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**THE PUBLIC LIBRARY IN THE DIGITAL AGE:
NEW TECHNOLOGIES / PERENNIAL PROBLEMS**

by

GEOFFREY M. OLIVER, B.A.

A thesis submitted to the
Faculty of Graduate Studies and Research
in partial fulfillment of
the requirements for the degree of
Master of Arts

Department of Economics

**Carleton University
Ottawa, Ontario
January 15, 1994**

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**"The Public Library in the Digital Age:
New Technologies / Perennial Problems**

**submitted by Geoffrey M. Oliver, B.A.
in partial fulfilment of the requirement for
the degree of Master of Arts**

Thesis Supervisor

Chair, Department of Economics

**Carleton University
26 November 1993**

ABSTRACT

This paper briefly describes a hypothetical extension of the current public library, a public data bank (PDB), that would provide books and other material in digital form to the public via computer modems and other transmission mechanisms, with no user charge. A select set of the economic issues that arise with this PDB are considered, particularly the difficulties stemming from the need to compensate authors. "Non-repetitive, perfectly substitutable" public goods are considered in the latter part of the paper, using a model and analysis developed by Oakland. The paper shows that under some conditions, a mixed system, where public provision does not completely crowd out the private sector, can be more efficient than pure private provision, and also avoid the over supply which can be a danger with pure public provision of the good.

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Robin was there to discuss ideas, help with editing and structure, and to graciously put up with a husband who for a long period was somewhat distracted and preoccupied.

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Friends, family and colleagues were supportive throughout: my parents and parents in law, who were always encouraging; Frank, who claimed his head hurt after helping me sort out the basics of the Oakland model before my discovery of Oakland's article; Steve Ferris, who provided enthusiasm, motivation and guidance in the murky beginnings of the project; Michael, who for all his realism always projected an unflagging faith that I could complete this project; and all the others who helped me — I owe you all many thanks and much gratitude.

While the paper has benefited profoundly from everyone's help, its flaws remain solely my own.

TABLE OF CONTENTS

ABSTRACT	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
I. INTRODUCTION	1
Overview of the Paper	8
II. KEY ECONOMIC CONCEPTS AND SELECTIVE APPLICATION TO THE PDB	10
Seminal Articles and Issues	10
Samuelson, Minasian, Buchanan, and Demsetz	10
Competitive Supply and Price Discrimination: Demsetz, Thompson and Borcharding	15
Demsetz's Beef and Hides Example	21
Economic Issues and the PDB	23
The Options	26
Compensation	27
Cheating the System	35
The Nature of Originality: A Common Dilemma	39
Newer Private Sector Alternatives	41
Advertising	44
Price Discrimination and the PDB	47
Further points	49
III. THE BALANCE BETWEEN THE PDB AND PRIVATE PROVISION: CONSIDERATION OF ONE TYPE OF PUBLIC GOOD	50
Private Provision: A Geometric Exposition Based on the Oakland Model ...	51
Assumptions	54
Analysis Assuming a Common and Fixed Market Price.	57
Considering Different Common-Market Prices	59
Output Under a Fixed Common-Market Price	61
Introducing Price Flexibility	64
Variable MC	70

	HR Public Goods and the PDB	72
	The PDB and Increasing MC	76
	Mixed Public / Private Provision	77
	Mixed Public / Private Provision and Rising MC	79
	Section Summary	80
IV.	CONCLUSIONS	82
V.	WORKS CITED	84
VI.	APPENDIX A: FIGURES	86
VI.	APPENDIX B: GLOSSARY OF NOTATION	95

"Info-property is distinct from "real property" in that it is not finite. I can use it, and you can use it, at the same time. And, in fact, the more people who do use it, the more information is likely to be generated.

So, property isn't what it used to be when Marx and the early Socialists built their theories on it.

*This is a fatal contradiction. Private property has been the defining characteristic of capitalism. Now, suddenly, the essential property transforms from symbolic to meta-symbolic, and from finite to non-finite in character. And that contradicts the very notion of property, which has been based on scarcity and materiality." (Alvin Toffler, *Preview and Premises*, 1984)ⁱ*

*"To try to apply the concept of copyright to all these stages and actors would require a most elaborate set of regulations. It has none of the simplicity of checking what copies rolled off a printing press. ... In the old technology of printing one could have a right to free press for the reader and the writer but try to enforce copyright on the printer and bookseller. That distinction will no longer work, any more than it would ever have worked in the past on conversation." (Itihel de Sola Pool, *Technologies Without Boundaries*, 1990, 258)*

i. Quoted in Chesterman & Lipman (1988, 18)

I. INTRODUCTION

Technological changes are having profound effects on the creation, distribution and consumption of information. One aspect of this impact is the technology's influence on the role of the public library in the era of digital information. This paper looks at the economic issues that would arise if the public library system were extended to offer digital copies of material to patrons. The actual form of digital distribution is technically significant but not economically critical — library material could be copied to a disk, or transmitted via telephone, coaxial or fibre optic cables, or over the airways. I shall refer to this extended digital library system as the Public Data Bank (PDB).¹ What is economically significant about the PDB is that patrons would receive their own permanent copy of material provided.

The new information technologies bring many changes, but two are most significant in this context: one is that, unlike the current mix of services provided by booksellers and the traditional library, when a PDB provides a digital copy of a work, this copy is now a perfect substitute for a digital copy provided by a private supplier; the second is that the new digital technology greatly exacerbates the difficulties of enforcing private property rights.

1. Essentially the PDB referred to in this paper is solely the author's conception. The PDB's attributes have not been selected from any specific source, though no doubt similar proposals have been described elsewhere.

De Sola Pool's quote highlights one extreme conclusion on how technological developments have eroded the ability to enforce intellectual property rights. However, de Sola Pool's pessimistic forecast will be partially offset by the new means of enforcement generated by changing technology.² Nevertheless, technological change seems to have eroded rather than buttressed the capacity to enforce copyright. This implies that the efficiency of the existing system of copyright may have decreased relative to alternative structures not subject to the same rise in enforcement costs. The PDB is one such an alternative structure, though as we shall see, the efficiency gains from reduced enforcement costs must be weighed against the PDB's own difficulties and costs. As well, rising enforcement costs are generating new private sector structures for creating and disseminating information, which will also need to be considered in a fuller analysis of the institutional options available to deal with "info-property".³

2. Minasian also noted that while the private provision of such goods required the capacity to exclude, "The probability of finding a cheaper method of exclusion will increase if there is a demand for such devices." (Minasian, 1967, 206) However, there is also a great incentive to evade such systems of exclusion, as illustrated in note 3. We shall be reviewing Minasian's arguments on the nature of public goods in detail in section II.

3. The work, *The Electronic Pirates: DIY Crime of the Century* (Chesterman, Lipman, 1988) presents a fascinating account of the modern information pirates. The book has a section on each of the main "information" industries: print, sound, film and computer software. The initial technology in each area was (or is still) different, but the pattern of behaviour is essentially the same. A copying technology becomes available - photocopier, tape recorder, Video Cassette Recorder, and the magnetic media of computers - and "entrepreneurs" rush to use the technology to generate the same output, but with none of the investment costs required to generate the original master.

Reading the accounts given in the book, we are struck by how inadequate and extraordinarily expensive and difficult the "copying wars" are becoming in all these areas. Most difficult of all appears to be protecting information in digital form, although even in this area the technology continues to change, and it is moot whether a relatively simple and cheap system of enforcing intellectual property will appear.

The erosion of intellectual property rights is a fundamental impact of technological change on private provision of information, but it will not be given significant further attention in this paper. However, the increased substitution between works provided on the PDB and the private sector is also critical, and motivates much of the analysis in the paper. One aspect of this increased substitution will be the need to compensate authors for providing their copyrighted material to the PDB, and much of this paper shall consider the nature of this compensation. Before considering compensation under the PDB, we shall briefly expand on the dynamics of the substitution between the goods available via the PDB and private provision.

Traditionally libraries only partially substitute for buying and owning one's own books. Libraries have restricted hours of access, they may not be located in a convenient location, they provide only limited time for borrowing, there is often a waiting list for popular material, and they try to forbid individuals from underlining and inserting "helpful" notes in book margins. No such restrictions apply to your own copy of a book, purchased at the bookstore. On the other hand, the public library offers a far greater selection of books than any one individual can afford. For these reasons, libraries to great extent complement the private bookstores, although since few people will borrow a book and subsequently buy it,⁴ (and vice versa!) some degree of substitution exists between these two organizations.

4. Presuming one finds the time to actually read the borrowed book!

All *these* distinctions between private and public provision are eliminated with digital material. A consumer looking for a particular work, and facing the choice between connecting to a PDB providing material for free, or a private source which charges, has a clear decision. Since the product is indistinguishable, price will be the deciding factor. (Assuming there are not significant and different transaction or information costs of finding the material.)

Private databank systems will not necessarily be displaced: they may be more innovative in organizing the material carried, offer specialized search services, or be the sole suppliers of time-sensitive information, etc.: hence readers will be willing to pay for their services. Further, if these specialized services are provided by subscription, without additional fees for specific material downloaded, then material on the PDB might also be provided on private data banks (as is currently the case with public domain material). Nevertheless, the competition from a PDB, providing a great deal of material with neither a general subscription charge nor a per item charge, will be significant.

Once an author agrees to provide her material on the PDB, private publishers or private databanks may be unwilling to purchase that material. Private publishers and databanks are likely to insist on contracts which exclude placing material in the PDB. Without exclusive rights, and with the author's material available for free on the PDB, a private databank will generally not be willing to pay. However, free "public domain" material is a complement to privately sold information, and private databanks with a subscription system may offer authors a minimal amount to include such "public domain" material in their overall information holdings, and thus attract

subscribers with a more comprehensive information source. Authors, however, will have little motive to release their material to the private databanks unless they anticipate increased combined revenues from both the private and public data banks, rather than from the PDB alone.⁵

Private producers can only offer the *typical* author a payment less than or equal to the added revenue the author's material provides to the databank. Since these revenues to the private databank are unlikely to be significant on material already available for free on the PDB, they will not be able to substantially compensate the author. Conversely, having the author's material privately available would reduce the number of downloads and the associated revenue from the PDB system.⁶ Thus, unless the author can negotiate contracts with private databanks and the PDB which in combination raise her overall income, the two systems are likely to be mutually exclusive for most copyrighted material.

This is a significant change from the current system: having a book available in the public library has not precluded publishers and bookstores from providing the

5. The agreement of authors would be legally required for inclusion of all copyrighted material on a databank, public or private. The enforcement of the authors' copyrights would presumably not be difficult for the PDB, as governments are generally embarrassed to be caught breaking their own laws. If private databanks are few and well known, a similar constraint will apply. However, once such databanks proliferate, particularly in countries where copyright is given less respect (and with dropping international communications costs), authors may find it difficult to protect their property rights once material is available in *any* databank.

6. The nature of the PDB revenue function will be described on page 27.

book, and the author's key source of revenue has not been seriously compromised. Under the PDB, which may replace private provision of material it carries, the matter of the author's revenue becomes salient. Yet even under the existing library system it has been argued that libraries provide a substitute for buying books and reduce authors' income. This has led to "public lending right" (PLR) systems being established in at least twelve countries to redress this problem.

There are three key systems of compensating authors available under the existing PLR systems or the PDB system considered in this paper. Under the PLR, one system of compensation (which is used in Canada) surveys a sample of libraries in a country, and the author receives a fixed fee per "hit". A second option available we shall briefly consider for the PDB, would be to simply purchase the copyright on the work from the author in a lump sum payment. Finally, a third system common to both the PLR and an alternative PDB system, is to monitor loans or downloads of material, and pay authors a set fee per hit. The British PLR system employs a loans-based compensation mechanism for most works. The paper will concentrate on a PDB where compensation is based on monitored loans or downloads, and the PDB lump sum purchase system is only sketched out as an alternative.

The system of compensation under a PDB is basically an extension of the PLR system, and the key difference between the two compensation systems is the amount of compensation which must be generated. The PLR is designed only to top up, rather than replace, the author's income from private sales.⁷ Part of the rationale for this is

7. See Brophy (1983) for a discussion of the various arguments advanced in different countries for and against the PLR.

that private sales are eroded by the large number of readers benefiting from each library copy of a work, for which the author receives the royalties from only a single sale. In contrast, a PDB copy of a work will effectively block private sale, and the only compensation the author will receive on a work included in the PDB will be from the PDB itself. Thus the compensation under a PDB will be more important for the author, and will need to be much higher than under a PLR system. Although the information difficulties in determining compensation will be similar under both systems, the implications of these difficulties for authors and the public will be proportionately greater under a PDB.

So far, the operating details of the PDB and its precise structure have not been provided. All that has been noted is: it is an electronic extension of the public library system; its name evokes a comparison with the current private databanks, but without the subscription or download fees; and that the PDB will need to incorporate substantial compensation for authors of the copyright material carried. However, rather than clearly define one particular PDB organizational structure to be analyzed in detail, it will be more useful to leave the details open, and discuss the economic implications of different organizational choices in turn. The key choices will centre on selection of material, and the system of compensation.

The paper's focus on libraries allows us to concentrate on the selection and provision of textual material; however, the variety of material which can be encoded

digitally also includes photos and images, video, sounds, and three dimensional virtual models — and the list continues to grow. Thus from a technical standpoint, as long as transmission and storage technologies can match the volume of information contained in such files, the PDB could carry and have available all types of information. However, for ease of exposition I have chosen texts as the core item available on such a system. Nevertheless, almost all the insights and analyses are applicable to these other forms of information.

Overview of the Paper

Section II will review some of the seminal economic articles on the provision of public goods, and then consider how some of the insights imparted can be applied to the key economic issues pertaining to the PDB. The critical issues raised in the literature are: the tension between the scarcity of resources required to create a public good ex ante, and the "superabundance" which a "pure" public good with a zero marginal cost of provision, provides ex post; the need for information to make optimal resource allocation and distribution decisions (both for public and private provision of public goods); the potential for over and underproduction of such goods; and, with regard to private provision of such goods, the capacity to price discriminate. An iterative series of articles in 1964 and 1967 by Samuelson, Minasian, Buchanan, and Demsetz (1970) will be the main articles considered, but a few of the points made regarding price discrimination in a triad of articles by Thompson (1968), Demsetz (1970) and Borcharding (1978) will also be briefly noted.

The third section will consider the interplay between the PDB and private provision following a model developed by Oakland (1974) dealing with a specific type of public good I have labelled Harlequin Romance or HR public goods, described as "non-repetitive" perfect substitutes. While the model used is somewhat restricted, it does illuminate some key aspects of how a public/private sector equilibrium can be established. The combination of public and private provision allows for an interesting balance between the goals of not excluding consumers when it is ex post Pareto inferior to do so, and acquiring the information required to avoid public sector over-supply of a public good.

A conclusion briefly summarizes the material and issues covered in the paper.

II. KEY ECONOMIC CONCEPTS AND SELECTIVE APPLICATION TO THE PDB

Seminal Articles and Issues

Samuelson, Minasian, Buchanan, and Demsetz

A well known exchange in the literature between Samuelson, Minasian and Buchanan (as well as comments from Demsetz and others) brought out many of the key economic issues pertaining to the supply of public goods. A blow by blow summary of the exchange is not deemed to be useful and is thus not provided — rather some parts of the discussion are reviewed to highlight the salient issues. As Buchanan notes, the exchange is unfortunately marred by the somewhat personal attacks by Samuelson against Minasian: Samuelson seems miffed that Minasian fails to note that Samuelson had "fully" addressed all the issues Minasian raises. Samuelson is equally dismissive of Buchanan's contribution to the discussion. Regardless, the exchange brings out some key issues, which we shall now consider. First, one point should be emphasized: the key aspect of the public goods under consideration is that they exhibit pure jointness in consumption, or non-rivalry of benefit — an additional person's enjoyment of this type of good in no way detracts from the enjoyment of that good by others.

The first round of the exchange begins with Minasian (1964) criticizing Samuelson's conclusion that charging individuals for access to a television signal results in a Pareto inferior allocation because $P > MC$, and some individuals are

excluded who, at no cost to any one else, could be provided the good. Minasian suggests that Samuelson's position reflects a "... misapplication of an optimality rule to this problem." (p. 71). The reason is that "The problem of scarcity requires a system for allocating resources, in the first place to television, and, secondly, within television, among different types of programs." (p. 72).

Samuelson's reply notes that his position is being grossly misrepresented, for in pointing out one intrinsic aspect of the public good problem — that setting $P > MC$ results in a Pareto inferior outcome — he is not ignoring the issue of institutional choice between alternative Pareto inferior systems.

There appears to be little to be gained in sorting out who is correct about who said what, when, with what emphasis, and deciding which interpretation of Samuelson's writing is "fairer". However, the exchange is very illuminating in terms of the economic points brought to light. On the one hand, to charge for a pure public good ex post is to move away from the Pareto standard, on the other, such charges will provide important feedback and information critical to allocating scarce goods to the production of select public goods. As Minasian notes, it will not be particularly useful to freely provide a signal nobody greatly values, such as an interminable sequence of beeps, particularly if the signal is costly to provide.

An ideal system would collect the required information regarding people's demand and ensure that everyone whose marginal valuation exceeds MC receives the good. It would also include a system to collect the required revenue without distorting either of these two aims.

Samuelson's free TV option addresses the distribution criteria, but the need for information remains. Both Samuelson and Minasian are sensitive to the need for this information. However, while Samuelson acknowledges that both the public and private provision of public goods present information difficulties, he is not as inclined to assume that private provision will *prima facie* be superior at addressing the information problem.

Samuelson's response to Buchanan notes that while Buchanan's examples are inoffensive, they offer little that is new to the discussion and they ignore the critical issue of how decision makers, public or private, are to gain information as to individual preferences and optimal levels of supply. "Each man knows this function [his marginal utility function] for himself. But only God knows them for all men. Buchanan does not; I do not; the government does not; monopolists and competitors do not." ... "... that same God-like omniscience which found the solution to my local Pareto-optimality conditions can find the solution to the total optimality conditions involved in my complete theory of public goods. Again I must warn against the danger of putting off on to that *deus ex machina*, the perfectly discriminating monopolist, the exercise of God-like powers; and of favouring any private enterprise solution of the public good problem by relating it in any way to the case of the perfect discriminator." (1967, 199, 204; italics in original.)

Minasian and others (particularly Demsetz, 1964) have a more optimistic appraisal of the information-revealing powers of the market. Under a price system, viewers express their preferences and impart valuable information: " Thus it is not true

that a zero price for television programs allows extra viewers to be made better off without making anyone worse off; the "free rule" makes it impossible for the actual or potential viewer to bid for programs which represent to him a more valuable alternative." (Minasian, 1964, 73).

Minasian and Demsetz acknowledge that exclusion for cases where $P > MC$ exacts a price, but they counter that information of value is gained. Charging a price immediately tells us a minimum number of people who value the product at least as much as the price charged.⁸ Unless provision is made to monitor use, a zero priced good will not easily provide information regarding its value to consumers. Demsetz argues "... we need information which is obtained by excluding non-purchasers, *provided that the information is worth more than the exchange and police costs necessitated.*" (1964; italics in original).

Demsetz seems to jump from the need for information to the requirement to charge a price, ignoring the sometimes simple option of counting the users of a zero priced good. Turnstiles can be installed at free outdoor events, free tickets provided to concerts, photographs of crowds can be taken to estimate numbers; we can fairly cheaply gain an equivalent level of information. Charging admission give us one price quantity point on the demand schedule, monitoring free admission gives us another, it just happens the price is zero. If the private provision of the good is *competitive*, and

8. Although, since consumer information is also costly, the demand information revealed by charging is underestimated. Some who might buy the product at the current price will not because they are unaware it is available. However, the same information difficulty would apply to public goods provided for free.

the full schedule of price/quantity points available to producers, we may gain more valuable information. Yet, if private provision has resulted in a single market price for a good for some period of time, the information imparted will be a single price quantity point.

One piece of information a zero price fails to impart is whether the product is actually worth producing. The private provision does not only determine just *any* point on the demand schedule, but only those, which by themselves (or in combination under price discrimination), allow revenues to exceed cost. The possibility of producing something that is of little or no value is eliminated.⁹ Under a zero price system, since revenues to pay for the good are divorced from consumption, overproduction can occur to an almost unlimited degree, only contained by the public budget and political constraints. Overproduction can only be avoided effectively if those collecting and allocating the public funds have adequate information and the correct incentives to avoid it.

The issue that continues to underlie the discussion is whether the extra information imparted by private sale of the public good more than compensates for the individuals excluded because their marginal evaluation exceed MC. Samuelson's relative neutrality on this point contrasts with the argument that private supply can be efficient,

9. Thompson (1968) has argued overproduction is possible under price discrimination and competitive supply. However, even under his controversial scenario, output, while not efficient, does not ever exceed the point where the value of what is produced is less than what is collectively paid for it. A brief discussion of Thompson's model is provided on page 20.

since with price discrimination the private market can gain revenues and information without excluding individuals whose valuation exceeds MC. However, in order to guarantee that market forces under price discrimination will lead to efficient levels of production and/or distribution, several quite restrictive assumptions must be adopted.

Competitive Supply and Price Discrimination:

Demsetz, Thompson and Borchering

We now return to Demsetz's 1970 paper where he argues that competitive supply of a public good can be efficient. The first part of Demsetz' exposition (293-300) relies on all consumers being identical. Inefficiency is avoided, because everyone views all TV tapes, and production of tapes occurs until the value of the marginal tape is equal to the sum of all individuals' marginal benefits. Since all consumers are the same, dividing the price of the tape by the number of consumers generates a viewing price reflecting the marginal benefit to each consumer. Difficulties arise when consumers have distinct preferences.

He addresses these difficulties in the second section, (300-306), and introduces price discrimination by audience groups to allow revenues to cover marginal costs. Several unexplored assumptions are crucial to Demsetz' results. The most obvious is that the informational requirements implied by an effective system of price discrimination must be met. Further, by insisting that second run broadcasts are significantly inferior to first run broadcasts, and thereby providing the original product to the entire audience all at once, he eliminates resale, and this allows price discrimination to func-

tion effectively. However, Demsetz also seems to believe that the capacity to effectively discriminate is somehow intrinsic to public goods, rather than dependent on his assumptions that information is available to producers on consumer preference, and that producers are providing the good all at once, and only once, to all consumers.

"But what is different is that competitively priced public goods lend themselves to price discrimination whereas competitively produced private goods do not." (Demsetz 1970, 304)

This conclusion is premature. Price discrimination in public goods relies on the ability to identify sub-markets, the ability to exclude, and, most importantly, the inability of consumers to resell the product. Even if we allow that the relevant markets can be identified, and that exclusion is feasible, many public goods, particularly intellectual property, are subject to resale, because copies can be made. (The existence of copying also erodes the ability to exclude.) With the "superabundance" provided by easy access to cheap copying, both jointness in consumption and inability to exclude increases. Demsetz imposes scarcity by assuming temporal scarcity,¹⁰ and by controlling the number of copies via the controls on broadcasting inherent in a pay system.

The presentation also assumes a competitive supply of public goods. In areas such as TV broadcasts, and other intellectual property, the degree of substitutability

10. By insisting the first run is unique, he allows the product to be only available in a single distinct block of time.

between products is questionable. For run of the mill shows, with close substitutes, a competitive framework may be appropriate. Unique, highly popular shows, will constitute a monopoly, particularly if they rely on a scarce commodity, such as the idiosyncratic appeal of the leading actress. However, Demsetz's efficient levels of output will still hold under monopoly provision of unique goods, since with the same capacity to price discriminate, the producer can extract the full consumer surplus and will produce at an efficient rate.

Pigou's classic exposition of price discrimination delineates three degrees of discriminating power. First degree price discrimination charges consumers their actual reservation price for each unit, thereby extracting the full consumer surplus from the buyer. Second degree price discrimination crudely approximates first degree discrimination, by charging n different prices, and charging buyers the highest price category below their reservation price. The third degree is fundamentally different, in that the monopolist uses "some practicable mark" to separate consumers into different price groups, without any *direct* knowledge of the individuals' demands. (Pigou, 1960)

This third degree price discrimination will be the one most often used, for rarely will a monopolist have adequate information about the buyers true demand schedules. Yet, the practicable mark employed must correspond in some way to the determinants of the demand schedule, or the price discrimination will provide no economic benefit to the monopolist. The determinants of each consumer's demand will be

price, income, tastes, and the price of substitutes. One, the price of substitutes, will not be considered, as such prices are essentially exogenous to the monopolist's decisions in setting pricing categories.

This leaves three further "dimensions" of demand relevant to price discrimination. Two, income and tastes, discriminate between different consumers, the third, price, discriminates between the value of the first good consumed and the second, and so on for each individual or group. If the monopolist controls the entire industry for TV tape production, then it will not be sufficient for efficient levels of production to discriminate only on the basis of distinct combinations of preferences and incomes in each group. If the monopolist knows the total demand for each group, she will profit maximize by setting output where marginal revenue is equal to marginal cost, and charging each consumer their demand price at this output of tapes. This will not achieve efficiency. Only if she can exercise further price discrimination between the valuations of successive tapes per individual will she, by being able to extract full consumer surplus, set output of tapes at the efficient level.

The endogenous effect of changing price for each individual can usually be only crudely approximated by the rule that as price goes down, an individual will buy more units — and monopolists can attempt to extract some of this intramarginal change in consumer value by using all-or-nothing or bundled pricing policies, tapered pricing, or quantity discounts: many of these strategies are commonly employed.

Of the two remaining determinants of demand, tastes and income, price discrimination is generally practiced on the basis of income. Older people, children, students are the groups usually targeted for reduced prices because these groups are generally less well off. The discrimination is successful because the groups are identifiable: they are likely to have different demand functions reflecting their lower income, rather than taste. It is far more difficult to discriminate on the basis of taste, for there are fewer external indicators of taste than income. Furthermore, there is an established acceptance of discrimination on the basis of income, (probably due to the redistribution it accomplishes), but it is not necessarily socially acceptable to discriminate on the basis of taste.¹¹

Demsetz's discriminatory categories must also include one category that sets $P=MC$ to avoid the inefficiency arising from unnecessary exclusion, which in Samuelson's example means a zero price option. Similar inefficiency from exclusion will result if any individual group is not assigned to the correct price category. In either case, revenues might not cover costs at the efficient level of output, and output will be generally less than optimal and some consumers will be inefficiently excluded.

11. One can charge a higher price for a *better* seat for a show, and those who have stronger preference for such shows will purchase the more expensive better seats (not considering differences in income). It would be most unusual to charge more for the same seat if persons really liked the show, and less if they didn't. I suppose if one auctioned off each equivalent seat some level of price discrimination based on taste would occur, but higher-valued users would be reluctant to bid high knowing perfect substitutes were coming up for sale later. Resale would also be a problem, though perhaps no more so than with discrimination on the basis of income.

Thompson's 1964 article was a controversial contribution to the price discrimination literature. The critical result of his competitive model was the generation of oversupply, to the point where all consumer surplus was exhausted and society becomes indifferent as to the supply of the good. Thompson invokes a peculiar combination of competition and price discrimination to achieve this result. Although consumers are neither able to conceal nor avoid paying their true marginal evaluation for each additional unit good, producers cannot extract the consumer's full valuation for each inframarginal unit consumed, and must charge the marginal price for all units. Thus the "full" marginal evaluation of each additional unit is not read off the standard demand curve, since each unit consumed will lower the cost to the consumer for each inframarginal unit. This results in consumers having a de facto demand schedule equivalent to the all-or-nothing demand curve considered in standard price discriminating monopolist models. However, since supply is competitive, the intersection of this all or nothing demand curve (and not its MR curve as under monopoly supply) with the supply curve determines the total oversupply.

Borcherding describes this Thompson model as describing "the behaviour of an open perfectly price discriminating cartel." (1978, 123). However, Borcherding rejects the dynamic result of the model, because it allows for the possibility of "a foregone rent, ... a potentially powerful incentive for some sort of mutually satisfactory exchange." (124). Firms will react to this opportunity by offering (via "complex contracting") to supply some of the consumers' output at a lower price since they can thereby capture sales from other firms. The resulting competition will drive some firms from the market and reduce supply to efficient levels.

I will not delve further into what Borcharding described as "a rather arcane but interesting controversy over the efficiency of the private supply of public goods". It will suffice to note that depending on the assumptions adopted about the degree of price discrimination that can be practiced, and the level of information available to various parties, a variety of output levels may be possible, including under and over-production, as well as efficient outcomes. The most fundamental issue is whether the private sector has the information to practice price discrimination. The competitive analysis developed by Oakland (1974) does not insist on the knowledge or control implied by this level of price discrimination, and thus appears more plausible, although the conclusions of his model are unusual.¹²

Before moving on to consider how these economic insights pertain to the PDB, one last issue from the literature will be addressed: to what extent the analysis of public goods is equivalent to the analysis of joint supply from a private good.

Demsetz's Beef and Hides Example

The preliminary section of Demsetz's 1970 article attempts to show that the economic analysis of public goods with jointness in consumption is equivalent to the analysis of joint supply, as exemplified by the supply of beef and hides from steers. However, it is in many ways a false comparison.

12. For a current discussion of these articles and the efficacy of price discrimination in public goods, see Smanske. (Smanske, 1991)

Steers produce two goods, beef and leather, and the demand schedules for these two products are added vertically, (as is the case for the individual demand schedules for a public good), to give the demand schedule for steers. Further, he notes that there is competitive supply of steers and thus the analysis can then be concluded in the standard manner — by considering the intersection of the aggregate supply and demand curves for steers. According to Demsetz, the same analysis can be translated in a straightforward manner to the competitive supply of public goods.

Two points should be noted. A public good may not be subject to competitive supply. Some public goods may be sufficiently close to being unique that they become natural monopolies. Further, unlike steers where there are just two goods being produced by one animal, the market for public goods may be divided almost infinitely, or at least up to the number of consumers. To the extent groupings of consumers are possible, and there are good substitutes for the public good, then competitive supply occurs and Demsetz article is more plausible. Yet, there is a fundamental conceptual distinction that is ignored. The consumers who demand leather will not be satisfied with beef, despite the vertical aggregation of the demand schedules. However, the product being considered in the vertical aggregation of individual demand schedules for a public good is the same. Thus while a different price can be maintained between leather and beef, it requires much greater information and control of the market to practice price discrimination on the basis of individual preferences.¹³

13. Similar criticisms are noted in Samuelson (1967, 202) and summarized in Smanske (1991,22-23).

Economic Issues and the PDB

The PDB is in many ways analogous to the pay TV example considered by Samuelson et al. Whereas TV used to be broadcast indiscriminately to all within broadcast range, pay TV identifies the consumer and exacts a fee for what is viewed. Electronic data banks are able to identify users via accounts and passwords, and can thus charge for material provided, or, offer such material with no user charge as discussed by Samuelson. The analogy is not perfect. A more apt comparison may be the distinction between charging per copy of a newspaper, or, as the *Toronto Globe and Mail* is now trying, to beam copies of the paper out on an unused section of the CBC television signal.¹⁴ This trial "broadcast" of the *Globe and Mail* allows blind individuals with *special receivers* to receive the newspaper in binary form, store it on their computer, and reproduce the paper in braille or listen to it by a computer voice reading system. Such a system, if extended to all paying households would be economically equivalent to pay TV, and if no charge were exacted, equivalent to current commercial TV. (If there were no charge revenues would presumably have to be covered by advertising in the issue.)

14. The black horizontal band (seen on a television when the vertical hold is adjusted to scroll the frame) carries the information, and already contains closed captions for the hearing-impaired. The data changes the used portion of this band from solid black to black and white speckles.

The PDB is slightly different in that works are not broadcast to everyone, but selected material is provided to each individual on request. Nevertheless, the same economic issues arise: the need for, and the benefits and costs of exclusion; the decision on how to allocate resources to produce and distribute an optimal mix of public goods (and, because of the resources thus reallocated, private goods); the possibilities for over and underproduction; the underlying information needs and costs to direct decisions; and the capacity of different private and public sector mechanisms of distributing textual material to address these economic problems.

The discussion will be selective: there are too many topics to pursue in a paper of this length. One simplifying assumption I shall invoke is that the marginal cost of providing textual material on the PDB is zero. This assumption is adopted partly to focus the discussion on the problem of covering fixed, rather than marginal costs, and partly because of the author's belief that the ongoing technological developments will allow incredibly cheap storage and transmission of vast quantities of material, and hence the MC component of providing material on the PDB will be negligible. This contention is bolstered by having selected text as the intellectual property for discussion.

Despite the enormous increase in the quantity of written material, storage and transmission of this increasing volume of material is not a great technological challenge.¹⁵ Text remains a very "low density" form of information in terms of resource

15. However, indexing and organizing the material so that relevant information can be quickly found is a substantial challenge.

requirements. A detailed photograph can take 10 megabytes of storage; those same 10 megabytes can hold 5000 pages of text. To produce or even read 5000 pages of text is very time consuming, whereas a digital picture takes seconds to capture, can be viewed in seconds, and seconds later the audience can be ready for another. Digital video is even more resource intensive.

While it is often noted that the amount of textual information produced appears to be doubling roughly every 10 or 20 years, the density of storage materials, rates of transmissions, and speeds of processors are improving by a factor of two every four years. Given these rates, in the near future handling the increasing volumes of written material should become easier. However, while the congestion problem may not be driven by written material, it will still arise because of the higher density of other material, where demand for storage and transmission can easily match the increasing technological capabilities. Hence the current assumption of zero MC for textual material is not truly realistic, since such material will still be competing for scarce resources when all the demands for those resources are considered. Not to charge for text transmission and storage would subsidize text at the expense of other media. On the other hand, given the relative demand on resources by text compared to other forms of digital information, the zero MC assumption is not that far fetched, for a page of text will consume orders of magnitude less resources than a single picture or a few seconds of video. Thus, it seems reasonable to assume that the truly relevant scarce resources are the time and effort required to create a page of text worth reading.

A further implication of the assumption of zero MC for dissemination and storage of text is that it eliminates the need to explicitly exclude material from the PDB, at least for economic reasons pertaining to technical costs. However, there are other issues associated with selection and exclusion of material, such as originality concerns and advertising, and these are addressed in later sections.

The zero MC assumption also moves the analysis closer to the TV broadcast scenario discussed by Samuelson et al. The following sections will look at some of the significant aspects of the PDB in light of the economic issues discussed in the previous section.

The Options

Choosing the structure of the PDB and determining its size and impact on private provision raises the question of institutional choice. In the narrower context, we can consider various combination of rules and structures for the PDB itself, where each permutation is in some ways a slightly different institutional structure, and we contrast the relative merits and difficulties associated with each "minor" institutional variation; in the broader context there are many private sector options that can also provide most of the services of the PDB. Thus a critical component of the discussion will reflect the debate on private versus public provision of public goods.

There is a danger in concentrating too much on the crude private versus public distinction, since there can be great flexibility and variety in the actual public and private structures that can and are being developed. Further, mixed systems of provision with both private and public institutions providing similar services, as well as hybrid individual structures that are partially public and private, increase the field of choice. The distinctions amongst all such options will often be a question of nuance rather than one alternative being clearly superior. It is not the intent of this paper to investigate all such alternatives, but rather to examine a select sampling of the options and to note how each deals with the common set of issues pertaining to the provision of public goods. The emphasis will still be on the PDB, with consideration of private sector alternatives for purposes of illustration and contrast.

Compensation

There are many issues and options surrounding how a PDB could compensate authors for providing their works on the PDB. The issue is critical for a PDB storing and transmitting digital text. Digital copies of a document are totally identical to each other, copying involves no loss of quality, and copies are thus perfect substitutes for originals. While there may be *some* distinction to consumers between public and private provision of such material, they are unlikely to be quite as significant as the current distinction between private ownership of a book, and borrowing it from the library. As a result, a PDB providing material to users at a zero price will almost completely replace private systems of provision where a charge is exacted. Thus authors will want to ensure that the compensation they receive from the PDB is greater

than what they could achieve by a private mechanism, or else they would not allow the PDB to offer their copyrighted works to the public. Compensation is thus crucial to providing current, copyrighted material on the PDB.

Compensation is also critical under the PDB and private systems because it will determine the allocation of scarce resources to writing. The greater the compensation, the more individuals will be encouraged to write; conversely, with inadequate compensation writing will be insufficient to meet the demand for reading material. Finally, compensation to authors under some systems will be linked to demand, and thus provide important feedback and information on the value of works, which in turn can help parties make resource allocation decisions. The following discussion looks at two alternative compensation systems available under the PDB, also considering and building on the current methods of compensation under the PLR systems.¹⁶

One simple method of payment under a PDB would be to purchase the full copyright from the author in a single lump sum payment. Another alternative would be to have the author receive compensation in proportion to the number of readers. These two possibilities are *somewhat* analogous to the two PLR structures, where compensation is based either on the number of loans, or the simple presence of a book in the library, as determined by the stocks of sampled libraries.

16. The information provided on PLR was gathered from a book comparing various international systems (Bohony, 1983), and in the case of the Canadian PLR system, from documents and a personal interview provided by the staff at the Public Lending Right Commission.

In the case of the PLR stock sampling mechanism, compensation reflects two levels of decision-making by public officials. One is the separate decision made by individual librarians to include a work in the library, (which will include consideration of the price charged for a copy of the work or subscription), and the second is the decision by the administrators of the PLR to set compensation "per stock hit" at a particular level. Under a PDB that purchases a work outright, there will only be the single decision of the PDB administrators as to whether to stock an item; the decision primarily based on their determination of the work's "value" and the price they can negotiate with and/or offer the author.

The level of information required and available to decision makers in these scenarios is critical. Under the PLR system where only stocks and not loans are sampled, librarians must exercise their judgment as to whether the acquisition of a particular work is justified, given their subjective assessment of its popularity, its "importance" to the collection and readers, its price, and the budget constraints they face. Further, the administrators of the PLR system must set a price per hit. While the current Canadian system has uniform compensation for all types of books they include, it would be conceptually reasonable, although in practice quite difficult, to differentiate between categories of books, and set remuneration per hit accordingly. Again, this would require public servants and administrators to estimate the value of the works under consideration: this, like the librarian's choosing which texts to stock, requires faith that these individuals have both adequate information and appropriate incentives to direct their choice.

For the PDB that is purchasing the copyright on a work, the information demands are similar, but the stakes are higher. Under the PLR, librarians are only paying for a single copy of a book, and the PLR only augments the income of the author from private sales. For the administrators of the PDB, the price paid will need to be much higher, since this will generally constitute all of the author's revenue. This inflated impact of the information difficulties is minimally counterbalanced by the removal of the need to set a download revenue rate, since under this scheme the purchase cost is not linked to the number of downloads. Nevertheless, deciding on a purchase price between author and PDB administrators is a difficult negotiation because neither party has full information on the value of the work to the public.

The current PLR system based on the stocks of sampled libraries is only partially analogous to the PDB that purchases copyright. There are many libraries but only one PDB, and the sampling of such libraries provides a crude ongoing flow of information that partially reflects the popularity of a work (as determined by librarians) and allows revenue to vary between similar works and over time. (For the PLR system to be fully analogous, it would simply compensate authors with a single negotiated sum for the use of their works by all libraries, without any need for sampling.) The need for greater information is a strong motivation in establishing PLR and PDB systems where compensation is linked to downloading.¹⁷

17. On the other hand, in the debate concerning compensation under the current Canadian PLR, most authors argued in favour of trusting librarians to identify "the true worth" of works rather than measurements of value based on popularity as determined by the number of loans. (Personal interview, Hoover, 1990)

The number of readers does provide a crude approximation of the value of a work. It is a reasonable basis for comparison between works in one dimension, for if two books have been *accurately* assigned into a particular category, say spy mysteries, then the number of readers will generally be proportional to the respective value of the works. Linking compensation to the number of readers is a prominent feature of the private sector system, where royalties generate the bulk of the author's remuneration — although royalty fees and advances can exhibit considerable variation even between works of the same type. However, royalties share between authors and publishers some of the financial risk stemming from insufficient information as to the demand for particular works.

While royalties based on sales and PDB fees per download do distribute risk and provide demand information, there remains the issue of how to set the rates for different categories. In comparing the value of, say, car mechanics manuals and spy novels, numbers of copies will hardly suffice. Different rates of remuneration for different works will be reasonable whether or not they are distributed under private provision, a PLR or PDB system. There are considerable information difficulties in determining the different categories of works, and setting relative dollar values for these distinct categories, but these are perhaps not insurmountable. However, they were sufficiently difficult in that the Canadian PLR system decided not to attempt to differentiate remuneration on the basis of category, although it did exclude many categories altogether.¹⁸

18. The Canadian PLR system is considered a means to promote Canadian culture, and thus only "cultural" works are included. Remarkably, all educational works were classified as non-cultural and

It may not ever be possible to establish categories and rates of remuneration in a PDB that will achieve perfectly optimal levels of production, but a PDB may be able to experiment with different category and price structures, and thereby improve the service they provide, while keeping costs in line. One source of information will be the private sector: the authors' choices between providing their works on the PDB or private sector will be one signal; the prices charged by the private sector another. To the extent that the private sector is not squeezed out by the PDB, it will generate feedback on the remuneration scheme used by the PDB. To put it simply, no private sector indicates that the remuneration *could* be too high, and no reputable authors agreeing to place their material on the PDB could indicate that the PDB should increase its rate of compensation.

This brings us to how the private sector sets its prices. How does the information flow to the private sector differ from that received by the PDB? First there is competition: a number of competitors are trying different pricing structures for different works, and each publisher can through industry price lists, reports of sales and word of mouth determine which price levels are likely to be most successful. Of course, their own sales provide powerful feedback on the success of their price strategy. Second, the need to make a profit provides a strong incentive for the private publisher to carefully monitor all the available relevant information, to continuously

excluded.

search for new sources of information, and most importantly to react to the information available. If the private publisher fails to consider any critical category of information then the resulting change in profits will be a signal and incentive to rectify the problem.

In the public sector, it is quite possible to ignore certain information, for there is often no immediate feedback to motivate the public servant to reconsider their decisions. The fact that the current PLR system does not differentiate between different categories of books may be one such example.¹⁹ This might not be so serious under the PLR, where revenues only supplement the income of authors, but such an omission would be more significant under the PDB.

Another example of a narrow and rigid approach under a public system is the Chinese system of rewarding authors, where amongst the various remuneration schemes attempted over different periods, many relied essentially on the number of words written. A fascinating article by David Wei Ze (1992) describe the evolution and history of copy protection in China. Of course, one effect he notes of a compensation system based on number of pages is that authors became "long winded"!²⁰

19. This is not to deny that it is a considerable challenge to differentiate between different types of books, and that this is one good reason not to attempt the task. Rather, it may be because the efficiency gains that might accrue from establishing even crude compensation categories of books are not fully internalized into the public servants' decisions, (and even those of the majority of authors consulted), that such categories have not been established.

20. Not surprisingly, a similar effect was chronicled by Adam Smith. He notes that the custom of paying attorneys and clerks of the court according to the number of pages produced has "contrived to multiply words beyond all necessity, to the corruption of the law language of, I believe, every court of justice in Europe." (Smith, Book V.i.b., paragraph 22)

More fundamentally, the compensation schemes adopted by the Chinese government were indifferent to the effects on writers' livelihood and their motivation to produce. However, the Chinese authorities did share one goal in common with public libraries and the PDB: and that was to encourage maximum access to written material by the population, both by encouraging copying (but having very strict penalties on copies that were not accurate!) and by focussing on keeping book prices very low.

A second consideration is that while the private sector sensitivity to market signals may ensure a more dynamic and flexible response, it must also deal with the information problem. The private sector has also resorted to crude approximations: Dickens was also paid by the page for the serial publication of his novels in newspapers. Nevertheless, the private system allows distinct contracts with each individual, as opposed to a uniform contract under a PDB.

A final aspect of a PDB which monitors downloads without charging for works is that many individuals may choose to download material just to see if they like it, without actually reading it. A non-zero time-charge would reduce such activity and avoid distortions in the information used to allocate scarce funds to produce what must be a limited quantity of material. (The charges would not reflect scarce resources in storing and transmitting the material, for we have assumed 0 marginal cost.)

The need to address this difficulty will depend on several factors. First, one would have to ask if this "distortion" occurs with equal relative frequency for all

works, (in which case we have no distortion), or if some works are more susceptible.²¹ Second, even a non-zero charge would not eliminate such information distortions, for under private sales many individuals purchase good books they never read, and bad books they regret having acquired, though a charge definitely reduces such purchases. One solution for the PDB is to allow patrons only to download partial copies of works to see if they like them (saving them download time), and only register a download for the author if the full work is subsequently acquired.

To summarize, compensation under a PDB thus presents some difficulties, many which are also shared by the private sector. Information difficulties beset public servants and private agents trying to categorize works or set royalties or "hit" rates, although there are usually stronger feedbacks and incentives for private agents than public servants. Further the zero-price policy of a PDB could lead to distortions in the information used to set compensation, though these could be offset by simple alterations to the compensation system. In the next section, we consider distortions that are not merely inadvertent, but arise from attempts to deliberately cheat the system.

Cheating the System

The need for adequate information is a theme that permeates all aspects of this discussion. If we consider the systems of compensation contemplated under the PLR or PDB, one of the points in favour of a loans-based compensation mechanism is that

21. If a work is "fully" read by X% of users, then for no distortion it must also comprise X% of all the more "frivolous" information-seeking downloads. If all works had an equal chance of being "frivo-

it potentially uses more information to set compensation than systems using a one-time acquisition price, or library sampling. However, whenever some source of information becomes the basis for decisions affecting the well being of an individual or group, incentives are created for the individual or group to influence or change that information. In short, people may be inclined to lie and cheat.

Even under a stock sampling system, or outright purchasing system, authors and/or publishers will wish to try and persuade librarians or PDB administrators to purchase their works. Bribery of public officials is a possibility. Less heinous, but more straightforwardly, under the PLR systems based on library stock sampling the author can give free copies to those libraries being sampled. In New Zealand, the rules of the PLR system specifically prohibit compensation on works donated to, as opposed to purchased by the library; but in Canada there is no such rule, and the list of sampled libraries is available to the public. This avenue for distorting the compensation structure has not been raised as an issue in Canada, though as one public servant noted, librarians with limited shelf space do not have to accept substandard donated works.

Under a loans based PLR system, computer checks have been put in place in England to prevent authors from repeatedly borrowing their novels to increase their revenue, and any book borrowed more than 12 times in a month is disregarded

lously" downloaded, then this would distort relative compensation in favour of less popular works.

(Brophy, 1983, 101)²². Under a PDB, with compensation based on monitoring of electronic downloading, the technology increases the opportunities for this form of cheating. An enterprising author could program her computer and those of friends to repeatedly download her works from the PDB and potentially increase her revenue. Administrators of the PDB would have to find a way to avoid such abuse. One approach would be to only randomly sample downloads, for it would be difficult for an author to skew the selections of a randomly selected group of readers. Another, and potentially more controversial solution, would be to monitor who downloads what works, and not to count repeated acquisitions by the same individual as more than one hit for compensation purposes.

The problem with this latter scheme is that it would involve a government agency monitoring the reading patterns of the population, and this could well be considered an unacceptable invasion of privacy. It could be responded that such monitoring already occurs as readers check works out of existing libraries, though such information is not (I believe) yet centrally available, and thus less subject to abuse. However, the impact of the electronic storage and dissemination of information on personal privacy is becoming an area of increasing public concern. Interestingly enough, in Canada the abuse of private data bases seem to be currently generating greater concern than public information archives, possibly because there are stricter legal controls on government information banks.

22. Presumably the odds of 12 different and unconnected individuals choosing to borrow the same book for only 3 days or less (on average) were considered too small (assuming a longer loan period is allowed), and this number of loans indicated some form of cheating.

Even if a system which does not accumulate hits for repeated individual downloads of a single work is adopted, there still may be the opportunity for cheating. Depending on the compensation offered per hit and the transactions costs involved in an author contacting individuals, an author may be willing to pay people to download her works! If the

$$[\text{price per hit}] > [(\text{transaction costs of finding and contracting with willing collaborators}) + (\text{price required to induce the person to download the work})]$$

then an author will be able to cheat the system.

Obviously, the greater the hit rate, the greater the chances of such cheating occurring. If the PDB has differentiated hit rates, such as 10¢ for westerns, and \$10 for advanced texts in genetic theory, then cheating will likely be a problem in the latter category. To address this problem, the PDB might wish to combine systems of payment, such as outright purchases of material, full monitoring, and random monitoring, depending on the type of work.

Returning to the privacy issue, there may be a technological solution on the horizon. Researchers in information systems and cryptography are claiming to have designed hand-held electronic devices and systems that act as electronic policeman: they will not divulge who is specifically doing what, only if someone is doing something wrong! A recent article by David Chaum (1992) gives an example of how one such device which when owned by a borrower will communicate to a bank's computer

that the borrower does indeed meet the financial requirements set by the bank for a particular loan, yet without providing the bank with the borrower's salary and list of assets. Such a system, if it actually performs as claimed and becomes socially acceptable, might allow monitoring of downloading to prevent cheating, but not infringe on personal privacy by divulging what one is reading.

Cheating has always been a problem for almost all systems organizing human interactions, and it is not surprising that it arises with new technologies and their associated organizational systems. The next section discusses another type of cheating related to false claims of originality; followed by a section looking at some newer private sector structures to deal with cheating in the form of illegal duplication of works.

The Nature of Originality: A Common Dilemma

What is being produced when we refer to intellectual property? In a standard economic diagram, what are we measuring on the horizontal axis? Perhaps we could use the number of words, ideas, etc. and the degree of originality in putting these words and ideas together. Originality is an intractable quality. The distinctiveness of each work assigned intellectual property rights, is a difficulty at the heart of the intellectual property rights system. What is being protected? On an economic level, one wants to ensure that incentives exist for the creation of unique, and useful works. But how does one define unique and useful? When is one legitimately building on the works of others, and when is one essentially just repeating their efforts, with only trivial alterations? This dilemma is faced by authors, publishers, the courts, academia,

and of course would confront the administrators of any PDB. The information and transaction costs associated with defining the legal and economic boundaries between different works can be enormous.

Plagiarism and copying have existed for eons, but the demarcation between copying and building on another's work has never been crystal clear, and appears to be getting murkier. There are cases before the courts about seemingly nebulous concepts such as the look and feel of software interfaces. Yet, under a copyright interpretation of originality, if the underlying computer code were sufficiently different, there would not be a copyright violation. If interpreted as a patent, different standards would apply. The standards for originality in academia, where reference is encouraged but not appropriation of the ideas of others as one's own, are different again. Returning to the copyright standard, we find that because the advent of computers allows instantaneous search and replacement of words and phrases, and quick restructuring of sentences, paragraphs, and chapters, it may become easier to generate "copies" that are more difficult to identify as such. On the other hand, the recent work of two scientists at the US National Institute for Health using computers to cross reference books and journals to find cases of "similarity" shows how the technology can be used to catch and prevent plagiarism, and advance originality.²³

This problem is unlikely ever to disappear, since real human effort will continue to be a scarce commodity, and need to be rewarded in some fashion —

23. *The Economist*, June 1993, pg. 88.

monetarily, or via prestige, tenure, or whatever. There will always be those desiring to achieve such rewards without the effort, and this is not what society wishes to encourage. Thus the problem of identifying and rewarding talent and effort, will be an informational problem that is unlikely to be resolved easily, particularly by technological means.

Newer Private Sector Alternatives

On the private side the technology also provides some relief from the increasing cost of enforcing intellectual property rights, although as noted previously, it seems for every technological system of enforcement, new means of copying are discovered. A great many resources have gone into this technological game of oneupmanship, and the associated transactions costs are an impediment to efficient private sector provision of public goods. However, innovation is not restricted only to sophisticated gadgetry and programs, and there are many new organizational and business systems designed to at least partially overcome some of these difficulties. Copyright clearance systems and shareware are two such innovations.

Copyright clearance schemes, such as *Cancopy* in Canada, attempt to deal with the exploding rate of photocopying of documents in schools, libraries, businesses and governments, by negotiating copying agreements between authors or publishers and a central private agency. Such a system essentially requires voluntary participation by copiers, and therein lies a key difficulty. The average student or individual is unlikely to call the relevant copyright clearance centre to get permission and arrange payment

for the article they are photocopying. However, such mechanisms have had more success in reaching agreements with institutions, such as boards of education, where copying practices are under greater public scrutiny, and the institution does not want to be seen to be violating copyright laws. However, these copyright clearance centres have been reluctant to negotiate agreements for transmittal and storage of digital copies of texts. This is because the release of a digital copy, even from a controlled source, will provide an even easier and less controllable means to copy the text. However, since digital text will probably become the preferred future format, such deals will eventually have to be negotiated, if they have not been already.²⁴

While some systems actually attempt to keep track of what items are copied, others only negotiate overall agreements with an institution for *all* copying done, without specific monitoring. Under such schemes, less information is collected, and the means of distributing funds to authors may be determined politically, which may create inappropriate incentives.

Shareware computer software is another example of a private sector innovation to deal with digital information. This system is also essentially voluntary, for even though the authors of the software retain legal copyright they authorize free *copying*. (Although they do not condone free use beyond exploring the abilities of the product.)

24. I am not personally aware of the full variety of the material on the private data bases, but it would be surprising if there is not some material available for which the database administrators have agreed to compensate the provider, on the basis of monitoring use or some other mechanism. Economically, such a system would perform a similar function as a copyright clearance mechanism.

Producers of shareware rely on the goodwill of the user to voluntarily send the purchase price to the author. Registered users gain added benefits such as technical support, the most current version of the software, and a bound copy of the manual, and the price of shareware is generally much lower than software marketed by more traditional means.

The problem with the shareware system is obvious: voluntary revenues from users may be inadequate to sponsor an efficient level of production. Yet it has considerable merits. First, revenues have been adequate to keep, or at least launch, many firms in business, although others have moved from shareware to a full charge system. The costs of distribution and advertising are nil or minimal. A particularly interesting feature is that shareware in effect provides the public good at zero price (to those unable or unwilling to pay the software is free) and no resources are expended trying to protect or evade copyright. Shareware thus shares with public provision the Pareto superior property of not excluding anyone from obtaining benefits from a non-rival public good, but they also have in common many of the information difficulties associated with public provision of goods.

The growing number of private databases is another significant private sector source of information. Such services can offer a variety of pricing systems, combining subscription rates, online charges and download fees, access to different levels and types of service. Recently, in a manner similar to magazines and television, one private online service has begun to offset their costs by providing advertising. The inner part of the screen contains the information desired by the user, and the outer part of the screen contains advertising.

The private databases are currently expanding and offering a wider selection of material and services. The degree to which the private data bases will, by providing both public domain and copyright material, displace the public sector provision of material and forestall the development of a PDB, will depend very much on the willingness of the public to support increased compensation for contributors to the repositories of public information, such as a PDB, and the ability of the private databases to enforce their property rights over the material they provide.

Advertising

One issue that is of interest in establishing a PDB is whether to allow a public service to carry advertisements. The private online services are now beginning to use advertising to offset their costs and it could also be source of revenue for the PDB.

Advertising provides a service to advertisers, and for this reason they are willing to pay for it. Presumably, the material is not of sufficient interest to the editor and readers of the journal, so that it could be submitted and accepted at no charge, or even be paid for by the journal! Yet, it is not entirely true that readers do not appreciate advertising. Information from a producer about their product may not be sufficiently unbiased to constitute one's sole source of information, but it may still be welcome nonetheless. Certain magazines may be as popular for their advertisements as their articles. Many readers of computer magazines peruse the advertisements for prices and new products as much as for the actual articles. Further, not everyone throws

advertising flyers in the recycling bin without a glance. This said, a public enterprise such as a PDB may not wish to passively allocate publicly financed storage and retrieval resources to provide free publicity for private firms.

One approach to this issue would be to allow the reader to control whether she receives advertising. The PDB could both accept paid advertisements directly into the bank, using this as a welcome source of revenue, as well as allowing journals and other publications distributed on the PDB to include advertisements in their publications. The important component of reader control would come into play, in that she could decide to include advertisements in the material she peruses or downloads. This compromise allows advertisers to communicate to those who are seeking such information, but not inflict unwanted sales communication on those who do not. Or, perhaps less controversially, advertisements could be included, and the reader herself could decide to erase such material after downloading. While traditionally each medium has had different costs for consumers seeking to avoid unwanted advertising, as these media collapse into digital form, such evasion may become cheaper.

The advertising problem is already being anticipated in some of the private sector digital publishing experiments. A recent article in *Business Week*²⁵ outlines how a new generic page layout software program will allow complex magazine pages to be easily displayed on computer screens, complete with images, titles, fonts, and searchable text (as opposed to text stored as an image). Amongst the implications they dis-

25. June 28, 1993, pg. 56

cuss for companies contemplating publishing their magazines electronically, is the fact that readers can more easily skim over, or even erase digital advertisements, and as on the PDB, this would affect the willingness of advertisers to place ads with the magazines.

In the public sector, there have been moves to offset the costs of some public services by emphasis on user fees, and more recently, private sector sponsorship. I recently perused a publication by the (then) federal department of Energy Mines and Resources where the substantial number of private sector advertisements made it difficult for me to realize that the brochure was in fact about a government program. A recent article in the *Montreal Gazette* (Austen, 1993) noted that investigation of private sponsorship of government programs is increasing, but also quoted one public servant as saying that such an approach must be carefully considered in each case, for we would not want a federal budget brought to us by McDonald's!

Advertising can be considered a means to jointly supply two goods more efficiently than producing both goods separately. Advertisers gain easy access to captive and readily defined audiences, and readers benefit from lower prices. However, it is also important to note that if one makes the assumption that advertising is not simply a useful source of information, but possibly sometimes a bad for consumers, and a source of dissipative competition, then in a larger context readers may not receive any significant overall financial break from the advertisers' contribution to the cost of a public good. Consumers pay for the advertising through the increased cost of the

products advertised. A consumer might wish to pay \$15 instead of \$5 for an automotive magazine without advertising, if she could thereby eliminate the advertising costs from the purchase price of her car.

Advertising costs can also be seen as a tax on consumption: a tax which is often used to subsidize the production of some public goods. Under this view, the issue becomes whether the public prefers direct taxation or supporting advertising costs as the means of paying for the provision of public goods. The answer will probably reflect the extent to which advertising is seen as a good — a source of information: or a bad — a source of disinformation and irritation.

Price Discrimination and the PDB

The brief discussion of price discrimination beginning on page 15 pointed out that by exercising price discrimination private producers could both cover the costs of extending provision to a greater number of individuals, and achieve more efficient levels of output. It was noted that price discrimination based on indicators of the income component of demand was both easier to implement and possibly more socially acceptable, than price discrimination that differentiates on the basis of tastes. Under a PDB, it would be possible to incorporate some elements of "income"-based price discrimination in its remunerative and allocative structures.

Under one PDB structure downloads of each individual were monitored to prevent authors or their agents from cheating by programming their computers to repeatedly download their works. This monitoring would also allow downloads to be cross-referenced via government taxation files to the income of the individual acquiring the work. remuneration to authors could be based on a schedule of hit rates directly proportional to the incomes of readers. As under a standard private system of income-based price discrimination, works which appealed to richer readers would generate greater income than those that did not.

This somewhat esoteric proposal raises some interesting issues. First the scheme is likely to be unacceptable socially, despite its having allocative implications which better reflect the workings of the private sector, and its increasing efficiency by linking supply more closely to demand.

The first reason is simply the invasion of privacy entailed which is unlikely to be politically acceptable.²⁶ The second reason for rejecting this proposal is that under this PDB system of "price discrimination", the rich get more "\$ votes" than the poor, but are not required to actually pay anything. (Though if taxes are progressive, they may indeed have already paid the proportional amount.) Under the forms of income-based price discrimination normally practiced by the private sector individuals must pay the higher amount that reflects their higher-valued use. Overall, this example

26. The private "electronic policeman" devices alluded to on page 38 might address this concern.

highlights the issue as to whether price discrimination is currently acceptable on the basis of increased efficiency, or for redistributive reasons.

Further Points

This section has addressed some, but not all, of the economic issues identified at the front. Two in particular need further elaboration: the possibility of under/overproduction, and the *nature* of the balance that might pertain between the PDB and private sector in providing written material. Both these issues are addressed in the following section, albeit in the context of a restricted model. However, the arguments raised are largely applicable to the provision of "generic" public goods as well.

III. THE BALANCE BETWEEN THE PDB AND PRIVATE PROVISION: CONSIDERATION OF ONE TYPE OF PUBLIC GOOD

This chapter examines aspects of how the PDB might function within the context of the existing private system, but only with regard to one type of good. Now it has been argued that once a novel is available on the PDB, then that precludes it being offered by the private sector (and vice versa), which leads to the question as to whether authors will choose the PDB or the private sector to distribute their works. This chapter analyses this question, assuming that the authors' remuneration will be the deciding factor. It further offers some insights on the balance that could be maintained between private and public sector provision of this material to the public.

The analysis is restricted to looking at a specific type of material, here called "Harlequin Romance" novels, or HR public goods. The HR public goods are non-repetitive (NR), perfect substitutes for each other: any HR is as satisfying to read as another, and one is indifferent between any two *unread* novels. Once read however, a HR novel becomes essentially worthless to that reader, and will not be a substitute for any of the unread HR novels. The paper considers how the HR type material would be provided — exclusively by the market place (building on a model developed by Oakland in 1974); only by the PDB; or under a joint system — and notes the equilibria that could result.

Private Provision: A Geometric Exposition Based on the Oakland Model

This section reviews and builds on the competitive model of the market supply of public goods first developed by Oakland²⁷, though the geometric flavour of the exposition and the positions taken on some minor issues, deviate from Oakland. One point that is not always easy to follow in Oakland's article is the difference between a unit of a good that is consumed, and a unit that is produced. This critical distinction is maintained here by the use of the terms *novel* and *copy*: a *novel* is what the author writes, whereas a *copy* is what the readers consume. One novel can physically exist as any number of copies.

A key feature of the model, not made explicit in Oakland, is that it deals with relatively uniform public goods, which I refer to as HR public goods, that are non-repetitive perfect substitutes for each other. This can be contrasted with a model that assumes that individual novels are essentially unique, and that the novelist has monopolist power over its distribution. The monopolist model may reasonably describe the economics surrounding a unique masterpiece, such as T.S. Eliot's *The Wasteland*, or Bernard Mandelbrot's *Fractal Geometry of Nature*²⁸, but it may be not be applicable to

27. The choice of the Oakland model over other models of competitive supply was prompted by its more plausible and standard assumptions regarding the information available to producers. The assumption adopted by Thompson, Demsetz and others — that producers had sufficient information about consumer preferences to practice significant price discrimination — seems unlikely, particularly for a product such as "Harlequin Romances". Oakland's model makes no strenuous informational claims about producers, and thus is closer to the standard assumptions concerning a competitive market.

28. I had some difficulty providing examples of "unique masterpieces" that were sufficiently contemporary that copyright had not expired. I found three sources of this difficulty: one, that such choices often seem subjective; two, masterpieces are often not recognized as such until long after the author's demise; and three, because works are often considered unique because they are the first to

more interchangeable works, such as the latest paperback western, or Harlequin Romance. A large body of traditional economic work already exists in the area of monopoly provision of a public good. An intermediate framework could also be established by easing the rigor of the monopoly assumption to allow for some level of substitutability between novels. The analysis would then likely follow the developments in the area of monopolistic competition.

In contrast, this competitive model, by assuming the goods considered are perfect non-repetitive substitutes, ensures novelists will not have monopoly power, and this moves the analysis closer to the standard competitive model. However, imposing a competitive framework cannot purge the model of the idiosyncrasies engendered by the *jointness in consumption* characteristic of public goods.

Public goods are usually categorized as exhibiting "jointness in consumption" and "inability to exclude". In capitalist economies, the problems posed by this latter characteristic are partially addressed through the legal constructs of copyright and the patent system, but the continued existence of plagiarism and illegal copying of copyrighted and patented material illustrates that this is by no means a perfect system. However, for the exposition in this section these problems are not addressed, and intellectual property rights are deemed to be perfectly and costlessly enforced.

announce a discovery, but are then followed by many fine works on the topic which would in fact be good substitutes for the originating work. Evidence of this third case are the many people who do not read the seminal works, but rely solely on secondary sources. The Mandelbrot example may be open to this latter criticism.

Variable prices amongst essentially identical goods are often associated with price discriminating monopolists, where the monopolist has some capacity to segment the market, and the problem of resale has been at least partially resolved. The model presented here is unusual in that variable pricing is the result of the competitive supply of a public good, albeit HR goods.²⁹

A monopolistic model generates a different price for each novel, based on the assumption that each novel is unique, with its own distinct demand schedule. In the following competitive model each HR novel faces a market demand schedule determined for the genre as a whole. Yet instead of a market-clearing price, the model predicts a schedule of prices determined by the combined readers' diminishing utility for each subsequent novel read.

29. In terms of providing predictions to distinguish between the two alternative assumptions, that goods are unique or substitutes, the variable price conclusion in itself will not be of assistance. Variable pricing will be observed both in the market generated by a monopolistic model and this competitive model, even though the nature of that pricing is entirely different.

Assumptions

The following are some of the key assumptions and characteristics behind this competitive model:³⁰

1. The model deals only with novels in a particular genre, though it should generally apply to any type of "public" good with high fixed costs, low marginal cost of reproduction, and subject to competition from these "non-repetitive" substitutes.
2. Number of novels (N) refers to distinct, new, novels produced and read in the market per time period. Number of *novels* does not refer to the number of *copies* (n) of novels available.³¹
3. Each novel in the category is a "non-repetitive" perfect substitute (herein referred to as an NR perfect substitute) for another, since no reader will read the same novel twice. To illustrate: a reader having decided to acquire two of three novels (A,B,C) available within the

30. While the model presented here is essentially identical to Oakland's, Oakland does not explicitly make all these assumptions. In a footnote he notes that he begins by following the example used by Demsetz of television tapes which are produced at constant costs, for which consumers have identical preferences, and which can be costlessly transmitted.

31. In general, capital letters are used to refer to values associated with *novels*, and small letters for those pertaining to *copies*.

given genre, would be indifferent between any of the 3 possible combinations of two distinct novels (AB, AC, BC), but she would not choose two copies of the same book (never AA, BB, or CC).

4. Novels produced in a previous period are not substitutes for novels written in the current period. This assumption prevents products that are produced costlessly, in terms of the present period, from competing with those novels just written at a positive cost to the authors.³²
5. To begin, all producers of the novels (writers) have the same constant marginal cost in writing a novel, set at MC. (This assumption will be relaxed later.)
6. The marginal cost of producing copies of any novel (mc) is assumed to be 0.³³

32. This is not entirely plausible. *Prima facie* there is no reason to assume that a reader would not enjoy reading older books as much as the current fare. Some justifications or modifications can be put forward, including extending the period of time under consideration. One can also assume that there is some change in quality in novels from different periods: language usage changes over time, and history progresses. Readers may not wish to read novels that are neither contemporary in setting nor style.

This argument may have greater merit in describing the music field, where tastes evolve more rapidly. Even here, however, there is competition from previous eras, and I have even encountered one contemporary pop-musician actually complaining about the excessive amount of money channeled to classical musicians playing "dead" music from the past.

33. This is a simplifying assumption that allows us to concentrate on the creative cost of writing a novel, rather than the mechanical costs of printing, marketing, distribution etc. However, in any empirical investigation of the book market, such costs will be significant. The model also assumes readers are fully informed as to what novels are available and at what cost, and there are no extra costs in acquiring a copy of any novel beyond the purchase price. This 0-cost simplification allows the model to focus on a single fundamental difficulty of the commercial production of public goods, that of cover-

7. Intellectual property rights are deemed to be perfectly and costlessly enforced. No one reads a novel produced during the period considered without paying the full price to the author (No resale). The costs of enforcing property rights may be considerable, but they are ignored here to focus on the competitive aspects of this model. (Oakland also assumes costless enforcement of intellectual property rights, but does not prohibit resale. The impact of resale is discussed in footnote 43.)

Following these assumptions, we can move on to consider the dynamics of the model. Novels are considered normal goods, and thus each individual will have a downward sloping demand schedule for novels. The vertical sum of all the individual demand curves will determine the market demand for novels, as illustrated in Figure 3.³⁴ N^* is the optimal number of novels to produce, where marginal value equals marginal cost ($MV=MC$). This is the efficient outcome, but it is not the likely market outcome.

Under competitive supply, the equilibrium number of HR *novels* will be determined by the "sub-market" for *copies* of the novels. Customers are charged per copy, and the novelist gains revenue to cover her cost of writing the novel from these

ing the fixed cost of production.

34. All Figures are contained in Appendix A.

sales. Because a given novelist's book, or books, have identical value to every other book in the genre (at least before the novels have been read), there is no reason to assume that her novel would receive anything other than a proportional share of sales, *assuming a common market price for all copies.*

In the following two stages of the analysis two supply-side factors will be distinguished and considered separately: one is the influence of competitive entry into the market when price is uniform and unvarying, the second considers what happens when suppliers are "free" to set price, and market entry is still unconstrained.

Analysis Assuming a Common and Fixed Market Price.

This section is included mainly for the purposes of exposition. Some of the insights will apply to either the fully competitive, variable price model; or the fixed price analysis of novel supply and demand under a PDB. While both this section and that on a PDB assume a uniform and unvarying price, the analyses differ in that in this section readers must actually pay the price, whereas under a PDB readers acquire material at no charge.

Assuming a fixed price per *copy*, consider how this affects the marginal revenue curve for *novels*. In Figure 1's diagrams for individuals 1, 2, and 3, we can see how each individual demand curve is separated into three regions by a given price, p_i — two triangles, one above the price line, and one to the right of the quantity line; and a rectangle, representing that individual's expenditure on novels at that price. For

any given price, p_i , the top triangle represents the consumer surplus from books purchased at p_i , and the right triangle represents the value to that consumer of reading further books, which at this price are not purchased.

The sum of all the rectangles representing individuals' spending at the price p_i , will be the area TR_{p_i} within the rectangle in Figure 2, and the area under the innermost MR triangle (Bp_i) in Figure 3. In Figure 3, the vertical height of the marginal revenue function MR_{p_i} above each subsequent novel N_i represents the (vertical) sum of the purchases of all buyers for their i th novel.

Assuming a common and fixed market-price, (without for the moment questioning how this price is set), we can consider the novelists' responses. In Figure 2, we have a horizontal sum of the individual demand curves, which allows us to determine the sales of copies for all novels at any given p_i . Because consumers are indifferent between novels, and all novels are offered at the fixed price, a novelist's revenue (per novel) will be determined by the average revenue curve, equivalent to the area of the rectangle, $TR(p_i)$, divided by the number of novels produced in the market. This must be greater than or equal to her opportunity cost, MC , of producing the novel:

$$AR = \frac{p_i \cdot n}{N} \geq MC$$

where n is the total number of copies sold in the market, and N is the number of novels.

At any given price p_i , novelists will continue to enter the market until the above expression reaches equality. With a competitive number of novelists, the intersection in Figure 3 of the $AR_{p,i}$ curve with the MC line determines the "equilibrium" number of novels $N_{p,i}$. Any new novelist entering the market at price p_i , will drive average revenues below marginal cost, MC.³⁵

Considering Different Common-Market Prices

Continuing to consider a common price (*for copies*) amongst producers, we can ask what happens when p_i is varied?³⁶ First we refer to the diagrams to get a clear overview of such a system. We can see in Figure 2 that, starting at the vertical intercept, as p_i decreases the area of rectangle $TR_{p,i}$ would begin to increase, reach a maximum, and then decreases as the price continued to drop towards 0.³⁷ Since the area

35. The analysis at this stage is not precisely the same as Oakland's, (pg. 932). Here, because of the common and unvarying price assumption, the market is shared, and authors receive average revenues. Oakland's simpler formula, $P=c/n$, (where c is MC (also fixed), P is the price *set by the producer*, and n is the number of copies (#C)), applies to the single producer, and simply requires that revenue equal MC. If we impose the common and unvarying price restrictions adopted in this section, and fix P , then since MC is fixed, n will also be constrained — ie. all producers would sell the same number of copies and receive average revenues.

36. The price is still considered fixed in that novelists are not free to set price. Rather, we are considering the change in outcome if the common price is fixed at different levels.

37. The diagrams and exposition use linear demand functions for expository purposes. Of course, for atypical demand functions (such as $P = 1/N$), MR will not be greater than 0, and the analysis would not hold. However this is not a telling restriction, for demand functions where $MR < 0$ are also not amenable to many typical economic analyses, such as the standard exposition of monopoly supply.

under the marginal revenue function $MR_{p,i}$ also has area $TR_{p,i}$, (the triangular areas will always be equal to the rectangular areas), then the triangular area under the sequence of marginal revenue schedules will similarly increase and decrease in size. This is illustrated in Figure 4.

The horizontal and vertical intercepts of this sequence of different marginal revenue curves in Figure 4 are also of interest. As the unit price per copy drops, readers will purchase more novels than at a higher price, and fewer readers are excluded. Thus on the horizontal axis the intercepts of the MR curves (each MR curve determined by a lower p_i) move out continuously.

On the vertical axis the movement of the intercepts of the curves generated by lowering the price per copy is more complicated. The vertical height of this intercept represents the revenue earned based on consumers' aggregated reservation prices for the first novel read. At very high prices, earning per copy will be very high, but few copies will be sold. As price per copy decreases, the lower price is offset by the greater number of copies sold, and the revenue from sales of the first novel will thus initially increase, and the intercepts will rise up the vertical axis. However, once the theoretical revenue maximizing price for copies of the first novel is reached, revenue will decline as the price per copy is further lowered. Increased sales are now offset by the lower price per copy, and the vertical intercept begins to move back down the axis. This pattern is traced out in the revenue curve for Bk1 in Figure 5, where the height of the curve theoretically corresponds to the heights of the vertical intercepts in Figure 4.

Output Under a Fixed Common Market Price

It is not surprising that under a fixed common market price both over and underproduction occur, depending on where the fixed price is set. For instance, in Figure 3, the AR curve has been drawn to intersect the MC curve at $N_{p:i}$, well within the optimal level of output N^* . For higher or lower $p:i$'s, or different patterns of individual demand, the AR curves will intersect MC at different points, but generally not where output equals N^* .

The following two numerical examples also show that with a price that is arbitrarily set and inflexible, both over and underproduction of *novels* can occur.

Underproduction (Assume *mc per copy* = 0)

		Reservation Prices		
	<u>Novel</u>	<u>1</u>	<u>2</u>	<u>3</u>
<u>Readers</u>				
10 of Type A		4	3	1
10 of Type B		3	2	1
10 of Type C		5	3	2

If the MC of writing a *novel* were constant at 37.5, and p in this market were fixed at 1.5, then underproduction would occur. Three novels should be produced, since the value of this third novel is 40, which is greater than the 37.5 it costs to produce. Yet, at a price of 1.5, if production of 3 books is assumed, 70 copies of the novels will be purchased, [10·(2 books for A + 2 books for B + 3 books for C)] for revenues of 105. Revenues per novelist drop to 35, below MC, and thus the third

novel will not be produced although it is efficient to do so. If two books are produced, 60 copies will be sold, for remuneration of 90. This will provide revenue of 45 and profits of 7.5 per novelist.

The critical factor in the underproduction is that the demand for the 3rd novel is split between those consumers whose reservation price is above and below the set price. Thus despite the total value of the 3rd novel being above MC, no single price will capture the full value of this demand.

Overproduction (Assume *mc per copy* = 0)

	Reservation Prices		
	Novel 1	2	3
Readers			
2 of Type A	6	5	1
2 of Type B	6	4	1
2 of Type C	5	4	2

If MC of writing *a novel* were constant at 10, and *p* in this market were fixed at 4, then overproduction would occur. Only two novels should be produced, since the total value of the third novel in this world of six individuals is 8, but it would cost 10 to produce. Yet 12 copies of the novels would potentially be bought at a price of 4, two by each individual, with total revenues of 48. Now if there were only two novels produced, revenues would be divided amongst the two, each selling 6 copies, receiving 24 but facing costs of only 10, for a profit of 14. However, other novelists could enter, until a fourth novelist reduced average earnings to 12, selling three copies each. (A fifth would drop average revenue below the MC of 10.) Thus in this scenario, double the efficient level would be produced. In this case, overproduction is

a reflection of the high reservation price for the 1st and 2nd novels read, in comparison with the 3rd and subsequent novels. That, in combination with fixed price and an AR pricing structure drives the overproduction.

One single market price case would be monopolistic production of all HR novels in one genre, where price would be uniform across novels, but the monopolist is free to set the common price. A monopolist constrained to provide all the novels in the market at a set price per copy would attempt to maximize profits, defined as total revenue minus total cost.³⁸ In Figure 4, this would entail choosing a price per copy, p_i , that resulted in largest area under the MR curves and above the MC line. This would not necessarily coincide with the price that maximizes the size of the revenue rectangle in Figure 2, since such revenue rectangles would include revenues for marginal books, whose revenue would not exceed MC, and thus would not be produced by the monopolist. Production is less than optimal, and this is the typical single-price monopoly result. The overproduction described in the competitive fixed common price setting would not occur, since it was based on producers facing an AR curve, whereas the monopolist considers the actual MR curve. How this monopoly output compares to the competitive outcome predicted by the model will be addressed below after fully describing competitive supply in this model.

38. See footnote 42 for references on monopolist models without the common price constraint.

Introducing Price Flexibility

The foregoing scenarios imposed a fixed common market price, yet, except for the case of the monopolist, where they actually can control price and output, it remains to be seen whether a single market price would be established under competitive conditions. In fact it would not.

First we can ask if there are incentives for individual novelists to change their price from a market rate? When p_i is in the upper part of the curve in Figure 2, a decrease in price increases total revenue, and it will be in both the individual author's and the collective group of authors' interest to lower the price per copy. The group will be initially better off because average revenue will increase. However, this would be offset by more novelists entering the market and forcing average revenue back down to marginal cost. Once we enter the lower half of the curve, a *general* price decrease would decrease total and average revenue.

However, any novelist sharing average revenues at a higher price, and earning revenue just equal to MC, will also have an incentive to undercut the common price. She could move to a lower price, say p_j , and unless she is joined by others, she could extract the full revenue for book 1, $MR_{p_j}(1)$, at this new lowest price. However, other novelists can also either match or undercut this new price, and drive the price down further. The low-price novel will extract all sales of "first-bought" novels, and this is the critical dynamic of the model. We can anticipate that the downward movement of individual novel prices would continue, as long as

$$MR_{pj}(1) > MC.$$

The price for the first novel will be driven down until revenues again just cover MC. No one will undercut this price, since it is equal to MC. No one will join this low cost producer, since they would have to split the revenues for the first two books. (If the MR revenue from the first novel at that price is just equal to MC, then the MR from the second will be less than MC, as will AR for the two books.) Thus this will designate the highest possible price, $p:\max1$, for the first novel purchased by consumers³⁹.

Similarly, the remaining novelists will jockey to sell the second novel, since they cannot profitably compete if copies of the first novel are offered at $p:\max1$. By a similar reasoning as used for book 1, the price charged per copy of book 2 will be driven down competitively until the MR for book 2 is equal to MC. This price is designated $p:\max2$.

This process will be repeated for each subsequent novel, determining a series of prices, $p:\max1 \dots p:\maxk$, where $p:\maxk$ is determined by the outermost intercept of the MC line with the series of MR schedules traced out as $p:i$ is varied.⁴⁰ In general,

39. $p:\max1$, is the lowest price charged for a book in the market, but it is the highest price one can charge and not be undercut in price.

40. Oakland claims that the maximum number of distinct prices is equal to the total number of individuals in the economy. This may be mathematically possible, but seems highly unlikely. Preliminary thinking on the subject suggests that a complicated relation would have to be maintained between the number of purchasers, and the reservation price of the "marginal" purchaser, at all prices. The change in the reservation price of the marginal consumer (with the lowest value) for the last novel produced/purchased would always have to be just equal to the reciprocal of the number of current pur-

the j^{th} book produced will be sold at price $p:\max_j$, and receive $TR_{p:\max_j(j)}$, which is equal to MC. As in most constant MC, competitive models, producers make 0 profits. Earnings are equal to MC, and any attempt to extract profits by raising prices would result in revenues greater than MC. This would provide an opportunity for a competitor to marginally undercut this price, and capture the profits themselves. The incentive to undercut the price would only be eliminated if all producers are earning no more than the constant MC.

Figures 5 and 6 illustrate the factors that determine what price will be charged per copy, and how many novels are produced in the market per period. (In these figures, the prices are $p:\max_1$ through $p:\max_5$, for the five novels produced.) Each curve in Figure 5, traces out the revenue generated by sales of books Bk1 ... Bk6 purchased by consumers at different prices. Consider a vertical line cutting through all the curves at some price, say $p:\#$, after the curve for book six intersects the horizontal axis. If we added the vertical heights of all the book curves, Bk1..Bk5 along this vertical line, the sum of these heights would be the height of the total revenue curve for the novels at price $p:\#$. That height would equal the area of the rectangle that would be generated in Figure 2 by price $p:\#$, or the area of the triangle under $MR_{p:\#}$.

chasers. Thus a rise in price proportional to the number of consumers would force the last consumer not to purchase the next unit.

A further complicating restriction is that if the population is W , for W prices to occur, there must not only be at least one consumer wishing to read W novels, but she must be willing to pay at least the full cost of production for the last novel.

Each rectangle traced out in Figure 2 by different prices $p:i$, can be divided into sub-rectangles of height $p:i$, but varying base lengths, corresponding to sales of purchases of consumers 1st, 2nd, 3rd, ... novel.⁴¹ The area of these sub-rectangles is traced out in the B_k curves of Figure 5. With the variable pricing predicted by this model, each novel will acquire the full revenue dictated by the sub-rectangle determined by the price charged, and the novel's position (1st, 2nd etc.) in the sequence of novels purchased and read. If you charge the third lowest price, you will gain the revenues from sub-rectangle for B_{k3} , at that price. The model predicts this revenue will be equal to MC , thus this price will be $p:\max3$. At price $p:\max3$, the area of the sub-rectangle for B_{k3} will be equal to MC , which is equal to the height of the revenue curve for B_{k3} , as traced out in Figure 5.

Figure 6 is essentially a blow up of the MC line in Figure 4, showing where the MR curve for each price, $p:\max1 \dots p:\max5$, and $p:6$, showing that the MR for each novel is equal to MC . (Recall from Figure 4 that the MR curve associated with each price is distinct, having different intercepts and slope.) A sixth book will not be produced, since maximum revenues for B_{k6} occur at price $p:6$, and yet these revenues are less than MC . The equilibrium price for each i^{th} novel sold is determined by choosing a price that will cause the resulting MR curve to intersect the MC line precisely above the point designating that i^{th} novel.

41. Note that if there is a common market price, consumers will not distinguish between novels, and each novel is likely to have an equal share of these sub-rectangles, sales of consumers 1st, 2nd, 3rd ... books.

The competitive result generates less novels than the optimal number N^* , since the MR curve based on any fixed price per copy is always inside the market demand curve (vertically summed) for novels. The underproduction occurs because in the individuals' demand schedules, those areas above and to the right of the revenue rectangle line will not be registered (See Figure 1). The price mechanism here will neither extract the value of consumers' surplus above the price line, nor will it allow the area to the right of the vertical quantity line, representing the non-purchasers' value of works not purchased, to be registered. A single price cannot extract high demand readers' consumer surplus for more novels and add it to the non-purchasers' value for those novels, and so some novels whose total value would exceed MC are not produced.

However, if all consumers have identical preferences and incomes (identical demand schedules), then both the vertical and horizontal demand schedules will simply be "stretches" (by a factor of the number of readers) of the typical reader's demand schedule. In this case, it can be shown that this model's "competitive" result will generate the efficient number of novels. This is because the last novel produced, say novel i , earns the maximum revenue possible for that novel, which the model predicts will be equal to MC. In the case of n identical consumers, the maximum revenue will be $n \cdot (p:i)$ (where $p:i$ is the prototype consumer's reservation price for the i th novel). But $(n \cdot (p:i))$ is also the marginal value of the i th novel, and since novels will be provided until $(n \cdot (p:i))$ is just equal to MC, output is efficient.

Except under the specific conditions detailed above, the "competitive" result produces less than the optimal output, N^* , but not necessarily more or less than the common-price monopolist output. For a monopolist charging a single price, output in this constant MC case is determined by the revenue-maximizing price per copy, p^* , (designated $p:4$ on Figure 4), that maximizes the size of the triangles or under the MR curves and above the MC line in Figures 3 & 4. (Similarly, this would be the price that maximizes the "traditional" TR curve, the vertical sum of the individual revenue curves in Figure 5 *when they are above MC*.) This would set output at N_{Mon} , where MR_p^* crosses the MC curve. (In Figure 4, $p:*$ has arbitrarily been set equal to $p:4$ to illustrate how this equilibrium point might relate to other common price equilibria.^{42,43}

42. The monopolist in this case can profit by a similar form of "price discrimination" as that which results from this competitive model. However, this must be clearly contrasted with the form of price discrimination that is sometimes used by monopolists when providing *private* goods. In this model the lowest price is charged for the highest valued novel (first read), which is precisely the opposite strategy that a profit-maximizing price discriminating *private* good monopolist practices when possible.

Several variations on the monopoly provision model where the monopolists can avail themselves of a somewhat similar "reversed" type of price discrimination are given in articles by Brennan and Walsh (1981), Brito and Oakland (1980), Burns and Walsh (1981), and are also discussed in Smanske (1991).

43. The reverse order price discrimination of this competitive model also avoids one aspect of the problem of resale that prevents many attempts at price discrimination. In this model, buyers of novels sold at a higher price per copy, have already purchased all the lower priced novels available. Thus there is no erosion of the sales of the higher priced novels by lower priced fare. Since the lower priced novels have already been purchased and read by readers of higher priced novels, they cannot be a substitute for a new, unread novel. This point is also made by Oakland.

However, on a broader basis, Oakland does not acknowledge that resale is still a potential problem. Some readers may choose to wait to read their first novel of the period, until another reader is finished with it, and purchase it second hand at a price less than P_{max1} . This possibility has been assumed away in this presentation of the model by assumption 7, which insists that all readers pay the full price charged by the author for their copy of her novel. In reality, second hand books sales are just one facet of the difficulty in controlling, and extracting compensation for, the fruits of intellectual effort.

Variable MC

Relax the constant MC assumption and we obtain similar results. In the constant MC case, it did not matter if individual authors could produce more novels at the given MC, as long as there were sufficient numbers of other authors in the market to force the competitive result. Now, we can proceed with either of two assumptions. One is that authors for novels in this genre are scarce, but essentially all have the same ability. Each novelist can, at increasing cost, produce more novels in the given time period. The equilibrium result will also be a variable price schedule for the first novels produced by each author. The MC curve will shift up for the set of novels representing each novelists 2nd novel, (as a result of the greater cost incurred by the authors), but a similar pattern of variable pricing will occur at the higher price. (See Figure 7a) Again, under this scenario, producers will make no profits.

Under the alternative scenario, an essentially unlimited number of novelists are available, but different authors have different skill levels, and a different conclusion results. The lower-cost authors can extract some rents for their skills. Say novelist A is the low cost producer for the first three novels, with costs MC_A , and Novelist B, can produce two books at MC_B , between A's costs, and the rest of the producers who can produce at the base cost, MC_M . Novelist A can charge for books 1, 2, and 3, the same distinct prices for each book, p_1, p_2 and p_3 , as would be the equi-

librium prices in the simpler, constant MC model, where $MC = MC_M$. Her MR for each book would be MC_M , but her costs would be MC_A , so she could extract producer rents of $(MC_M - MC_A)$ on each book.

Similarly, novelist B will also charge the "going rates" for books 4 and 5, $p_{\max 4}$ and $p_{\max 5}$, and receive rents of $(MC_M - MC_B)$ per book. The rest of the producers will set prices for books 6 and onward at the same prices, $p_{\max 6}$, $p_{\max 7}$, ..., just as in a constant MC_M model, and earn revenues equal to cost of production. These results are illustrated in Figure 7b.

These results are similar to a competitive market for standard goods, except for the variable price result. Prices are set in a way that the MC for the *marginal* producer is equal to marginal revenue, and lower cost producers extract rents based on the difference between their costs, and the costs of the marginal producer. Thus in a manner consistent with Ricardo's analysis of the rent on land, it is the marginal producer, or in Ricardo's case the marginal piece of land, that determines the rents to the efficient producer.

Note that for all authors, including the low cost writers, there is no need to distinguish between the producer of the first and last good sold. Even though A was presented as having sold novels 1, 2, and 3, this would not necessarily be the case. She would be indifferent between selling any novels within the equilibrium maximum number, since each novel receives revenues of MC_M , and thus provide the same profits. This allows for the possibility that the low cost producer would not in fact be the low price, high volume, seller.

HR Public Goods and the PDB

Let us now consider how a PDB would provide such HR novels. We assume that the public mechanism or body that determines the revenue function is aware of the similarities amongst the works in this genre, and thus whatever overall formulae are used for the full variety of material on the PDB, it will assign remuneration for these HR novels at some constant level, say k . k is *not* the author's total revenue, but a revenue *factor*, with the author's total revenue set at $(k \cdot \# \text{ of downloads})$. The revenue earned is paid to the author from government funds.

In the section describing market provision under a common fixed price, each novelist received the average revenue, and the analysis considered an AR curve associated with the MR curve determined by a particular, set market price. Novelists entered the market until average revenue just covered MC. Under a PDB, novelists will also receive an average share of the total revenue. With non-repetitive (NR) perfect substitutability between novels,⁴⁴ a constant 0 price to readers, and in the absence of any information costs to readers, there is no basis for why one novel will be read/downloaded more than another. However, the average revenue curve in the case of the PDB will be quite different to that provided under market conditions.

44. It has been an uncontested assumption that both under private provision, and under the PDB, that all novels are indeed perfect NR substitutes, without stating how individuals working in either sector can recognize a novel as belonging so perfectly to a particular genre, that NR substitutability holds. One mechanism used at Harlequin Romance is to provide very strict guidance to authors as to plot, vocabulary, writing styles, and a lists of do's and don't's. (Mallet, 1993) Such an involved and directive approach would be difficult to administer under a PDB.

Under market conditions, readers must actually pay for the books they read, and thus the MR curve and AR curve reflect readers diminishing marginal utility as more novels are read. Under a PDB, readers can read for free, and their decisions are divorced from the novelists' revenue factor, k . Thus readers will continue to read additional novels as long as they provide any positive benefit whatever.

Novelists will produce and provide novels to the PDB until $AR = MC$. The number of novels produced under a PDB, will be $N = (TR)/(MC)$. The total revenue (TR) refers to the sum of all authors' incomes, but it will not correspond to the function described on page 58, and in Figures 3 & 4, which provide the average and marginal revenue function derived in a *competitive market* with a fixed price. Since total revenue for the PDB is determined by the number of downloads and the revenue factor k , the number of novels available can be regulated by setting this revenue factor. Note that because the information required for remuneration, (# of downloads) is only discovered after the novel is written and included on the PDB, the authors must absorb the risks of writing the work without a guaranteed minimum remuneration.⁴⁵

45. The PDB could offer an advance on anticipated royalties and spread the risk, as is done in the private publishing sector, however it might be prudent, given the already difficult information problems facing the administrators of the PDB, to forego the use of advances at least in the initial few years of operations.

The AR function will depend on the TR and MR functions. The MR function under the PDB has the following properties. First we must consider a *marginal reader* function, MRd, that traces out the number of readers for each subsequent novel available (readers with a reservation price greater than 0). This curve should slope downwards, since there will always be less people willing to read $X+1$ books than X books. We then can stretch this function vertically, by multiplying by the revenue factor, k . This will trace out the diminishing revenue for each subsequent novel. Once the number of novels reaches N_{Lim} in Figure 8, where the number of copies of novels read will have reached and stay at n_{lim} , MR will be at 0 from then on, and total revenue will not increase.

The AR curve associated with this TR, in conjunction with the MC cost curve for novels, (MC of producing novels is again assumed to be constant) will determine the number of novelists willing to provide material on the PDB. The AR curve will be a scalar of the generic average number of readers curve, ARd, associated with the MRd. Administrators of the PDB can set the scalar k , and thus determine the intersection of the AR and MC curves, and the number of novels provided on the PDB. The relevant curves are illustrated in Figure 8.

Under a PDB with NR perfectly substitutable novels, there is both the possibility of under and overproduction of novels. An excess number of *novels* can be generated, for as the revenue function increases the writing of novels will continually increase. However, there is still the upper limit to the number of total *copies* provided, even at zero price, which will be n_{lim} , the intersect of the horizontally summed demand schedules with the horizontal axis, as seen in Figure 2. As more novels are

generated, copies will increase until n_{lim} , after which the n_{lim} copies will be evenly distributed amongst a greater number of novels.⁴⁶ Thus the total revenue for all novelists can never exceed $n \cdot k$. The level of output will be essentially regulated by the setting of the k value, mediated by the MRd curve described above. Since this is quite divorced from the marginal benefit provided by the novels, overproduction is a distinct possibility. Underproduction can be similarly generated by reducing factor k until AR intersects MC inside N_0 .

To achieve the optimal level of production, the revenue function of the PDB would have to be set at k^* , so that the AR curve cut the MC at the same point as the vertically summed demand curve, as illustrated in Figure 8, on the curve AR_{opt} . If the revenue function is set too low, underproduction will occur; if too high, and with free entry into the PDB, overproduction will result. The difficulty of course, is knowing where to set k , since the administrators of the PDB cannot be presumed to know in advance either the MC of writers in producing novels, nor the precise nature of the public demand for such material.

Despite the potential for over and underproduction, there are possible Pareto efficiency gains to supply by the PDB. A good that is already produced will not be fully exploited under single price private provision since readers with reservation

46. The number of novels could theoretically be greater than n_{lim} , implying not all of the novels written would be read. If R were sufficiently large writers could risk creating a novel for the *expected* share of revenue.

values below the price are excluded. Yet, no one will be excluded from reading any novel within the PDB. Including such readers via the PDB results in potentially significant efficiency gains.⁴⁷

The inefficiency that is implied by over and underproduction does not result in any transfer of wealth to or from producers. Writers will not earn any economic profits unless they have a lower than average MC of production, and so far we have assumed constant MC.

The PDB and Increasing MC

Two increasing MC scenarios were considered in the section examining private provision of HR goods. We will now consider each of these MC scenarios under the PDB. First, if increasing MC reflects the existence of low cost producers, then entry to the PDB will still continue until $AR = MC$, and as under private provision, the low cost producer will extract rents for their skills.

47. Strictly speaking, providing the good at zero price via a publicly financed PDB may not be Pareto superior to private provision, depending on how revenues are collected. If some non-readers are taxed to pay for the PDB, then they are made worse off. It is however correct to state that the zero price PDB option is on a point on the Pareto frontier, and that private provision will be within this boundary.

The question of how to fine tune the system of public revenues for the PDB so as to ensure a Pareto superior outcome is an important and fascinating area of discussion, but it will not be dealt with here.

Second, if the MC cost curve rises because of a limited number of authors, each of whom can produce many novels at increasing costs, then each author could extract profits, which is not the same result as under private provision. Recall that under private provision, the first novels are provided at a price that just covers the MC of those first novels, not the MC of the last novel produced in the market. Thus there were no profits under private, multi-price provision. Here, there is only a single AR received, and it is equal to the MC of the last novel; so authors will profit on the lower cost novels.

Mixed Public / Private Provision

The purely private provision of NR perfectly substitutable public goods was shown to generally lead to underproduction. One exception occurred when consumers had identical demand schedules, in which case the number of novels written was optimal, and we further noted that no one was excluded from reading any of the books written.⁴⁸ However, under the more plausible assumption of differing consumer demand functions, inefficiency resulted in two "dimensions". A sub-optimal number of novels were written, and inefficiency also resulted from readers being excluded while $p > mc(=0)$. A PDB eliminated some of the inefficiency resulting from exclusion, but the possibility of underproduction remained, and the potential for overproduction was introduced.

48. If all consumers have identical preferences, then if anyone is willing to pay for the equilibrium price for the i th book, then so will all consumers. Thus no one will be excluded from reading a book because the price is above their reservation price.

A combination of public and private provision of HR goods could partially offset the inefficiency resulting from exclusion, and achieve a Pareto superior outcome to purely private provision. If the revenue setting authority of the PDB were to start from a very low figure, and gradually increase k , this would result in an increasing number of authors choosing to provide their material on the PDB, rather than selling copies in the private market. This process could efficiently continue as long as at least one novel (of that particular HR genre) was still being provided by the private sector.

If the PDB were to completely crowd out the private provision of any particular type of HR public good, then there would be a serious risk of having raised k too high, resulting in oversupply of the good. This risk would be exacerbated since the PDB would be the only source of revenue for authors in the genre, and thus likely to be subject to intense lobbying by authors to raise the revenue factor, k .⁴⁹

With an k that is not so high that the PDB crowds out private provision, and under a constant MC assumption, the same number of novels will be written as under a purely competitive system. However, more readers will gain the benefits of this production, since all PDB material is available for free. Further, since under any of a private system, a PDB, or a mixed system, all authors receive only MC, the total cost

49. Alternatively, authors might lobby the PDB to restrict entry, which would increase average earnings. This might allow private supply to continue, but would essentially result in a transfer of wealth from taxpayers to an "elite" (relative to private sector authors) group of public sector authors.

of producing this quantity (the equilibrium private or mixed number of novels) will be the same under all systems of provision. The gain in efficiency will be the sum of the valuations of all individuals, over each Book i , who value Book i less than the equilibrium price that would be set for Book i under private provision.

Mixed Public / Private Provision and Rising MC

A mixed system will also achieve comparable output levels to the both the forgoing mixed, and the purely private system, if MC rises because of the existence of lower cost producers. The low cost producer will be indifferent between the PDB and private provision, for in either case revenues will be equal to the MC of the marginal producer.

If MC rises because producers are limited, and each faces an increasing MC of production, there will be a difference between the mixed system and private provision in terms of costs. If the PDB provides an k such that the PDB provides sufficient novels that higher MC novels are provided to the PDB, then there will be profits earned by all authors on their first, low MC novels sold to the PDB. Thus for this type of rising MC, the cost of provision via the PDB will be higher than under private provision. Under private, multi-price provision revenues for each novel were shown never to exceed MC.

Section Summary

This section has considered private and public provision (via a PDB) of HR public goods, which exhibits non-repetitive perfect substitutability. Following and building on Oakland's work, it has presented the dynamics of private provision under somewhat restrictive assumptions, but notably without the problematic assumption that producers have sufficient knowledge and control of consumers to practice price discrimination. The exposition of private provision was handled in two steps, the first dealing with a fixed common price structure, and the second section rejoining Oakland to consider the equilibrium that results when price is free to vary. The fixed common price exposition was included mainly as an aid to understanding the dynamics of common-price monopoly and PDB provision of the good, for while not identical, they all have much in common. The multi-price equilibrium that results under private provision with no price restrictions was shown to generally result in underproduction, and some exclusion. The private model was further extended to consider the impact of rising MC, which did not substantially change the analysis.

The supply of HR public goods under a PDB, and a mixed system was then explored. The PDB was shown to be vulnerable to both under and overproduction; but a mixed system, where the PDB did not fully crowd out private provision, was shown to be generally Pareto superior to purely private provision. Under rising MC due to limited number of authors with increasing MC of writing novels, the mixed system still would result in the same number of novels, but authors would receive greater revenues than under private provision.

The model is of course limited by its assumptions. First, it only deals with HR public goods, and these can be contrasted with public goods such as George Orwell's *1984*, which is arguably unique and not subject to competition from other written material. Second, the absence of transactions costs is quite unrealistic. For the multi-price equilibrium to obtain, consumers have to have perfect information about the nature of all novels in the genre, (ie. know that they are NR perfect substitutes for each other) and full information on price, if they are to be able to discriminate effectively between the novels they should read first, second and so on. Further the costs associated with enforcement of intellectual property rights, which can be substantial, are not considered.

IV. CONCLUSIONS

This paper has considered the economic problems associated with technological change and the provision of public goods, focussing on the PDB (with reference to the PLR and the existing public library system) while also considering some private sector alternatives to the distribution of textual material. In reviewing the relevant issues, several themes predominated: the tension between exclusion resulting from setting $p > mc$ and the need to efficiently direct scarce resources to the production of public goods; the information difficulties associated with determining the value of intellectual property (particularly in a PDB where authors' might attempt to manipulate the information for their own advantage); the associated problems of over and under production; the information problems of determining what is unique; the problem of enforcing intellectual property rights in the private sector; and most significantly, the great variety of mechanisms currently being developed in both the private and public sectors in response to the new technology.

No structure was identified as clearly superior to all the others: each had its strengths and limitations. The fundamental informational problems are not resolved by any single structure. It is thus high impossible to predict the final mixture of economics systems dedicated to the production, distribution and consumption economics of texts that will develop. While the strength of the PDB was its avoidance of exclusion, it posed great difficulties in terms of acquiring adequate information to direct production, and avoid over or underproduction. Further, the overlap possible between private and public systems of provision was particularly notable: shareware (which while

now available for software, is equally applicable to texts) is a private system of distribution that provides a de facto 0 price option, as does a public system; and public systems largely financed through user fees or advertising are becoming increasingly similar to private provision.

The third section developed a model on private provision of HR public goods, and extended it to the PDB. Key results of this section were that over and under production were possible in a pure PDB system, but that a mixed system provided PDB administrators with feedback that could avoid overproduction, and yet still make works available at the assumed $mc=0$.

This presentation of the PDB also raises many unanswered questions. Issues that warrant further investigation include: sources of revenue and the public finance aspect of the PDB; the economics of the Internet, which has already established itself as a type of virtual library; a more detailed consideration of the exact categories of works that can be established, and the "appropriate" hit rate for each; further review of the PLR systems to determine how well they are functioning; and greater work analyzing the newer private sector options developing. In addition to these various issues and options, we can continue to ask: will there be a role for a PDB — a public library system that provides a *full* selection of digital material via modems and other technologies, free of charge?

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APPENDIX A: FIGURES

FIGURE 1

3 Individual's Demand Functions for Novels

(Or for Unique Copies)

2 of/de 2

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
ANSI #250 TEST CHART No. 21

Demand for Copies: Horizontal Sum of Demand Functions

FIGURE 2

FIGURE 3

Demand for Novels: Vertical Sum of Demand Functions

Figure 4

Demand for Novels (vertical summation) and MR Curves for Different $p:i$

Revenues per Novel as Determined by Price per Copy

Figure 5

Figure 6

MR Curves Intersecting MC Line at
Equilibrium $p:\max1 \dots p:\max5$

Increasing MC and Competitive Supply: 2 Cases

Figure 7a

Figure 7b

FIGURE 8

PDB Provision of HR Public Goods

APPENDIX B: GLOSSARY OF NOTATION

p	price per copy
p: maxi	equilibrium maximum competitive price under of ith book sold
R	revenues for novels
RII	revenue from individual I
Rbki	revenues from ith book consumed
N	number of novels
N_{lim}	maximum number of novels any person would read with p=0.
N*	optimal number of Novels to produce
n	number of copies
n_{lim}	maximum number of copies of all novels available that would be read at p=0.
MC	marginal cost of producing a novel (Can also be seen as the fixed cost of producing copies of that novel.)
mc	marginal cost of producing a copy of a novel (assumed = 0)
MR	marginal revenue for novels
MR_{p: maxi}	marginal revenue curve determined by price per copy of p: maxi

k	PDB's revenue factor
k*	optimal k to achieve N*
MRd	Marginal reader curve: maps the number of individuals willing to read a given number of novels
ARd	average reader curve: (MRd)/N
b_{ki} or	
B_{ki}	refers to the ith novel: for consumers, it references the ith novel read, which under a common price per copy (p) may not designate a specific novel. If copies of different novels are sold at different prices, then the i will order the books from cheapest to most expensive. In Figure 7a the i designates the order of cost to producers of writing novels.

END

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FIN