distribution of talent. The environment for pirating reflects both the technology of pirating and features of the legal system, such as patent law, copyright law, and their administration, that either impede or facilitate pirating. The interpersonal distribution of talent allows for the existence of geniuses, who are much more talented than ordinary potentially

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<sup>1</sup>Stanley Besen and Leo Raskind (1991) provide an overview of this literature together with a summary of the relevant features of the legal system. David Gould and William Gruben (1996) and Walter Park and Juan Carlos Ginarte (1997) report empirical estimates of how economic growth depends on aspects of the legal system that relate to intellectual property rights.

<sup>2</sup>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, predators, and guarding against 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, 2001).

creative people.

This analysis defines pirating to include any appropriation of the saleable 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 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 saleable value of the ideas that inventors create, but also decreases the ability of pirates to appropriate the saleable 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, to act as guards. 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. The analysis assumes that inventors choose this fraction to maximize their wealth.

The paper begins by analyzing a simple model in which each potentially creative person is equally talented. This analysis shows how, through the choices made by potentially creative people, the saleable 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 are geniuses. 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 saleable value of ideas being created.

The paper concludes by showing that the amount of time and effort that inventors allocate to guarding their ideas probably is larger than the amount that would maximize the net saleable value of ideas created. In this sense the allocation of time and effort by inventors results both in intellectual property rights being too secure and in the saleable value of ideas created being too small.

## 1. Potentially Creative People

Assume initially that each potentially creative person is equally talented. As already mentioned, 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 mentioned, inventors allocate their time and effort between creating ideas and guarding these ideas. Assuming that inventors price their ideas to maximize revenue, let  $\Omega$  denote the saleable value of the ideas that each inventor could create were he to allocate all of his time and effort to creating ideas.<sup>3</sup> Also, 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. The fraction of his time and effort that an inventor allocates to guarding is  $G/(1 + G)$ . Assume further that the net saleable value of the ideas that an inventor creates equals  $\Omega/(1 + G)$ , which is the product of  $\Omega$  and the fraction of his time

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<sup>3</sup>This analysis abstracts from the stochastic factors emphasized by Kenneth Arrow (1962) and Jack Hirshleifer (1971) in their seminal contributions to the economics of creative activity.

and effort that he allocates to creating ideas.

For simplicity, assume that the combined saleable value of an idea to its inventor and to any pirates who appropriate the idea is independent of the number of pirates who appropriate the idea. This assumption implies that the consumers of the idea have unit elasticity of demand in the relevant neighborhood. Accordingly, the pirating of an inventor's ideas results in a sharing of  $\Omega/(1 + G)$  between the inventor and any successful pirates.<sup>4</sup>

To model this sharing of the saleable value of ideas, let  $p$  denote the fraction of the saleable 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.

To determine  $p$ , assume that the larger is the number of pirates relative to the number of inventors the more pirates each inventor encounters. 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 success a pirate has in any encounter. These assumptions imply that  $p$  depends negatively on  $R$  and positively on  $G$ . To incorporate these effects into the analysis, assume specifically that

$$(1) \quad p = \begin{cases} \frac{1}{1 + \theta R/G} & \text{for } R > 0, \quad \theta > 0 \\ 1 & \text{for } R = 0. \end{cases}$$

In equation (1) the exogenous parameter  $\theta$  quantifies the environment for pirating. This parameter determines the effectiveness of pirates in appropriating an inventor's ideas for a given value of  $R$  and the inventor's chosen value of  $G$ . As mentioned above, the environment for pirating reflects both technology and features of the legal system.

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<sup>4</sup>A welfare analysis, which the present paper does not attempt, would take into account that, even if the appropriation of ideas by pirates does not affect their saleable value, pirating can result in consumers paying lower prices for ideas and, consequently, can increase both the utilization of ideas and their social value. Ginarte and Park (1997) emphasize the tension between the welfare effects of innovation and imitation. A complete welfare analysis also would take into account costs associated with the implementation of features of the legal system that influence the environment for pirating.

The development of the compression technology that has facilitated the pirating of music is an example of a technological innovation that increased  $\theta$ . An improvement in the technology for encryption is an example of a technological innovation that would decrease  $\theta$ . 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 an innovation in the legal system that would decrease (or increase)  $\theta$ .

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

$$(2) \quad C = \frac{p \Omega}{1 + G}.$$

Let  $D$  denote the wealth of a pirate. To calculate  $D$ , observe that the saleable 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 saleable 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

$$(3) \quad D = \frac{1 - p}{R} \frac{\Omega}{1 + G}.$$

## 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 analyze 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

$$(4) \quad G = \sqrt{\theta R}.$$

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 loci represents equation (4).

Consider next the choice 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), and assuming that  $R$  is finite, we find that  $C$  is equal to or larger than  $D$  as  $G$  is equal to or larger than  $\theta$ . This relation between  $C$  and  $D$  implies that the choices to be an inventor or a pirate are such that

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

Equation (5) says that, if  $G$  were equal to  $\theta$ , then some fraction of the potentially creative people would choose to be pirates, whereas, if  $G$  were larger than  $\theta$ , then every potentially creative person would choose to be an inventor. (The ratio of pirates to inventors is undefined for  $G$  smaller than  $\theta$ .) 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

$$(6) \quad R = G = \theta.$$

Figure 1 illustrates this equilibrium. With  $R$  equal to  $\theta$  inventors choose  $G$  equal to  $\theta$ , and with  $G$  equal to  $\theta$  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.<sup>5</sup> Substituting equation (6) into equation (1), we find that the fraction of the saleable value of his ideas that an inventor retains is

$$(7) \quad p = \frac{1}{1 + \theta}.$$

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

Finally, let  $Z$  denote the net saleable value of ideas created in aggregate by the potentially creative people. In this simple model,  $Z$  equals the product of three factors: the fraction of the potentially creative people who choose to be inventors, the fraction of their time and effort that inventors allocate to creating ideas, and  $\Omega$ . Using equation (6) to calculate this product, we obtain

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

Equation (8) implies that  $Z$  is smaller than  $\Omega$  and that this shortfall in the saleable value of ideas created is larger the larger is  $\theta$ . Note that  $Z$ , as given by equation (8), also equals the average wealth of inventors and pirates.

Taking together, equations (6), (7), and (8) have the following unsurprising 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 saleable value of ideas created. Also, the less secure are intellectual property rights.*

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<sup>5</sup>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.



### 3. Geniuses

This section complicates the analysis by introducing 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  $E/(1+E)$ . Also, let  $\Omega_o$  denote the saleable value of the ideas that each ordinary creative person could create, and let  $\Omega_e$  denote the saleable value of the ideas that each genius could create, where  $\Omega_e/\Omega_o$  is much larger than one.<sup>6</sup> Finally, let  $\bar{\Omega}$  denote the saleable value of the ideas that the geniuses and the ordinary potentially creative people on average could create, where

$$(9) \quad \bar{\Omega} = \frac{E}{1+E} \Omega_e + \frac{1}{1+E} \Omega_o.$$

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

Let  $v_e$  denote the fraction of potentially creative 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 potentially creative people who have ordinary talent and 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

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<sup>6</sup>In this formulation the perceived interpersonal distribution of talent has only two realizations,  $\Omega_o$  and  $\Omega_e$ . 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.

geniuses and ordinary creative people are equally effective at pirating.<sup>7</sup> This specification is consistent with 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 saleable value of ideas that pirates appropriate, we have

$$(10) \quad C_e = \frac{p \Omega_e}{1 + G},$$

and

$$(11) \quad C_o = \frac{p \Omega_o}{1 + G}.$$

Let  $D$  again denote the wealth of a pirate. Assuming that each pirate obtains an equal share of the total saleable value of the ideas that pirates appropriate,  $D$  equals  $1 - p$  times the saleable value 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 saleable value of ideas created is  $(v_e \Omega_e + v_o \Omega_o)/(1 + G)$ . Thus, we have

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

#### 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),  $G = \sqrt{\theta R}$ .

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<sup>7</sup>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.

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  $\theta$ .
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  $\theta$ , 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  $\theta\bar{\Omega}/\Omega_o$ , 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  $(G/\theta - \bar{\Omega}/\Omega_o)/(\bar{\Omega}/\Omega_o - 1)$ . 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  $\theta\bar{\Omega}/\Omega_o$ . In this case,  $R$  would equal zero.

Summarizing these results we have

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

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

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

$$(14) \quad R = \begin{cases} \theta & \text{for } 1/E \leq \theta \\ 1/E & \text{for } \theta < 1/E \leq R_1 \\ R_1 & \text{for } \theta < R_1 < 1/E < R_2 \\ \{R_1, R_2, 1/E\} & \text{for } 1/E \geq R_2 \geq R_1 > \theta, \end{cases}$$

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

If  $E$  is sufficiently small and if  $\Omega_e/\Omega_o$  is sufficiently large, then we can rule out all but one of the possible equilibrium values for  $R$  given by equation (14). First, if  $E$  is smaller than  $1/\theta$ , then the equilibrium value of  $R$  cannot be equal to  $\theta$  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  $\Omega_e/\Omega_o$  is sufficiently large, 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 geniuses are sufficiently talented relative to creative people, then in equilibrium all of the ordinary creative people choose to be pirates.

These results together imply that, if  $E$  is sufficiently small and if  $\Omega_e/\Omega_o$  is sufficiently large, then we have

$$(15) \quad R = 1/E.$$

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

$$(16) \quad G = \sqrt{\theta/E}.$$

Figure 2 illustrates this equilibrium.

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.*

## 5. Geniuses and the Net Saleable 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 saleable value of his ideas that an inventor retains is

$$(17) \quad p = \frac{1}{1 + \sqrt{\theta/E}}$$

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

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

and

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

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

More interestingly, the net saleable value 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  $\Omega_e$ . Also,  $Z$  equals the average wealth of inventors and pirates. Using equations (18) and (19) we obtain

$$(20) \quad Z = \frac{E}{1 + E} C_e + \frac{1}{1 + E} D = \frac{E}{1 + E} \frac{\Omega_e}{1 + \sqrt{\theta/E}}.$$

Equating  $\Omega$  in equation (8) to  $\bar{\Omega}$ , we find that, if  $\Omega_e/\bar{\Omega}$  is sufficiently large, then the value of  $Z$  given by equation (20) is larger than value of  $Z$  given by equation (8).

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, for a given value of  $\bar{\Omega}$ ,  $\Omega_e$  is sufficiently large relative to  $\bar{\Omega}$ , 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.

In sum, this analysis yields the following implication:

*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 there being more pirates and in intellectual property rights being less secure, the existence of geniuses nevertheless results in a larger net saleable value of ideas being created.*

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  $\theta$ ,  $Z$  is larger the smaller is  $\theta$ . 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 analyzed, 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 saleable value 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  $Z$ . These solutions are not necessarily the same.

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  $Z$ .

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  $\epsilon$  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.<sup>8</sup> 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 saleable 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

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

Comparing equation (21) with equation (20), we see that, if  $\Omega_e/\Omega_o$  is sufficiently large,

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<sup>8</sup>We also could have  $R$  equal to zero for values of  $G$  as small as  $\theta\bar{\Omega}/\Omega_o$ . But, values of  $G$  not larger than  $\theta\Omega_e/\Omega_o$  would not be uniquely associated with  $R$  equal to zero. In any event, the implications of  $\Omega_e/\Omega_o$  being large would apply even if we associated  $R$  equal to zero with values of  $G$  as small as  $\theta\bar{\Omega}/\Omega_o$ .



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,  $\bar{\Omega}$  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 saleable 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 in order to induce ordinary creative people to be inventors would be large.

This analysis has the following implication:

*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 all potentially creative people would choose to be inventors, rather than pirates, and, as a result, intellectual property rights would be perfectly secure. But, if geniuses are sufficiently talented relative to ordinary creative people, then such an increase in time and effort allocated to guarding would decrease the net saleable value of ideas created.*

Now observe that the wealth of an inventor depends not only on the saleable value of the ideas that he creates but also on the fraction of that saleable value that he retains. But, the saleable value of given ideas is independent of whether or not the inventors retain this value. These observations suggest that inventors are too concerned with the security of their intellectual property rights and, hence, 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  $\theta$ , 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 saleable value 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

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

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 saleable value of ideas created. With less time and effort allocated to guarding ideas, although intellectual property rights would be less secure, the geniuses still would choose to be inventors, and the net saleable value of ideas created would be larger than in an equilibrium in which inventors are maximizing their wealth.*

## 7. Summary

This paper has analyzed 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 saleable value of ideas created as well as the security of intellectual property rights depend in equilibrium on the environment for pirating, which includes the legal system, and on the interpersonal distribution of talent.

We can briefly summarize the most interesting 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 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 saleable value of ideas being created.
3. If the fraction of potentially creative people who are geniuses is sufficiently small, then each inventor allocates more of his time and effort to guarding his ideas than would maximize the net saleable value of ideas created. The net saleable value of ideas created would be larger in a hypothetical situation in which intellectual property rights were less secure than in an equilibrium in which each inventor is maximizing his own wealth.

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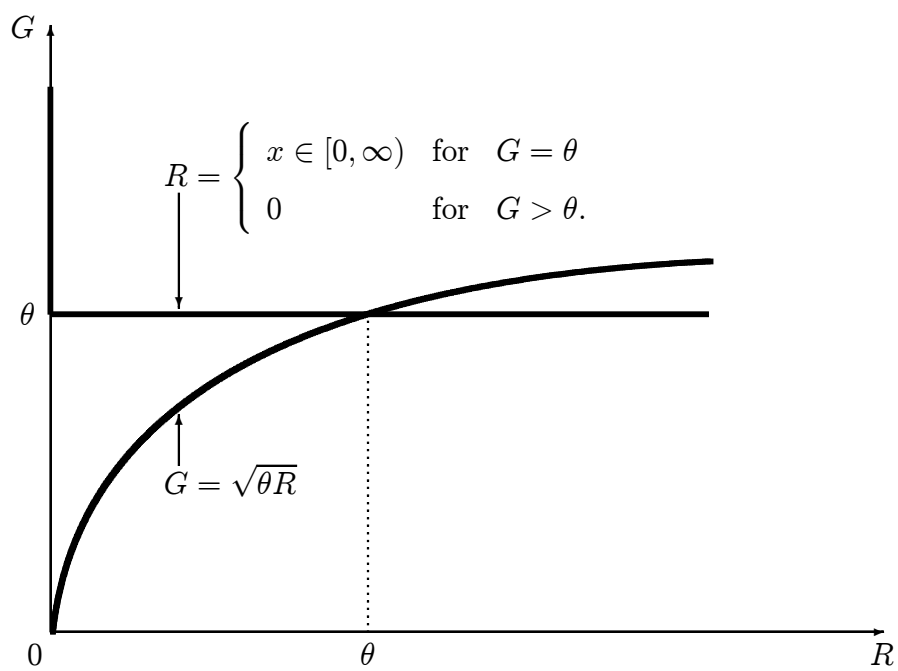


Figure 1: Equally Talented People

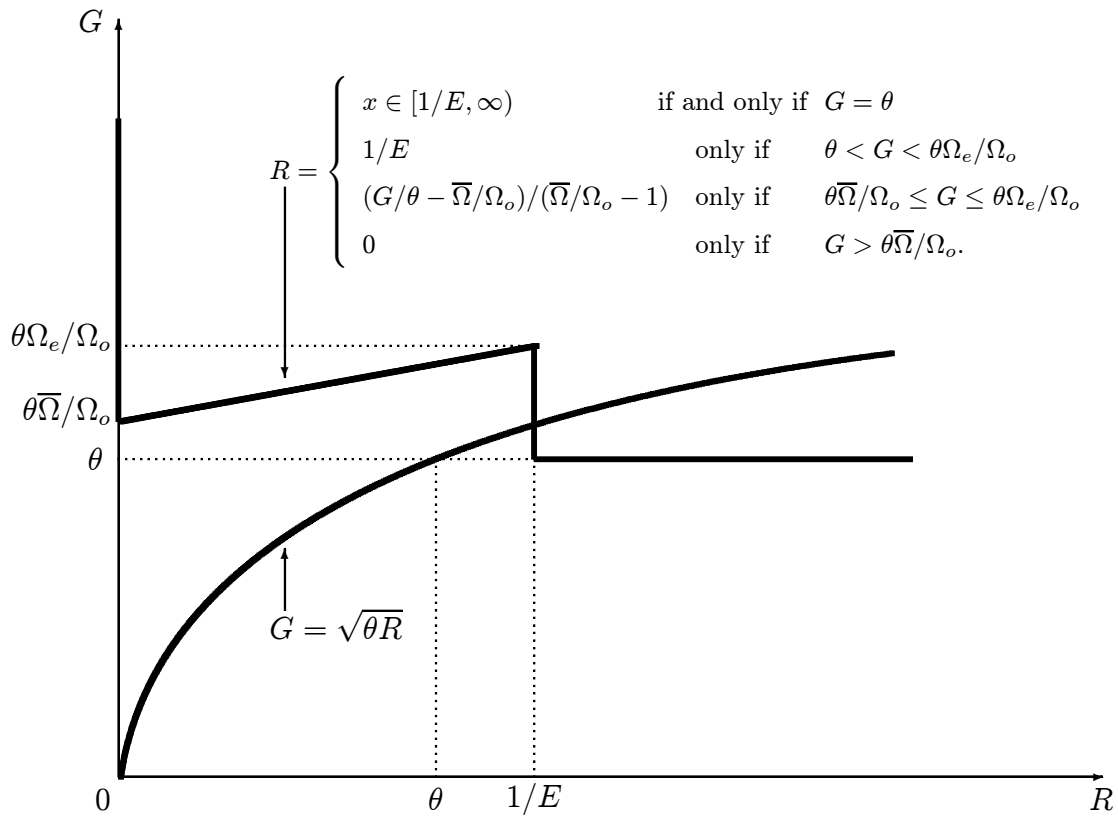


Figure 2: A Few Geniuses