Return of the Invisible Men:
The Microeconomic Value Theory of Inventors and Entrepreneurs

William J. Baumol[1]

I have already and repeatedly joined other voices in noting the virtual expulsion of the entrepreneur from contemporary mainstream literature of economics. I have also joined the call for the restoration of the entrepreneurs' place in the theory, given the fact that no one seems to deny their importance for the workings of the free-market economy in general and for its growth and innovation in particular. Here, I begin by offering my own explanations for the entrepreneur's exclusion. More important, I hope to show how inventors and entrepreneurs can be restored to their proper place in production and distribution theory and actually take first steps toward realization of that objective. I will offer theory that undertakes to explain their activities, that analyzes their remuneration and shows that discriminatory pricing is a normal state of affairs in this arena, even in the classic Schumpeterian model. Specifically, I will argue that in a wide range of cases competitive market forces make them into discriminatory price takers and that the vector of discriminatory prices that the supplier of innovation is forced to adopt will, if competitive pressures are sufficiently strong, tend to be Ramsey-optimal. Furthermore, I will argue that this fits right in with the Schumpeterian model, in which, however, the discrimination entails prices that differ over time, rather than differing among submarkets, as occurs in common models of differential pricing.

[1] Harold Price Professor of Entrepreneurship and Academic Director, Berkley Center for Entrepreneurial Studies, New York University; and Senior Economist and Professor Emeritus, Princeton University.

Why the Entrepreneur Has been Exiled from Standard Microeconomic Theory

There are, actually, at least two very good reasons why the entrepreneur is virtually never mentioned in modern theory of the firm and distribution. The first, and less significant reason is summed up in what I call "Baumol's Third Tautology: Innovation is an entirely heterogeneous output." Production of whatever was an invention yesterday is mere repetition today. So, in an analysis of entrepreneurial activities, there are none of the homogeneous elements that lend themselves to formal mathematical description, let alone the formal optimization analysis that is the foundation of the bulk of microeconomic theory.

The more critical explanation of the absence of the entrepreneur is that in mainstream economics the theory is generally composed of equilibrium models in which, structurally, nothing is changing. But, this excludes the entrepreneur by definition. She is absent from such a model because she does not belong there. This has been definitively argued by Joseph A. Schumpeter (1911) and Israel M. Kirzner (1979) who have demonstrated that sustained equilibrium is something that the entrepreneur does not tolerate, any more than she tolerates sustained disequilibrium. Here, Schumpeter's key insight is that the entrepreneur's occupation is the search for profitable opportunities to upset any equilibrium. That is exactly what any innovation, in the broadest sense, entails. But the rest of the story is told by Kirzner, who recounts that the entrepreneur, with his critical ability—alertness—recognizes in any disequilibrium a profitable arbitrage opportunity and, by taking advantage of that opportunity, he provides the pressures that move the economy back toward an equilibrium condition. So the job of Schumpeter's

entrepreneur is to destroy all equilibria, while Kirzner's works to restore them. This is the mechanism underlying continuous industrial evolution and revolution, and it is surely not the stuff of which stationary models are built. Thus, it should hardly be surprising that a stationary Walrasian model, even in a more sophisticated variant, has no room for the entrepreneur.

This is particularly evident of the standard theory of the firm, which analyzes the repetitious decisions of the enterprise that is already present and fully grown. In such a scenario, the entrepreneur has already completed his job and left for other places where his firm-creation activities can be used. Even if the creator of the firm has not departed, he has transformed his role from entrepreneur to manager, so that although he, himself, remains in place, the entrepreneur has gone.

I conclude that the neoclassical theory is not wrong in excluding the entrepreneur, because it is dealing with subjects for which he is irrelevant. It would, in my view, be as indefensible to require *all* microeconomic writing to give pride of place to the entrepreneur as to exclude him universally. But that does not mean that no theory of entrepreneurial is needed. Universal exclusion condemns us to leave out of our discussions what I consider to be the most critical issues that should be examined (although not exclusively) in microeconomic terms: the determinants of innovation and growth and the means by which they can be preserved and stimulated. We have left in the hands of the economic historians what I regard as the greatest and most important mystery that economics faces: Why have the free-market economies in the past two centuries been able to outstrip, probably by more than an order of magnitude, the

performance in terms of growth and innovation, of all other forms of economic organization?

Division of Innovative Tasks between Small and Large Firms

Much of the discussion that follows emphasizes the difference between the innovative roles of small and relatively new enterprises and large established firms that operate in high-tech oligopolistic markets. Elsewhere I have provided striking evidence indicating that private innovative activity has been divided by market forces between small firms and large, with each tending to specialize in a different part of the task (Baumol, 2002a). Even though the preponderance of private expenditure on research and development (R&D) is, by far, provided largely by the giant business enterprises, a critical share of the innovative breakthroughs of recent centuries has been contributed by firms of very modest size. These radical inventions then have been sold, leased or otherwise put into the hands of the giant companies, which have then proceeded to develop them—adding capacity, reliability, user friendliness and marketability more generally—to turn them into the novel consumer products that have transformed the way we live. I have referred to this division of labor as the "David-Goliath partnership," the value of whose combined contributions clearly exceed the sum of the parts.

To the extent that the facts confirm this characterization, it is clear that the small enterprises have made and continue to make a critical contribution to the market economies' unprecedented growth and innovation accomplishments. Without breakthroughs such as the airplane, FM radio and the personal computer, all introduced by small firms or individuals working independently, life in the industrialized economies

would be very different today. Moreover, without these breakthrough inventions to work upon, the big companies would not have the items upon which to confer their improvements, each of which by itself, is unexciting, but when accumulated can constitute enormous advances. This is typified by the evolution of the Wright brothers' primitive aircraft into the Boeing 777 or the steady improvement of the computer chip whose computational speed has grown over three decades by some 3 million (!) percent.

My objective here is to provide the theoretical underpinnings for the activities of the small firm and the large innovative concern and, in particular, with the structure of their pricing and remuneration relative to their innovative activities and prices, to see how these can be fitted directly into mainstream value and distribution theory. We will see that a central part of the story is centered about discriminatory pricing, with the contention that the pertinent competitive market forces do not merely *permit* such prices, but actually force the firm to adopt them *and dictate what those prices must be*. This is all in contrast with the more usual contention, that discriminatory prices cannot be adopted by the firm unless it possesses monopoly or market power. It will be argued that this ain't necessarily so and that, on the contrary, in a wide variety of instances, it is the very presence of effective competition that *forces* discriminatory prices upon the firm.

In summary, this first proposition in this paper asserts that in a broad range of market types and conditions akin to those assumed in elementary economics textbooks—i.e., where entry is unimpeded, where consumers can be separated into distinct groups with different demand elasticities and where the market's commodity cannot easily be resold by one group to another—market pressures will prevent any equilibrium for the large innovative firm in which the product price is uniform. Not only will each such firm

be *forced* to adopt discriminatory prices, but it is likely to be forced to adopt an approximation to a unique vector of prices each dictated by the market. Thus, in this paper I will seek to show why price discrimination may occur, and occur frequently, not *despite* competitiveness of the market, but *because of it*. In fact, I will show, in highly competitive markets *firms may have no choice: Competition can force them to adopt the vector of profit-maximizing discriminatory prices.* For different reasons and in a different pattern, a variant of this pricing pattern will hold both for the small entrepreneurial enterprises and the large innovative enterprises engaged in oligopolistic competition.

Moreover, in the second central proposition of the paper, I will argue that in equilibrium these discriminatory prices are not haphazard in their welfare properties but that they will generally constitute a Ramsey optimum—satisfying the second-best welfare attributes of revenue-constrained economic welfare. And as a corollary, it will be asserted that, unless marginal cost pricing of all of the firm's products yields zero economic prices, uniform pricing must be incompatible with welfare maximization.

It may be noted, incidentally, that none of these conclusions means that all firms that employ discriminatory prices can automatically to be taken to possess no monopoly power and should therefore be exempted from regulation. But it does imply the converse: Such firms should not automatically be deemed appropriate objects of regulatory oversight.

Oligopolistic "Red-Queen" Innovation Games and Mandatory Price Discrimination

Elsewhere (Baumol, 2002, especially Chapter 3), I have described the R&D activities of the oligopoly firms in the high-tech industries of the developed economies as

an "arms race." Following Schumpeter, I emphasized that these firms now regard such things as price to be weapons of *secondary* importance in their competitive battles. The primary weapon has clearly become the new or improved product that these firms race to introduce before a rival can bring to market an alternative that is equally or more attractive to consumers. No firm in this position dares to fall behind in the race to create new and better products, because protracted failure to do so can be fatal. And, in analogy with the description provided by Lewis Carroll's Red Queen, each firm finds itself running as fast as it can in order to stand still, in terms of its position in the market. I maintain that this Red-Queen-game feature of the market is a key attribute of the advanced economies that helps to account for their continuing outpouring of innovations. It is evidently far more powerful than just a high monetary reward, because mere accumulation of riches allows the recipient to rest on his laurels and withdraw from further innovative activity. But an innovation arms race permits no rest, lest competitors outperform and thereby kill off the enterprise of anyone who is inactive.

It is noteworthy that this incredibly effective and, indeed, ingenious arrangement is yet another product of the market mechanism, not consciously invented, designed or imposed by any person or group. Unlike the other developments that underlie the growth performance of the free market, which I have ascribed largely to historical accident, the Red-Queen-game attribute of the innovation process is automatically introduced by oligopolistic competition and is therefore yet another of the contributions of the market mechanism itself.

The pertinence of these last observations to our analysis can be summed up in three observations: First, the oligopolistic high-tech firm finds itself unable to avoid

frequent and substantial reinvestment in R&D, without which it cannot survive, but it also cannot survive if its pricing approach precludes recoupment of those outlays. Second, relative ease of entry into the innovation process condemns the firm to expect to earn near-zero economic profits, but with the opportunity to recoup the repeatedly sunk R&D outlays, because entry will not occur with any lower level of earnings. Third, because an outlay is increased by an expansion in the number of customers for its products, none of this R&D expense will enter marginal cost, so that marginal-cost pricing will generally not be viable for such an enterprise.

The First Central Proposition: Mandatory Price Discrimination in Separable Markets without Entry Barriers

The analysis of the purely theoretical side of the issue rests on only four assumptions about the pertinent markets:

1. Firms can enter and exit at low cost and with little delay, doing so whenever there are profits to be earned. Such a market is one I have elsewhere dubbed "contestable." There, barriers to entry in the Stigler sense are zero and equilibrium profits must also be zero.
2. Customers can be divided into different groups with differing demand elasticities (e.g., students, senior citizens), constituting different submarkets with negatively sloping demand curves for the firm.
3. If members of one such group are offered a pertinent product at a lower price than that available to the members of the other group, it is not feasible for the former to resell their purchases to the latter.

4. The average cost curves of the firms should be roughly U-shaped, at least in the relevant portion of the loci. This last premise is needed to ensure the existence of a discriminatory equilibrium that is stable and competitive.

The second and third premises are, of course, the standard assumptions underlying any model of price discrimination. In addition, it will be assumed throughout that the cost and demand conditions in the pertinent market are such as to result in existence of an equilibrium that is unique. The first assumption—zero entry barriers and entry whenever profits are available in a market—is, of course, an extreme case. Indeed, interpreted strictly, it rules out sunk costs, for the need to incur such costs does indeed constitute a barrier to entry, imposing risk costs upon the entrant from which the incumbent is immune.

Aside from the premises just described, no further restrictions are required for the central result. Nothing need be assumed about the magnitudes of fixed and variable costs or the presence or absence of the former, so long as those costs, though fixed, are not sunk once and for all. There is no need for additional restrictions upon the nature of demand, or the ability of firms to operate in more than a single market, or their ability to limit the quantities of output they can offer at a given price (since restricted output can, if profitable, be replaced by a rival's entry). Even in the absence of any such assumptions, other than those listed above, we have the result

Proposition 1. Entry enforces discrimination. In a market with no barriers to entry, the firm's equilibrium economic profits will be zero. But if, in addition, a seller can

separate its customers into distinct submarkets with different demand elasticities of the firm's submarket demand curves, and the firm can prevent its product from being transferred from one customer to another, the normal assumptions of the theory of the firm will require discriminatory prices if losses are to be avoided, so that equilibrium will entail such prices.

Proof of the proposition follows directly from the basic assumptions listed above. As will be emphasized in the next section, all of them are quite familiar and appear widely in the literature, including even the elementary textbooks.[2] It should be noted however, that the assumed differences among demand elasticities in the different submarkets preclude perfect competition, with its universally horizontal supplier demand curves.

It should immediately be clear, intuitively, that the first three of our four assumptions yield Proposition 1. For if the market conditions require the firm to charge its profit-maximizing prices in order to break even, and those prices permit it to do so, then those are the prices it will be forced to select in equilibrium. But if there exist discriminatory prices that yield profits higher than those that are possible under uniform pricing, it then follows that the (zero profit) equilibrium profit-maximizing prices must be discriminatory. Moreover, if the maximum is unique, the firm will be a price taker, with a unique vector of discriminatory prices, dictated element by element by the market. However, it should be noted that we have so far not made use of the fourth premise, the U-shaped average costs, which we will need to consider for the existence and stability of the competitive, discriminatory equilibrium.

[2] The proposition is foreshadowed by the Baumol, Bailey, Willig weak-invisible-hand theorem, which asserts that, in a monopoly market that is perfectly contestable, the discriminatory Ramsey prices are sustainable against entry (see Baumol, Panzar and Willig, 1988, Chapter 8).

Existence and Stability: Need Entry Undercut Discriminatory Prices, and Can Discriminators Coexist?

The preceding arguments can be expected to raise at least two questions in the reader's mind. First, will not the easy entry, whose frequency in reality we have already noted, force prices toward uniformity? Second, there is the other side of the matter. Will not the discriminating firm be able to take over the market and evolve into a monopolist? The general answer to both questions is that in some circumstances either can happen, but not in the situation described by our model. These questions also draw our attention to the issue of existence and uniqueness of the discriminatory equilibrium, an issue that will not be examined formally here, but that will be dealt with intuitively.

To deal with all this most directly and intuitively, I will next go over the workings of the model with the aid of some simple diagrams. To avoid complications, I assume that there are two customer groups, each with downward-sloping and linear demand curves, $p_i = AR = a_i - b_i y_i$ (I = 1,2). Hence, their marginal revenue will also be linear, with twice the slope of the demand curves, as shown in Figures 1(a) and 1(b) for submarkets (customer groups) 1 and 2, respectively. As usual, to find the profit-maximizing decisions for the firm as a function of its total output in the two submarkets, we add the marginal revenue curves horizontally, to obtain the kinked marginal revenue curve for the firm as a whole since, as we know, profit maximization at any given output level of the discriminating firm requires marginal revenue in the two markets to be equal. We obtain the familiar kinked marginal revenue curve of Figure 1(c). At low levels of total output y $= y_1 + y_2$, the firm serves only the more lucrative submarket, market 1 (the submarket

which, at low volumes, offers a higher marginal revenue than is offered by the other submarket at any output level). But once the amount of output sold in market 1 becomes sufficiently large, say at

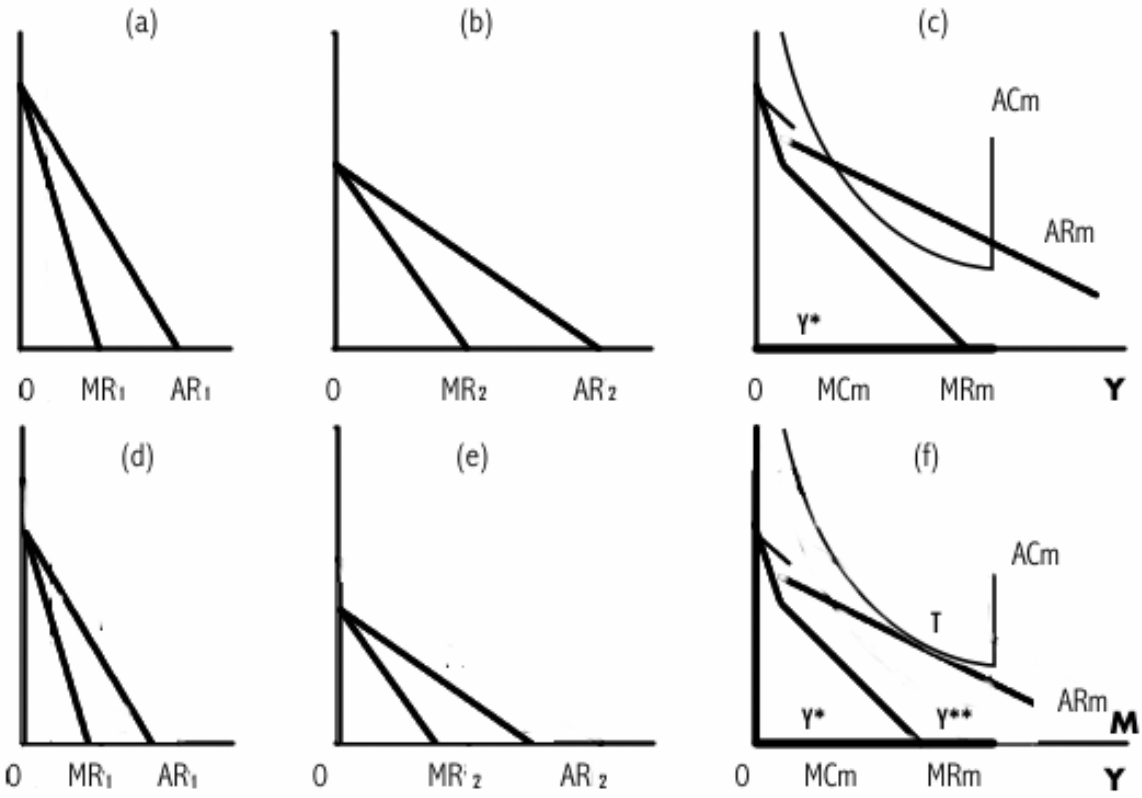

Figure 1

y = y*, it will pay to supply some amount of product to submarket 2. From the marginal revenue curve for the two submarkets together we can derive a curve of average revenue for the firm as a function of its total output, and on the assumption that the price in each submarket is set so as to maximize the total revenue derived from that level of y. To the

left of y* the firm's average revenue curve will have the usual relationship to submarket 1's MR curve, both starting at the same point and MR having twice the downward slope of AR. But at y* the firm's average revenue curve has a downward discontinuity at y*, as shown, because at higher values of y the firm obtains part of its revenue from a submarket with lower average returns than the initially-served submarket, thereby reducing the average of the returns from the two sources together. Thereafter, to the right of y*, the average revenue curve will be linear with a slope that is intermediate between those of the AR curves of the two submarkets.

Now, suppose that the average cost curve for the combined market is as shown by AC_m, part of which lies below the market AR locus, as in Figure 1(c). Then it is clear that in the absence of barriers, as assumed in our model, we can expect entry to occur. As in the usual story, the result will be a downward (leftward) shift in one or both of the submarket demand curves, which will proceed to the point of tangency, T, between the AR and the AC curves, if such a point exists [Figure 1(f)].[3] Thus, if the curvatures of the average cost and revenue loci are appropriate, there will only be one such tangency point at a unique output level, y**, and at any other output level the firm will incur losses.

[3] In Figure 1, for illustration, the AC curve is evidently that for a total cost that is entirely fixed, and provides an absolutely limited capacity to the firm. However, it should be clear that none of the discussion depends on that premise.

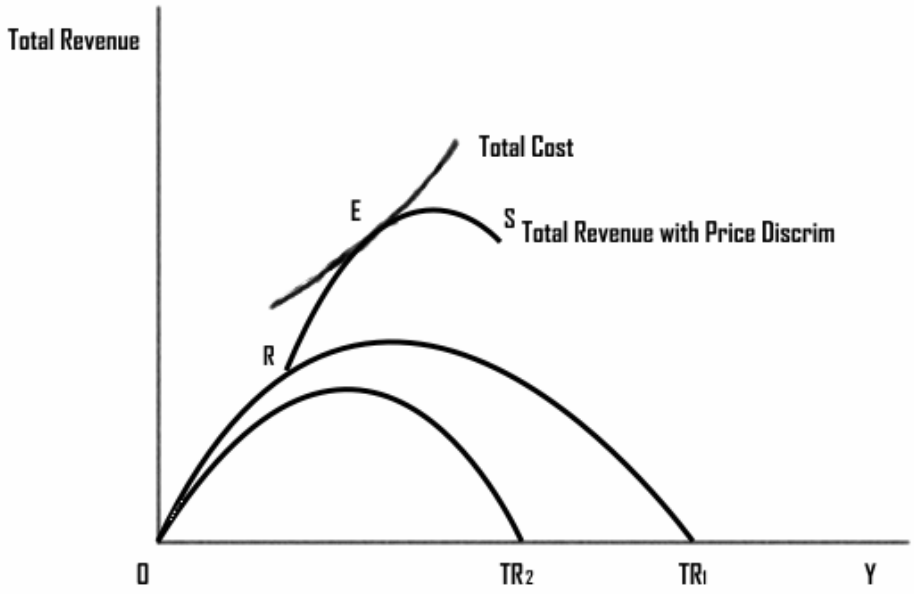

Figure 2

Figure 2 shows *total* revenue and cost in the circumstance described in Figure 1(f). With the demand curves linear of the form AR = a – by, the total revenue curves will satisfy $TR = ay + by^2$. So they will be parabolic, as shown by curves $0TR_1$ and $0TR_2$. As before, when total output is small, it will pay the firm to serve only submarket 1, so the total revenue curve for the firm will coincide with that for this submarket. Moving to the right, to larger values of y, we reach a point where the slope of $0TR_1$ equals that of $0TR_2$, meaning that marginal revenues in the two submarkets are equal at these points and there it will pay the firm to begin to supply some of its product to submarket 2. From that point

onward, the firm's TR locus will lie above the OTR_1 parabola to the locus labeled RS.[4] The figure also shows an illustrative total cost curve and its tangency point, E, with this TR curve. E will evidently be the equilibrium point corresponding to that in Figure 1(f).

The observation from the two diagrams that is most important to us is that in the situation with which our model deals, at any output other than the equilibrium output at the tangency point in either Figure 1(f) or Figure 2, the firm will lose money and be unable to survive. This is where our fourth assumption, the U-shaped average cost curve for the firm, comes into play. It will be seen from the diagrams that with the lineal demand curves in the firm's submarkets, this is sufficient to produce that result, though it is not necessary. What is required, clearly, is that the curvature (convexity) of the AC curve be greater than that of the AR curve, and that the former contain a downward sloping segment whose slope (if continuous) decreases in absolute value as y increases from a level initially higher than that of the corresponding point on the total market AR locus, and that finally the slope of AC exceed that of AR.

We are now in a position to answer the two questions posed at the beginning of this section. First, we see that there is nothing in our equilibrium analysis that precludes the existence of a multiplicity of firms that compete in the markets in question. The nature of the cost and demand relationships is such that it prevents expansion of the firm's output

[4] Such a heightening of the TR curve will also occur under uniform pricing when the firm begins to serve submarket 2, but the heightened curve will only begin at a level of y greater than that under discriminatory pricing, and the uniform-price heightened curve segment will generally lie below that under discriminatory pricing. The second assertion follows from the superior profitability of discriminatory pricing when the cost function is given. In the linear case, the earlier rise in the total revenue curve under discrimination is also easily shown. Using the equations from above, we see that the equations of the marginal revenue curves are of the form $MR = a - 2by$, that the vertical axis intercept of the submarket 2 AR curve is evidently a_2 and its slope at that axis is also a_2 so that with a uniform price the firm will begin to serve submarket 2 when the price in submarket 1 reaches a_2, which will occur when $a_2 = a_1 - b_1y_1$ or $y_1 = (a_1 - a_2)/b_1$. But under discriminatory pricing, submarket 2 will begin to be served when submarket 1's MR falls to that of submarket 2 at the vertical axis, requiring $a_2 = a_1 - 2b_1y_1$ or $y_1 = (a_1 - a_2)/2b_1$.

level above the equilibrium amount. Consequently, total market demand for the product may well be many times as large as the equilibrium output of our firm. This means that there can coexist a plurality of such firms with similar demands, costs and equilibrium outputs, and that can constitute industry equilibrium and can be stable.

Similar reasoning suggests that in such an equilibrium it will not be possible for the discriminatory pricing to be undermined by "cream-skimming" entry that attacks only the most lucrative segments of the overall market. For in the circumstances depicted in the graphs, any firm with the same revenue and cost possibilities will incur losses by serving only one market. It follows that, even with the competitive pressures that characterize a market with absolute freedom of entry and exit, there need be no force that drives prices toward uniformity. The argument suggests that while successful entry into our industry is possible, at least in the unique equilibrium case, it will only be an entrant opening for business fully grown to the equilibrium output who will be able to survive. Of course, reality is somewhat different from that, and a few words will be said about this presently.

We can conclude this part of the discussion with a few remarks on the implications of the discussion for existence and uniqueness of the equilibrium with discriminatory prices. What has been shown here indicates that with little more added (such as continuity of the relevant portions of the derivatives of the AC and AR loci), we can expect such an equilibrium to exist. Uniqueness, however, is a bit more complex. Aside from the obvious possibility of a multiplicity of tangency points, made implausible by the U-shaped AC curve assumption, there is another complication. Along with the discriminatory-price equilibrium, there may coexist an equilibrium with uniform prices.

Suppose, for example, that the firm has substantial fixed and sunk costs, that there exist two submarket for the firm's product with profit maximizing prices $p_1 > p_2$ and that the firm's uniform-price AR curve cuts its AC curve at price $p < p_1$. Then p will be an equilibrium uniform price for the firm, that prevents entry via its fixed costs and zero profits. But while that can indeed be a second equilibrium, and one with uniform prices, it is difficult to see why the firm will not take advantage of the opportunity to charge the profit-maximizing discriminatory pricing, that will only enhance its earnings temporarily, but that is surely better than nothing. Once the discriminatory price equilibrium has been attained, the profit will be eroded more or less gradually by the threat of entry, and it is difficult to see how the uniform-pricing equilibrium will again come into play.

Discriminatory Price Makers or Price Takers?

There are, of course, firms with monopoly power and some of them do charge discriminatory prices that yield monopoly profits. But where entry is sufficiently easy, as we have seen, discrimination brings no such profits. More than that, ease of entry deprives the firm of choice in the setting of prices.

The reason for this should now be easy to see. For this purpose, we need only consider the likelihood that, in practice, the profit-maximizing price vector for the firm will be unique. If that is so, where that price vector and no other yields zero profits, the firm will have no choice. Any enduring deviation from that vector must be suicidal. The firm will, effectively, be a price taker, though not one that follows a posted price that emerges publicly on a market such as that for, say, pork bellies.[5]

This is not mere theory. In practice, we see marginally surviving firms scrambling for every perceived source of potential revenue, and adopting for every such source the price they believe necessary to capture that revenue. Neither the impecunious theater nor the marginal airline can tolerate empty seats. Each seeks desperately to fill them with whoever can help its finances—students, leisure travelers and others who are unwilling to pay high prices, but who will pay a price that contributes *something* in addition to marginal cost. Similarly, that airline cannot forgo the higher price it can impose on business travelers who book at the last minute, for without their contribution to total cost recovery the firm's financial problems will be exacerbated. To the best of their ability, they will select the prices that promise to maximize profits, that is, to minimize losses. Experience may well enable them to come close to selection of those most lucrative prices and, if they do not succeed in this, they will be replaced by others who can do so more effectively.

Thus, market forces impose selection of approximations to the profit-maximizing discriminatory prices. The profit-seeking firm that charges a lower price to union members or to older customers does not do so out of charity but because market conditions force it to do so in order to survive. And the supplier firm that charges higher prices for its product when it is sold in the United States than when it is sold in Africa is equally forced to do so. In particular, the airlines that charge higher fares on routes served by few other carriers are not manifesting a monopolist's ability to select an exploitative price. Of course, one cannot doubt that they would want to adopt such lucrative prices if entry was difficult and those prices could bring in substantial economic profits. But even

[5] Because, so far, only the price-taker side of the firm's activities has been discussed, there is little room for insights from game theory. However, we will see presently that there is more to the story because the market's equilibria are vulnerable to constant disturbance.

if that were not so, entry would still force them to adopt such prices, whose magnitude is dictated by the rule that maximum profits are zero profits. Discriminatory pricing is not a sign of a breakdown of contestability but rather a manifestation of its normal functioning. If the constraint on profit imposed by entry is potent, the only way for the firm with large fixed and continuing sunk costs to survive will be actually to engage in price discrimination of the most sophisticated variety that is workable. And only the firm that is more efficient in finding and carrying out better pricing strategies will survive against less creative firms.

The bottom line here is that, where entry is easy, price discrimination is not to be taken as a manifestation of monopoly power.[6] It is true that a monopolist may well also be able to engage in this practice and, if it is feasible, the monopolist will generally prefer to do so. But in effectively competitive markets the same type of prices can be expected to emerge, and emerge as a mandate of the market throughout the industry. The firm that charges discriminatory prices in such an environment is, effectively, a price taker, not a price maker, because there is no substantial range of prices among which management can select. Rather, it is the need to survive that makes those selections, selections that may well be unique.

Two things need to be said here to adapt this conclusion to reality. First, as has already been noted, in markets of the sort in question it is not unusual for prices to change frequently, indeed, sometimes with astonishing frequency. The fact that the airlines adopt

[6] On this point, I have my only disagreement with Hausman and Mackie-Mason's excellent and illuminating article, when they speak of "…the necessary monopoly power for price discrimination to take place" (1988, p. 245 fn). For the origin of the argument that discriminatory pricing need not require monopoly power, see Levine (2002).

hundreds of thousands of price changes every day can well elicit skepticism about the assertion that the firms have little choice about the prices they adopt. Yet it should be noted that in the most competitive of markets, the commodity and the securities exchanges, price change is virtually continuous, varying from moment to moment, yet no one is led by this to suspect that a relatively small wheat farmer is really a price maker. Indeed, it is mostly in industries where there is reason to suspect that the firms possess market power that prices tend to persist unchanged, often for many months. Sticky prices are not a hallmark of industries in which pricing is controlled by the market.

Here, however, I must not exaggerate. Unlike a farmer or a purchaser of stocks, the executives in charge of pricing in an airline cannot communicate with any organized market electronically to determine what fares current circumstances impose. These people must constantly do their best to determine the current profit-maximizing prices for their firm, but at best they do so very imperfectly. They do not have access to current demand functions for their products or even a set of accurate demand functions for some time in the past. Neither they, nor anyone else, know their marginal costs or even their average costs, as is confirmed dramatically by examination of the records of any substantial antitrust trial in which predatory pricing is an issue. In these trials, in the absence of the pertinent cost data in the records of the firms, specialists on both sides are commonly employed at great expense to determine their own greatly differing and admittedly imperfectly-accurate cost estimates. Given the unavailability of the requisite information and the speed with which the firm finds it necessary to respond to changing market conditions, the prices selected will at best be rather imperfect approximations to the profit-maximizing prices toward which they are driven by market pressures. But that

is still very different from the leisurely and considered pricing choices available to the firm that is really a price maker, protected by lack of competition from having to obey the dictates that emanate from a powerful market.

Proposition 2. Ramsey Optimality of the Price Taker's Discriminatory Prices

I come next to my second central result:

Proposition 2. Ramsey Optimality. If the profit-maximizing equilibrium that yields zero profit with discriminatory pricing is unique, then it is a Ramsey optimum.

That is, the equilibrium will entail the vector of prices that is Pareto optimal, subject to the constraint that the (expected) economic profits of the firm (and the industry) are zero. The argument is almost trivial. If this is the only set of prices that satisfies the zero-profit requirement, then there can be no other prices that satisfy that constraint and add to consumers' plus producers' surplus, or that benefit some individuals without harming anyone. That must be so simply because any other price vector, whether better or worse, will violate the constraint. That is all there is to the argument. However, we can do a little better than this, deriving the requirements for the equilibrium and showing that they lead to the usual Ramsey formulas. For simplicity, I deal with the case where the marginal costs of serving consumers in the different submarkets are all the same and equal to C', while the demands of the different submarkets are independent, so that all cross elasticities of demand are zero. Then, using obvious notation, equilibrium requires

(1) $$\text{Max } \Sigma\, p_i y_i - C(y_1,\ldots,y_n)$$

Subject to

(2) $\Sigma\, p_i y_i - C(y_1,\ldots,y_n) = k$ (where we will select k = 0). The Lagrangian is

(3) $L = (1+r)\,[\Sigma\, p_i y_i - C(y_1,\ldots y_n)] - rk$, where r is the Lagrange multiplier.

But the first-order conditions for maximization of (3) obviously include

(4) $(1+ r)\,[1 + (y_i/p_i)\, dp_i/dy_i\,] = (1+ r)\, p_i\, [\, 1 - 1/E] = (1+r)\, C'$ or

(5) $(p_i - C')/\, p_i = 1/E,$

which is, of course, the most elementary form of Ramsey equation.

What Drives the Pursuit of Breakthroughs by Innovative Entrepreneurial Firms?

I will suggest that the heterogeneity of enterprising behavior precludes any universally applicable scenario, particularly one that imposes a uniform response upon the entrepreneurial firms. In this respect, the story differs from that of the innovating oligopolists who, I will maintain, are normally driven in similar ways by powerful market forces toward their specialization in incremental improvement. For the small firm, I will suggest, there are several pertinent and important influences that also are ingrained in the economic environment, but these are rather more amorphous, not stemming from a pure profit calculus or any market-imposed threat to their survival.

I will focus on three mechanisms that characterize the relation between the market and the entrepreneurial firm. They can be suggestively referred to as: (1) the superstar reward structure; (2) the psychic rewards to innovative activity; and (3) the scarcity and cost disadvantage of large-firm competition in the arena of breakthrough innovation. I will presently discuss each of these in turn. But, first, let me offer an

observation that relates to them all. As is to be expected, I will find that the market does provide clear incentives for entrepreneurs to undertake the hazards of radical innovation. But, paradoxically, I will find that each of the three mechanisms we will discuss entails *financial underpayment* of the average innovative entrepreneur. That is, it entails the expectation of financial returns lower than those to corporate employees with similar education and experience who provide comparable efforts.

A few preliminary words must also be said to avoid misunderstanding of just what it is that is to be explained. It is not my hypothesis that a large percentage of entrepreneurs employ innovation in the new firms they create. On the contrary, the evidence, imperfect though it is, suggests that most new firms are virtual replicas of many firms already in existence, and there is nothing innovative about them. Second, I am not suggesting that even among that relatively uncommon species—the innovative entrepreneur—that preponderant focus is on anything that can reasonably be deemed breakthrough innovations. Here again, casual empiricism indicates the reverse—that the bulk of the novelties they introduce are only slightly better mousetraps. So it is not my claim that most entrepreneurs devote themselves to radical innovation or even to any innovation at all. Rather, I propose the converse: that among the (rare) innovations that can be considered to be radical, a disproportionate share is provided by independent innovators and their affiliated entrepreneurs.

Thus, in what follows, I will have to account, first, for the comparative paucity of breakthroughs that emerge from the sizeable labs and affiliated facilities of the large, established and innovative firms. Second, I will have the task of explaining why a significant group of entrepreneurs and inventors, albeit a comparatively small one, are

willing to undertake the great uncertainties and the typically enormous personal effort that pursuit of this objective requires. The issue is not why there are so many that do so, but why there is a significant set of these adventurers at all.

Superstar Market Reward Structure, or the Multimillion-Dollar Lottery

The most obvious incentive to which one can attribute the relatively frequent focus of independent inventors and their entrepreneur partners upon more radical ideas is, of course, the great wealth and enormous prestige that success in their undertaking appears to promise. We all do, indeed, know of inventor-entrepreneurs who are enduring legends: Eli Whitney, James Watt, Elias Singer, Thomas Edison, the Wright Brothers, etc., etc. Indeed, it is striking how familiar they are.

There is an immediate consequence: The enormous prestige and great financial rewards, *along with their rarity,* transform the innovative entrepreneur's activities into a lottery that offers just a few mega-prizes, like so many of the lotteries that nowadays capture the headlines. An innovator’s activity is like such a mega-lottery, or like the pursuit of an occupation that offers a limited number of superstar positions. But the prize is available only to those who provide *breakthrough* innovations. A technological contribution that permits humanity to fly or to send messages through the air can elicit headlines, but a minor improvement in automobile door handles is hardly likely to compete. And just as multimillion-dollar lotteries have a greater attraction than a thousand-dollar lottery of the local club, even though the latter’s terms are better actuarially, the pursuit of breakthrough innovations surely has a very special attraction to the independent entrepreneur.

Monetary Compensation, Psychic Compensation

A very well-recognized attribute of lotteries is their built-in unfairness, as measured in actuarial terms. The average payout is sure to be less than the per-ticket-holder take of the lottery operator—that is why he is in the business. We will see that there is a somewhat similar loss prospect for the representative entrepreneur. In part, the willingness of innovators, like the buyers of lottery tickets, to accept these biased terms may be attributable to over-optimism or to sheer miscalculation. But that is hardly the end of the story. Each of these activities—innovative entrepreneurship and the purchase of lottery tickets—also provides an important payoff of a second sort. Both activities offer distinct psychic rewards, and not only to those who have already achieved success or who even have a real and substantial likelihood of success. The *prospects* of glory, of wealth and fame, are something of value even if they never materialize. They are, indeed, the stuff that dreams are made of. And for the entrepreneur, contemplation of imagined success is only part of the psychic reward. Reading the biographies of the great inventors, one must be struck by the fascination that the process of their work elicited, by the moments of triumph, and even the pleasure of puzzle-solving and experimentation, though punctured by frustration and exhaustion.

These observations find support in some significant economic data. There is systematic evidence (see, e.g., Freeman 1978) that the average earnings of self-employed individuals are significantly lower than those of employees with similar qualifications, and the same is presumably true, in particular, of the self-employed innovative entrepreneurs. There are at least two studies that support this hypothesis for innovative

entrepreneurs. Thomas Astebro (2003) reports on the basis of a sample of 1,091 inventions that, "The average IRR [internal rate of return] on a portfolio investment in these inventions is 11.4 percent. This is higher than the risk-free rate but lower than the long-run return on high-risk securities and the long-run return on early-stage venture capital funds…the distribution of return is skew; only between 7-9 percent reach the market. Of the 75 inventions that did, six received returns above 1400 percent, 60 percent obtained negative returns and the median was negative (p. 226)." Perhaps even more striking is the recent work of Nordhaus (2004), who provides evidence showing how little of the efficiency rent goes to the innovator: "Using data from the U.S. non-farm business section, I estimate that innovators are able to capture about 2.2 percent of the total surplus from innovation. This number results from a low rate of initial appropriability (estimated to be around 7 percent) along with a high rate of depreciation of Schumpeterian profits (judged to be around 20 percent per year)....the rate of profit on the replacement cost of capital over the 1948-2001 period is estimated to be 0.19 percent per year" (p. 34).[7]

Perhaps even more striking and more extreme is the phenomenon of open sourcing and shareware in computer programming. Here, a great and growing body of complex and valuable material has been painstakingly created, and much of it is evidently of enormous value in economic and other terms. Yet it has been created and offered to others with modest, if any, restrictions, and without financial reward. Thus, a much noted and much valued activity is produced with a zero financial reward, a payoff evidently far below what the work could have elicited if performed inside an established business enterprise. But the enthusiasm of those involved seems equally manifest.

[7] Using a cruder and more-intuitive approach, the present author also reached a very low figure for the returns to innovation that are not dissipated in spillovers (see Baumol, 2002b, pp. 134-5).

An explanation is readily available and follows immediately from the attributes of the activities that have just been noted. The representative entrepreneur may indeed be underpaid in terms of financial reward alone. But his *total* payoff may be closer to what economic theory would lead us to expect, though part of the payoff takes a form other than money. It is as though he were being paid off in two different currencies: partly in dollars, partly in euros. In equilibrium, such two-coin payment recipients could clearly expect fewer dollars than someone similarly engaged whose contract calls for payment only in that one currency.[8] That this is how markets work is easily confirmed by casual observation.

The story pertains not only to the entrepreneur. It recurs throughout the economy. The fact that that multimillion-dollar lotteries are carefully and openly structured to be actuarially unfair means, as already noted, that the purchasers of tickets in such a lottery will on average and as a whole receive back less than they put into it. It is arguable that the masses of purchasers who endure long and time-consuming queues to grab up the tickets are not irrational but that they receive an adequate payment in another currency: the psychic rewards. That same scenario helps to explain, in an example from another arena, why despite the rigors of their training and the difficulties of their work, the typical earnings of professional dancers are so meager.[9] One can easily think of other occupations with similar attributes.

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[8] This suggests one way in which it may sometimes be possible to place a monetary value on psychological enjoyment and even esthetic pleasure. A similar situation has been noted in other arenas. For example, there are data showing that the average financial return to investment in works of art is significantly lower than the return to investment in bonds, the difference being interpreted as the financial valuation of the esthetic yield of painting ownership (see Frey and Pommerehne, 1989).

[9] Other areas where some element of non-pecuniary income is likely to exist include scientific research, academic occupations and perhaps professional work more generally. It may also arise among the self-employed in their enjoyment of freedom from control by superiors (Hamilton, 2000; Frey and Benz, 2003). This phenomenon and its relation to the work of innovators has long been recognized: "The knowledge of

And the reason is not just sheer willingness of the recipient of psychic benefits to be exploited in financial terms. The market mechanism enforces it, as Adam Smith pointed out: Given two occupations, one very distasteful and the other a source of great pleasure, if other things including payoffs and ability requirements were equal, we must expect the workforce to shun the one and flock to the other, driving wages up in the former and depressing them in the latter as a garden-variety manifestation of supply and demand.[10]

Entrepreneurs' Competitive Position and the Low Supply Cost of Psychic Benefits

There is an important implication of this story whose relevance will become clear presently. So far we have not assigned a critical role of the market mechanism in eliciting disproportionate allocation of entrepreneurial activity to breakthrough innovation. We will now come to such a role of the market. Psychic benefits are a very tangible reward to the recipient but are generally *costless to the provider*. This implies that an innovative entrepreneur who on average receives great pleasure but meager financial rewards from the activity may nevertheless be richly rewarded overall. But the low financial payment means that innovations obtained from this source are purchased cheaply in financial terms, giving this sector of the economy a marked competitive advantage. That is, this

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the man of science, indispensable as it is to the development of industry, circulates with ease and rapidity from one nation to all the rest. And men of science have themselves an interest in its diffusion; for upon that diffusion they rest their hopes of fortune, and, what is more prized by them, of reputation too" (J. B. Say, 1819, 1834, p. 82).

[10] "The wages of labour vary with the ease or hardship, the cleanliness or dirtiness, the honourableness or dishonourableness of the employment…. A journeyman weaver earns less than a journeyman blacksmith. His work is not always easier, but it is much cleanlier…The exorbitant rewards of players, opera-singers and opera-dances, &c. are founded upon these two principles: the rarity and beauty of the talents, and the discredit of employing them in this manner. It seems absurd at first that we should despise their person, and yet reward their talents with the most profuse liberality. While we do the one, however, we must of necessity do the other" (Smith, 1776, Book I, Chapter X, Part I).

analysis tells us that the independent innovative entrepreneur will tend to be the economical supplier of breakthrough innovation to the economy. As we know, one of the virtues of markets and competition is their ability to move economic activities toward those suppliers who can provide them most economically. In the case at hand, it means that the low-cost psychic reward component of the independent innovator's compensation will make it more economical for the large firm, in considering its make-or-buy options, more generally to acquire its breakthroughs from others rather than seeking to provide them in-house. Firms are forced to do so for fear that if they do not, their rivals will. This, then, suggests one market-based reason (that is not mere happenstance) why a disproportionate share of radical innovation stems from the independent entrepreneur.

There is one more observation to be offered here. Why does this low-wage competitive advantage of the independent innovator-entrepreneur not extend also to the less radical innovations—the cumulative incremental improvements that are a giant firm specialty? At least part of the answer is the greater complexity and investment cost characteristic of the latter. A Boeing 777 is obviously far more complicated than the primitive device the Wright brothers made airborne at Kitty Hawk, and the transformation of the Boeing 747 into the Boeing 777 entailed an army of engineers and designers and an expenditure that made the outlays of the Wrights dramatically insignificant by comparison. This, too, is not accidental. By its very nature, this revolutionary invention, like so many before it, grew ever more complex as it was repeatedly modified and improved. Thus, the independent innovator was and continues to be at a marked disadvantage in the financing of incremental improvements of inventions that have reached an advanced stage of sophistication.

This completes my scenario seeking to describe how market forces drive the individual actor away from the small developments and toward the breakthroughs. I turn next to the other side of the story: the giant firm and its characteristic preoccupation with the small changes that are designed to provide only gradual improvement.

Differential Quality and Ricardian Rent

Next, we come to another fairly surprising conclusion. In the preceding analysis, both capital and labor were homogeneous in quality and perfectly mobile. We now retain these assumptions for capital but relax them for labor. In other words, we are dealing now with an arts company or a sporting team whose inputs are supplied by humans with yields that differ in quantity, quality or pertinent cost. Monetary payments are made to the labor and, as before, the suppliers receive psychic returns; however, in the current scenario, the purchasers of their services, the investors, do not. The heterogeneous nature of the labor input is observable in the variation in qualities or skills of members of the opera company or basketball team. One or two of them in particular—the "superstars"—are so distinctive that they bring public adulation and fame to themselves and the company; this is the high-profile singer or athlete with strong audience drawing power, for example. Such stars may or may not have a strong commitment to the company employing them, reducing their willingness to move to a rival organization. Note that the stars may co-exist in a company or team alongside workers conforming more to the homogeneous input case discussed above; an opera or dance company, for example, generally comprises a handful of recognized star-quality soloists together with an anonymous and more or less homogeneous chorus or corps de ballet.

This situation of differential input quality and zero psychic returns to investors allows, with slight modification, an application of the Ricardian rent model. The lesson is clear. Provided that there are no impediments to the flow and transfer of capital, the financial rewards to the different suppliers of inputs (including each differentiated unit of labor) must exactly equal their differential financial contribution to the investor-purchaser, over and above the contribution of the marginal input supplier. Hence, the *financial* rewards must in total correspond precisely to the differences in the money values of their net incremental contributions. This must refer to the *total financial* payment to each input supplier and the total contribution of that supplier to the investment. The logic is simple. If any supplier were paid less than this, investors would quickly transfer capital to the purchase of those underpriced services, raising their market value to the predicted value. Put another way, the result follows because in equilibrium the perfectly mobile capital must receive exactly the same return on investment in every investment venue that attracts any funds.

However, the fact that famed dancers or basketball stars also receive in monetary compensation the full value of their marginal revenue products but, in addition, obtain a psychic return from the adulation of the audience means that *in a Ricardian market, the stars will be overcompensated*. The total value they receive in the two coinages together will systematically exceed the value of their contribution to the investor. This surplus return will, moreover, be of different value to different input suppliers, depending on their ranking in the field and their own mental attitudes. And in our model, the surplus will be provided at zero cost to the employers because of its quasi-public-good characteristics, a matter discussed further below.

How can one explain the sharp difference in implication of the two models?—that in the preceding section where the combined equilibrium return in the two coinages was always precisely the same in all transactions, and the model of this section in which the combined rewards are systematically excessive, and vary haphazardly from one transaction to another? The answer is that we are dealing with two types of input: On the one hand, we have homogeneous capital that is assumed perfectly mobile, and on the other we have non-homogeneous skilled labor. In both models, the investment of capital *does* receive exactly the same payoff in equilibrium, because its mobility eliminates both excessive and inadequate payment relative to the current norm. But in the model of this section, it is the monetary returns to capital that are always equal while it is the other input—the heterogeneous labor—that is generally overpaid. (And this is our first example of a paradoxical phenomenon: The limitation on ability to bargain and compete that is the result of immobility leads to overpayment of the immobile input, rather than the reverse.)

Outsourcing of Breakthroughs

A final part of the story has already been noted. Because of the comparatively low financial remuneration of the representative entrepreneurs described earlier, these entrepreneurs become a source of low-wage, low-cost search for breakthrough innovations. This makes it more profitable for the large, established firm to buy rather than to make such service. The incentive is no different than that for the outsourcing of computer programming to India. The large firm is thereby given an incentive to outsource this activity, choosing to acquire the resulting intellectual property from the entrepreneurs

in the market for inventions, rather than incurring the higher costs of doing the job of producing them itself.

There seems to be no reason to expect the market forces just described to be very transitory. If they are indeed enduring, it follows that we can expect the current division of innovative labor between small and large firms to continue. There is also no reason to believe that this will be damaging to the public interest.

Notes on the Value Microtheory of Entrepreneurship and Innovation

The sunk costs that have been mentioned earlier may seem of questionable relevance as matters of the past that can no longer affect rational current decisions. But the sunk costs that are important for us are not once-and-for-all outlays. Rather, they are continuing expenses typified by the competitive requirement that the firm in a "high-tech" industry budget continuous outlays that must be sunk in R&D.[11] As we know, in such an industry a firm that has once introduced a superior product or a more-efficient production process cannot afford to rest on its oars. For it knows that it is engaged in a kind of arms race with its rivals, with expenditure on further innovation the prime weapon, and success in the race ultimately a matter of life and death (on this see Baumol, 2002, part 1).

The sunk costs that are said by traditional theory not to matter for an incumbent firm's decisions are the once-and-for-all expenditures made in the past and not repeated thereafter. These are the ancient history that no current decision can change, whereas the

[11] It must be admitted that the high-tech industries do not seem to have been nearly as successful as the airlines in differentiating their prices among customers. Still, extensive school and student discounts for computers and software and negotiated terms with large corporate purchasers are examples in which the sellers do what they can to employ discriminatory prices.

sunk outlays that the firm *must* be expected to recoup are those that are incurred currently and will continue for the foreseeable future. It is these expectable and recurring sunk outlays that most directly drive the firm to discriminatory pricing. And it is crucial to recognize that they are not barriers to entry in Stigler's pertinent sense, because they are equal burdens for the entrants and the incumbents. That is, they offer no substantial competitive advantage and, hence, no monopoly power to an incumbent firm.

All this is directly pertinent to the construction of a model that can determine the prices of the services of entrepreneurs, independent inventors and the large firms with substantial R&D activities. With entry into innovative activities largely unobstructed, and the big firms driven by an innovative arms race to constantly repeated investment in the innovation process, we conclude from our analysis that they will driven toward normal profits on their R&D outlays, although the quest for survival will prevent them from abandoning the activity. Moreover, given the low marginal cost of use of the resulting information, they will be forced to adopt the market-determined discriminatory prices that maximize their profits in order to recoup their R&D investments. Third, by Proposition 2, those prices will tend to be Pareto optimal.

But what about the independent entrepreneurs and inventors? Can a similar story be told for them? The answer, although it may at first not be obvious, is that this is precisely what the Schumpeterian scenario already has told us. Only it has done so in a manner that disguises the price discrimination side of the story, which precisely follows what was just offered for the large established enterprises. However, what is entailed in Schumpeter can be better described as *intertemporal* price discrimination. The entrepreneur and inventor recoup their outlays of money and effort in the initial period

after the introduction of an innovation when competition is weak or nonexistent, so the seller's demand curve is inelastic and the profit-maximizing price is high. But as imitators appear, the initial seller's demand curve grows more elastic and that price consequently falls. The remainder of the story should be obvious.

The implications of the analysis for rethinking of criteria is illustrated by an ancillary issue, the observation that margins in air passenger transportation tend to be higher the fewer the carriers that serve a given route. This has been widely interpreted to imply that in sparsely served routes the firms possess monopoly power and, more broadly, that it refutes the conjecture that the air transport markets are highly contestable. I had previously accepted those conclusions, but am now forced to recant. While passenger air transport may or may not approximate a high degree of contestability, it is clear from the preceding analysis that the empirical observation about number of airlines serving a route and the magnitude of margins does not help to settle the issue. Indeed, in a perfectly contestable market the cited differences are precisely what should be expected. The smaller the number of airlines that serve a route, the lower one can *ceteris paribus* expect the firm's elasticity of demand for service on that route to be. As we have seen, market forces will then make higher margins on that route a mandatory, not an optional, choice. Moreover, besides having little choice on this matter, the frequency of experienced entry indicates that, for this and probably other reasons, the airlines cannot expect to derive any monopoly profits in the long run from such pricing. Thus, the firm has no power to extract monopoly profits from these discriminatory prices, and no option of setting very different prices without courting financial suicide. It seems hard to

conclude, then, either that this shows the firms to possess monopoly power, or that it proves the airlines to be operating in markets that are far from contestable.

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