THE MARKET FOR SPECTACLES IN WEST-GERMANY: PRICE DISCRIMINATION AND TAXATION BY REGULATION

In Submission for the Degree
of Doctor of Philosophy
from
the
University of Glasgow

by
Hans-Wilhelm Hess

The Research was Conducted
in the
Department of Political Economy
in the
Faculty of Social Science

The Thesis was submitted in September 1986

ACKNOWLEDGEMENTS.

I would like to thank my supervisor, Professor Malcolm McLennan and my associate supervisor, Douglas Briggs of Glasgow University.

Professor McLennan gave unlimited time and showed great patience with numerous unformed drafts from a "mature student" who had returned to his alma mater after 25 years spent in his first profession as optometrist.

Douglas Briggs stimulated and encouraged me with my empirical work.

I am very much indebted to Mark Partridge of Glasgow University for reading the draft and providing helpful criticisms of my statistical work.

I would also like to thank all those members of staff who provided insightful comments and stimulating discussions, in particular Professor Andrew S. Skinner and Gavin Wood.

I am grateful to Professor Louis Phlips of CORE, Louvain la Neuve, who gave valuable advice at an earlier stage of my research.

My appreciation to my employees at Hannoversch Muenden who cooperated enthusiastically to provide the empirical work measurement and to my secretary, Frau Strack, who helped diligently with the word-processing of this thesis.

Table of Contents

LIST OF TABLES.

LIST OF FIGURES.

CHAPTER 5

CHAPTER 6

CHAPTER 7.

ERRATA

p. 37 line 3 'inter' should read 'intra'.
line 5 'intra' should read 'inter'.

p. 149 after line 9 the equation should read:

$$\frac{ACC = TC - \sum SC_i}{Q} \qquad (7)$$

where ACC = average common cost,
SC_i = aggregate separate cost of the ith product,
TC = total cost per time period, and
Q = number of units produced in that time period.

line 13, AC_i should read 'ACC_i'.
line 18, AC_i should read 'ACC_i'.

p. 231 line 6 bottom $(^n/_7)$ should read '$(^7/_n)$'

line 7 bottom $(^n/_7)$ should read '$(^7/_n)$'

ABSTRACT.

This thesis explains several economic phenomena in the market for spectacles which have long confounded interested observers. Such phenomena include:

1. Prices of spectacles are almost completely uniform over the whole of West - Germany.

2. At the same time the industry is preponderately small scale.

Economic theory would normally explain such pricing and industry structure either with perfect competition or in terms of a high degree of cartelization. The existence of perfect competition is ruled out for the market of spectacles and a high degree of cartelization is not normally associated with low concentration ratios and small-scale enterprises. Thus, one is lead to suspect a high degree of regulation in this health sector of the economy.

As the likelihood of market failure through externalities, asymmetry of information and natural monopoly is explored it becomes obvious, however, that regulation as severe as to cause the observed pricing behaviour is not called for.

The theory of taxation by regulation, developed by Richard Posner in 1971, offers an explanation. According to this theory it is often in the interest of regulators to make the regulated industry supply certain commodities or services at regulated prices below cost and subsidize these by charging above cost for commodities which are not regulated. In the case

of spectacles such cross - subsidisation may take the form of price discrimination. However, aspects of price discrimination between differentiated commodities, although discussed in spatial economics, are strangely neglected by the traditional theory of price discrimination and the view is widely held that only third degree price discrimination exists in practice. Recent developments in the theory of price discrimination are presented which acknowledge that product differention may play a role and that second degree price discrimination may exist in practice.

Spectacles can be seen as differentiated commodities using the Lancastrian characteristics approach. They are then viewed as bundles of characteristics, i.e. they are made up of the characteristic correction of faulty vision which they all have in common bundled with additional characteristics such as prestige through better quality frames, comfort through light - weight lenses etc. An empirical investigation reveals that a high degree of product differentiation does indeed exist in the market for spectacles and that the complex situation can only be adequately explained if the distinction between horizontal and vertical product differentiation is introduced.

Posner's theory is verified empirically if it can be shown that the prices of the different varieties of the differentiated commodity spectacles are discriminatory such that the basic commodities provided at regulated prices are sold below cost and other varieties above cost. Normally, the "hedonic" method is used to test empirically for price discrimination. By defining demand - based and cost -

based variables a hedonic demand and a cost schedule are obtained by multiple regression. Price differences which are due to demand influences are then taken as proof of price discrimination.

In this vein a hedonic demand and a cost schedule are estimated and the existence of price discrimination in the market for spectacles is seemingly established.

However, a discussion of the method reveals severe shortcomings:

1. The hedonic method does not incorporate the distinction between horizontal and vertical product differentiation. Therefore the complex pricing structure cannot be adequately described.

2. The hedonic method produces unambiguous estimates of costs of differentiated commodities only if pure competition is assumed. However, in the context of price discrimination pure competition is ruled out by definition.

It is therefore necessary to develop and use a model of price discrimination which takes horizontal and vertical product differentiation into account and to employ a method of cost estimation which is valid in a monopolistic environment. The model developed in this thesis employs the Lancastrian concept of characteristics space and combines vertical and horizontal product differentiation with second and third degree price discrimination to show costs and prices in three dimensions. Prices and costs are measured on the y - axis, quantities of the differentiated varieties on the x - and z - axes. Such a three - dimensional representation produces price- and cost- planes showing exactly which varieties are sold below cost, which cover cost and which are sold above cost.

As already mentioned, an unambiguous estimation of costs is essential. The relevant cost concept is that of marginal cost under full adaptation. Calculation of marginal cost is greatly facilitated if it can be shown that marginal cost is constant, for then, marginal cost equals average cost. It is shown that marginal cost is constant by constructing a long-run average cost curve and a Cobb-Douglas production function from data which the association of opticians in West - Germany has collected.

The costs of each individual differentiated commodity are made up of average cost and separate cost. Average and separate cost of each individual variety of spectacles were estimated in a cost study undertaken in the writer's own optical practice in Germany by methods of conventional cost accounting according to advice given by the chief cost accountant of the Volkswagen factory at Kassel.

Costs of every pair of spectacles are thus determined and compared to the prices of each individual variety. It is therefore possible to construct the price- and cost- planes for a representative sample. These exhibit almost exactly the magnitude and shape that was predicted by the theoretical considerations. Thus, the empirical work confirms the theoretically derived predictions that:

1. The pricing structure of the optical profession in Germany is highly discriminatory.

2. Provision of "National Health" spectacles is cross-subsidized by revenues from spectacles sold at unregulated prices.

Chapter 1

ECONOMIC CHARACTERISTICS OF THE OPTICAL PROFESSION.

1.1 OPTICIANS AND PROFESSIONALISM.

The optical profession in Germany is something of a paradox. On the one hand it can be considered a retail trade, as opticians in Germany almost without exception operate from premises exhibiting the normal features of retailing outlets, i.e. they offer their wares to the public in well-decorated shop windows, engage in advertising, etc.

On the other hand it is also a handicraft as opticans normally run a workshop in which spectacles are made up from rough, uncut lenses into the final form ready for wear. The skills required to do this require three years apprenticeship. In Germany, there is a special law governing the handicrafts (Handwerksordnung).[1] According to this law, in any of the regulated trades an apprenticeship has to be served and an examination has to be passed at the end of it. By passing this examination the apprentice becomes "Geselle" (journeyman) and may later become "Meister" (master-craftsman) by passing a further examination. This examination is the legal prerequisite for setting up in business.[2]

Thirdly, there emerge distinctly certain features of a profession, as in effect an upgrading of qualification requirements has taken place; contrary to the intentions of the craft-act only graduates of the four optical colleges are allowed to sit the master-craftsman examination as from approximately 1980.[3] A college degree is therefore required to set up a business or, perhaps it is better to say, a practice. Professional ethics are very much stressed by their association and by opticians themselves. The most striking feature, however, and the aspect in which they most resemble a profession, is the pricing behaviour of opticians.

1.2 THE PRICING BEHAVIOUR.

From an economic point of view German professions may be said to run legalized price-cartels. They are required by law to charge prices according to rates which are regulated in every detail. These rates are minimum rates - the professional may charge a higher price, but this always has to be a percentage of the prescribed rate. In fact higher charges than the minimum are rare: to charge prices lower than the minimum is forbidden by law.[4]

Opticians do not have an official rate-structure like fully-fledged professions. But in effect they behave in the same way. This may seem surprising as opticians do not charge rates for the services they perform, i.e. for dispensing the lenses into the frame, for sight-tests, for adjusting spectacles etc.

but quote prices for a particular pair of glasses by adding up the price of the right lens + price of left lens + price of frame - all service charges are included in this quotation. Prices of lenses vary according to the lens power, i.e. higher lens powers command higher prices and they also vary according to the quality of the lens as every particular power can be supplied for instance in "basic" version or in an "enhanced" version. Examples of such enhancements are tinted lenses, lenses made of plastic instead of mineral glass etc. Prices for each variety are predetermined in recommended retail price lists supplied by the lens manufacturers. There are no price differences between lists of different manufacturers.[5] Although adherence to recommended retail price lists is not enforcable by law in Germany, in reality there is no "chiselling" and no secret rebates are given.[6] It follows that there is complete uniformity of the prices of spectacle lenses just as with fees charged by the professions in Germany.

Prices of frames exhibit the same features. Here recommended retail price lists are not provided by manufacturers. Instead, opticians use so-called "calculators"[7] provided by the local guildmasters. These are lists which display for every price at which the optician buys in a frame the recommended retail price. These "calculators" have an interesting history.[8] They originate in price-stop legislation of 1937[9] when guild-masters at the local level were required by law to guide their members as to the "right" prices to be charged, when prices were frozen by National Socialist -legislation at the time.

"Calculators" were issued in response and revised editions were issued from time to time. This practice continued quite openly after the second world war until about 1970, when, for the first time, revised editions of the calculators were sent anonymously to opticians. Until that time guild-masters obviously had no reservations about possible violations of anti-monopoly legislation. This state of affairs becomes understandable as it was as late as 1957 that the Federal government had enacted anti-monopoly legislation, the "Gesetz gegen Wettbewerbsbeschraenkungen"[10] which / prohibited horizontal price agreements. Obviously, it took the guildmasters more than a decennium to realize that the practice of sending "calculators" to guild-members was very probably not within the law. The administrative agency set up to supervise the anti-monoply law, the "Bundeskartellamt" has not become aware of the practice and has not implemented any steps to stop it. In the profession the feeling is very strong up to this date that calculators are a legitimate device and it is universally used to "calculate" the prices of spectacle frames. It has already been shown that prices for spectacle lenses are uniform over the whole country as a consequence of the use of recommended retail price lists and therefore it can be concluded that, in effect, prices for spectacles are almost completely uniform over the whole of Germany and therefore resemble the highly cartelized pricing structure of other professions in Germany - with the important proviso that this commonality of prices is brought about without the legal backing which those other professions enjoy.

Turning now to the structure of the industry a number of interesting features can be noted. In 1983 6384 firms were registered with the Zentralverband des deutschen Augenoptikerhandwerks (ZVA), which may be translated as the Federal Association of Ophhtalmic Opticians. Of these only approximately 600 had branch outlets. The average turnover was DM 780000 (£ 210000). Employment per firm was 6.6 employees including apprentices. Although there are 4 nation-wide chains the turnover of these does not account for more than 9% of total turnover of the industry.[11] These figures show an industry which is predominantly small scale with no signs of a price leader. The statistics on the size and cost structure of the industry collected at the behest of the Federal Association of Ophthalmic Opticians[12] lead to the conclusion that economies of scale are insignificant. On the contrary, firms in the industry are possessed of a great natural ability to follow profit opportunities. Setting up in business only requires the renting of premises in a suitable location and the acquisition of a modest stock of frames and lenses, furniture and workshop equipment. Net capital investment on average per firm was in 1982 approximately DM 80000 (£21500), but a viable business can be started with half that amount if investment on display furniture and workshop equipment is kept to a minimum. These economic characteristics suggest that there are no significant barriers to entry arising from the usually cited obstacles such as economies of scale, initial capital requirements etc. There is little evidence of absolute cost barriers.

In order to explain the observed uniformity of prices it could conceivably be argued that opticians' firms are local monopolies in many cases.The argument would run along the following lines: 10000 inhabitants in a locality is the minimum required to sustain an optician. A local market of up to 20000 inhabitants would thus constitute a local monopoly, because up to that size there is only room for one firm. It could further be argued that even a local market of 40000 inhabitants would only sustain four firms; a number of firms which is prone to oligopolistic cooperation. Almost any community which has between 10 and 20 thousand inhabitants serves as a trade center for its environs which will double the market potential. Thus communities of a size between 10- 20000 inhabitants would be prone to local monopoly or oligopoly. 14.5 percent of the population of Germany lives in the 644 cities and villages which have 10000 - 20000 inhabitants.[13] To this figure must be added an unknown but probably considerable number of instances in which suburbs of larger cities in fact constitute local markets not in excess of 40000 potential customers. Therefore in more than 644 local markets[14] there is scope for local monopoly or monopolistic cooperation and this monopoly power would explain the observed uniformity of prices. However, local monopoly cannot explain the observed commonality of prices as, firstly, 61% percent of the population lives in cities with larger local markets and secondly, demand curves must be expected to vary considerably between different locations; i.e., between rural areas and cities. Supply curves will also differ because of differences in wage levels, rents etc. For every monopolist there will therefore be a different optimal price. What has been said about local monopolies is valid a fortiori concerning local oligopolies. There, the difficulties of hitting and sustaining the optimal prices for joint profit maximisation will increase the propensity for different monopoly prices to exist in different localities even further. Local monopoly and oligopoly cannot explain the extreme uniformity of prices all over Germany.

There are, however, aspects of the regulatory framework of the profession which may well provide a satisfactory answer and it is therefore proposed to consider this regulatory framework next.

1.3 THE REGULATORY FRAMEWORK.

The regulatory environment has essentially two roots:

1. The legal framework bestowed by the German Guild system, i.e. the "Handwerkergesetz" (craft-law).

2. The legal framework given by the German "National Health" system i.e. the "Reichsversicherungsordnung" (imperial state insurance act).

1.3.1 The German Guild System.

Both sets of laws can best be understood when their historical origins are known. To begin with the craft-law: As Prussia gradually assumed power over the greater part of Germany during the 19'th century it introduced free trade in all its newly acquired provinces. An exemption was made, however, for handicrafts which were considered to merit protective legislation even then. Thus the guilds retained one of their most important priviliges; namely the monopoly of their trade. It has already been established that any person who wishes to set up a business in one of the regulated crafts even today is required to have passed a master-craftsman examination (Meisterpruefung). Before he is allowed to sit the master-craftsman examination he or she must first have served a 3-years apprenticeship, must have passed the "journeyman-examination" at the end of it and must have worked for at least two years as a journeyman.[15] The guilds conduct the journeyman and master-craftsman examination. Legally the guilds are private corporations run by elected committee and led by a chairman traditionally called "Obermeister" (guild master). Whereas historically it has always been an object of guilds and other self-regulating bodies[16] to ration the supply of competitors through the examination right conferred upon them, the crafts have been strictly limited in this respect by the craft-law.It provides for supervision by a body specially created for the purpose - the Handwerkskammer, (chamber of crafts) for an outside chairman and a senior journeyman on the examination committee. Subjects of examination are limited by a description of the occupation (Berufsbild) approved by the Ministry of Commerce.[17]

The craft-law then, does not present great obstacles to acquiring the qualification necessary to set up in business. The guilds are not in a position to restrict entry into the profession to any significant degree. This contention is true , however, only for the situation as it was up to 1978. As from that date opticians have succeeded to some extent in strengthening entry barriers by accepting as candidates for the master-craftsman examination only those who have before received the college degree of "staatlich gepruefter Augenoptiker." This degree requires attending for at least two years a full-time college course at one of 4 state-run optical colleges[18] and the examination is rather difficult. Although this behaviour is very probably not within the law, the guilds have not been challenged so far. The capacity of the four colleges is great enough, however, to limit the supply of qualified opticians only to a qualified extent. For instance, in 1983 398 opticians received the master-craftsman degree.[19] While there are no statistics covering the average age at which self-employed master-craftsmen leave their active professional life, the following rough estimation is instructive. The average age of qualification is 25 years. At this age the opticians''s life expectancy was 47.3 years in 1983.[20] It is reasonable to estimate that the average qualified optician works for about 35 years after graduation. Then out of the population of approximately 8500 active master-craftsmen[21], 242 leave the profession every year. There is then, a net addition of approximately 156 qualified opticians per year. It can be concluded that the situation described represents stiffer, but does not constitute a significant barrier to entry. A study of the market for spectacles compiled at the behest of the association of compulsory sickness funds[22] comes to similar conclusions:

> "for ophthalmic opticians there are no severe barriers to entry due to the legislatory framework."[23]

1.3.2 The German National Health System.

The second main determinant of the regulatory framework governing the optical profession in Germany is the state insurance act (Reichsversicherungsordnung). It, too, has its origins in the late 19'th century. Like most national health insurance systems in Western Europe the German arrangement goes back to voluntary, cooperative "friendly societies" which were founded in order to provide basic coverage in the event of urgent medical needs.[24] Bismarck gave them vigour and the backing of the state by introducing the then almost revolutionary state insurance act.[25] The state insurance act, in German "Reichsversicherungsordnung" has survived not only Bismarck's resignation but has been accepted and expanded by such divergent governments as the Weimar Republic, Hitler's Reich, the Allied occupation forces and the Federal Republic.[26]

The original provisions of the act as well as the multitude of additions by statutory act, ordinance and court rulings have important bearing on the economic behaviour of the optical profession. A development which had not been envisaged by its founders, however, is perhaps the most important. Originally the sickness funds which administer the state insurance only insured persons considered to be in need. Gradually, an increasing proportion of the population came to be thus insured, until in the 1970s the funds were opened to more or less all comers so that today 94 % of the population is insured by one of these funds.[27] This development had the important consequence that it is vital to every optician to be allowed to supply glasses under the state insurance act at the prescribed conditions and prices as otherwise he would be without customers. The prices and conditions at which spectacles are supplied to statutory sickness funds are negotiated between the federal association of opticians and the associations of statutory funds.[28] One might suspect that this prerogative gives the association of opticians the power to keep its members in line. If only members of the optical association were entitled to supply spectacles to statutory sickness funds this would indeed give the association enormous power. However, this is not the case. The association negotiates prices and conditions, but anybody holding the necessary qualifications is entitled to supply glasses to the statutory funds - even if he is not a member of the optical association. Guilds at the local level supervise in cooperation with the funds whether the necessary qualifications are held, but if this is the case they have no power to exclude anybody from business with the statutory funds.[29] Uniformity of prices is not, however, the only feature of pricing policy. It has been shown that 95% of the population are members of the statutory sickness funds which pay for spectacles of basic quality at prices agreed upon by the Association of Ophthalmic Opticians and the several Associations of compulsory sickness funds. 5% of the population, however, are not so covered, and therefore have to buy their spectacles privately. They, too, sometimes buy spectacles of basic quality. Comparison of the prices paid by "private" patients and by the statutory sickness funds provides a clue to another feature of the pricing policy which will play a prominent part in its explanation. This further important feature is the presence of price discrimination.

In Table 1 the prices of lenses of different powers paid by statutory insurance funds are compared to private prices.

TABLE 1.

Prices of Spectacle Lenses paid by Insurance Funds Compared to Prices Paid Privately.

Lens Power	Insurance Fund Prices	Private Prices
Diopters	DM	DM
+-2	11.45	22.50
+-4	12.40	24.00
+-6	15.60	27.00
+-8	21.25	32.50
+-10	27.45	40.50

Source: Retail Price List, Rodenstock and Price List of the Association of Compulsory Funds.

The prices paid by the statutory sickness funds are between 49% and 33% lower than private prices. The pricing structure of opticians is therefore discriminatory. The price discrimination exists between insurance fund prices and private prices. Price discrimination can only be found in a monopolistic environment. Only regulation can explain this monopolistic environment. It must therefore appear that the regulatory process will provide an explanation of the occurrence at the same time of price discrimination and common prices of spectacle frames and lenses of varying powers and qualities. How can this effect of regulation be explained? This leads to a consideration of the complex field of the theory of regulation. In the course of this study it will be shown that the particular theory required is Posner's theory of taxation by regulation. In order to justify this claim it is first necessary to show that other theories of the effects of regulation are not adequate.

Chapter 2

THE OPTICAL PROFESSION AND THE THEORY OF REGULATION.

2.1 THREE "THEORIES OF REGULATION."

On reading overviews on the subject of regulation one is confronted with a wealth of different accounts and interpretations of the subject. This is only to be expected in a field claimed not only by economists but also by sociologists, political scientists and scholars working in a host of related fields, some of whom are mentioned in the three footnotes which follow. [30], [31], [32]

For the purposes of this study it is proposed to follow an article by Richard Posner[33] which admirably sums up the historical and current debate. Use will also be made of an article by Joskow and Noll[34] and the important contribution of George Stigler.[35]

The subject has proved rather intractable to neat theoretical solutions. It is therefore difficult to identify a single "theory of regulation". There are, rather, two strands of thought, which, however, are only rarely expressed in their pure form. Usually both of these ideas or "theories" enter any theoretical formulation to some extent and any particular author can only be identified as adhering to one or the other according to the emphasis he puts on one of these explanations of regulation. In their pure form these theories would be termed:

1) The public interest theory.

2) The "capture" theory.

These two aspects are merged to form a third theory:

what Joskow and Noll term:

3) The "political economic" theory of regulation formulated by George Stigler.[36]

2.1.1 The "Public Interest" Theory.

The "public interest" theory assumes that regulation is necessary to protect the consumer from abuse by big business, mainly natural monopolies, and in cases where consumers are allegedly unable to judge the quality of services rendered or products purchased. Under this view regulatory agencies are set up in order to remedy these instances of market failure.

In the last two decades the "public interest" theory has been subjected to empirical investigation by many prominent economists. If this theory were valid, regulation would mainly be found in highly concentrated industries where the danger of monopolistic exploitation is greatest. Posner, however, cites a host of examples which contradicts this. It may well be asked why prices and entry into the airline industry should be fixed by the government.[37] The case for railroad regulation has been questioned.[38] Even in formerly unquestioned areas such as medicine, the legal professions and safety of drugs,[39] the necessity and the beneficial effects of regulation have come to be seriously doubted.

2.1.2 The "Capture" Theory.

Right from the beginning of modern economic science there have been proponents of quite a different view, which for want of a better term is usually described as the "capture" theory of regulation. According to Richard Posner this theory is held by an odd mixture of writers which includes, among others, Adam Smith, Karl Marx, "Ralph Nader-type mudrakers" and political scientists such as Bentley.[40]

Generally it can be said that the "capture" theory holds that regulation is supplied in response to the demands of interest groups struggling among themselves to maximize the income of their members. According to this theory the impetus for regulation comes from the industry itself. It welcomes regulation as a vehicle which enables it to restrict output in order to charge higher prices and thereby to raise its profits and safeguard these gains by installing barriers against the entry of competition.

It is alleged that industries influence legislators to exact legislation which has the appearance of serving consumer interests and which remedies "market failure". Under this influence the legislator passes legislation and sets up a regulatory agency for implementation. These agencies are then "captured" and perverted in their aim by industry so that they serve the interests of those whom they are supposed to supervise.

Such an outcome is said to be likely for several reasons. It is argued that a fundamental asymmetry exists. While the interests of industry are well-organized and funded, because the very livelihood of the firms concerned is at stake, consumer interests are diffused and badly organized because only a very minor part of their interests is touched upon, as a particular industry concerns only a minute portion of consumers' budgets. It is argued further that regulatory legislation is presented in the guise of serving consumers' interests, so that no effective opposition is built up against the schemes of industrialists to turn the regulation to their advantage.[41]

2.1.3 The "Political Economic" Theory.

It must be recognized, though, that any puristic view as to the dominance of one of these theories is somewhat naive. Accordingly, refinements which take into account the essential conflict of interests and the solution of these conflicts through a political compromise have been added. The "capture" theory thus tends to shade into what Joskow and Noll term the "political economic" theory of regulation. This approach owes much to the path-breaking article by George Stigler.[42] The political economic theory of regulation seeks to apply the basic assumptions of economic theory, i.e. that human beings act mainly to promote their self-interest. Regulation is seen as a means of reaching or striking a compromise between these conflicting interests.

Stigler's main contribution is to apply the concept of demand and supply to regulation. Industry can be said to have a demand curve for regulation; legislators provide the supply curve. Legislation will be supplied to the point where the cost of the provision of regulation equals the price the demanders are willing to pay. Stigler goes on to test the political economic theory of regulation empirically in two instances. One test concerns highway weight limitations for trucks, the other occupational licensing. Only the results of the study concerning trucks clearly supports his theory. The underlying ideas of the test are the following:

1. The higher the influence of the agricultural lobby in a state the more likely is legislation favourable to trucking in that state.

2. The longer the average railroad haul in a state the less is the opposition to heavy trucks, because at the time of the study (1930) trucks competed mainly in the short-haul business with railways.

3. The better the quality of a high-way system the more favourable to trucks will a state's legislators be.

For each of 46 states of the United States the three criteria enumerated above were represented by statistical data, i.e. strength of agricultural lobby was represented by number of trucks per thousand of farming population. Average length of haul represents a second explanatory datum and percentage of highways with high quality surface was a third. The weight limit in each state was taken as dependent variable and a multiple regression was performed of the form:

$$X_1 = a + bX_3 + cX_4 + dX_5$$

where, X_1 = weight limit on 4-wheel trucks (in thousands of pounds), X_3 = truck per thousand of agricultural labour force, 1930, X_4 = average length of railroad haul of freight traffic, 1930, X_5 = percentage of state roads with high-quality surface. 1930.

The regression yielded the following result:

$X_1 = 12.28 + 0.0336X_3 + 0.0287X_4 + 0.2641X_5$; R^2 = 0.502

The three explanatory variables are statistically significant (T-values exceed 2) and each works in the expected direction. R^2, the multiple correlation coefficient is 0.52 and can therefor be taken as sign that over 50% of variations are explained by the explanatory variables. This is a good result in an empirical study of this kind. It can therefore be concluded that the pattern of weight limits on trucks supports the political economic theory of regulation.

In the second study Stigler estimated a regression in which the likelihood of a profession to obtain the right of licensure was explained by four variables. A positive effect would be exercised by:

1. The size of the occupation.

2. The per capita income of the occupation.

3. The concentration of the occupation in large cities.

A negative influence would be exercised by:

1. The presence of a cohesive opposition to licensing.

The results of this study, however, are not convincing. The R^2's, the multiple correlation coefficients are small, i.e. they are < 0.2 for ten out of 11 occupations tested and more than half of the regression coefficients are not statistically significant. Although Stigler puts the disappointing result down to the crudity of the available data, he appears to rather fail in his empirical application of the model as far as one of the main fields of regulation, namely the field of occupational licensing is concerned. Nevertheless Stigler's approach is a great step forward. The emphasis is now put on the goals of the legislator and of the regulatory agencies which have to implement the legislation. It is in this context that the application of the principle that humans are seen as trying to promote their self-interest can be most fruitfully applied. The bureaucrats of the regulatory agency wish to increase the size and standing of their agency and also their own, individual reputation, as in this way salaries and job satisfaction are increased. To be able to increase its size the agency must minimize opposition to its decisions. The regulator serves several constituencies: the industry he is regulating, the legislators who have to approve the agency's funds which ultimately determine salaries, and other interest groups such as customers of the industry, its employees, environmental pressure groups, etc. The outcome is a mixture of some effects predicted by the public interest theory and of others predicted by the capture theory.

2.2 EVIDENCE CONCERNING THE OPTICAL PROFESSION WHICH SUPPORTS THE MODERN THEORY OF REGULATION.

Turning to the optical profession the question has to be asked whether this modern hybrid theory of regulation can explain the behaviour of the industry. Is there a "public interest" case for regulating the provision of spectacles? Prima facie, it would seem that a case exists. Do the craft laws and the national health regulation and the agencies set up to implement them create entry barriers which, it might be suspected, are used by opticians in order to raise prices by collusion above the competitive level and thus to pervert the original intention of the regulation in such a way that their own economic interests are served? What, then, are the aspects of the provision of spectacles which potentially give rise to market failure? They fall into 3 categories.[43]

1. Externalities.

2. Natural monopoly.

3. Asymmetry of information.

2.2.1 Externalities.

A popular example of an externality in health care is the inoculation against contagious diseases. A third party, i.e. someone who is not inoculated receives a benefit; that of reduced risk without explicitly choosing to do so. Similarly, it can be argued that road users receive a benefit if all drivers are optimally corrected for sight-deficiencies. When spectacles are priced according to prices set in a free market system some drivers may not acquire the necessary spectacles and cause an accident. There is an external benefit to be derived if road users were to compensate drivers for their outlay on spectacle and still remain better off. The argument is that a free market system will fail to bring about such payments. Government intervention is called for in order to remedy this misallocation of resources for instance by supplying spectacles at reduced prices or even free of charge.

This argument is often put forward in a defence of the provision of spectacles as a free good. However, providing the entire population with free glasses may be a costly way of ensuring their provision to the subset who are also drivers. And there is another problem: those who refuse to wear their glasses out of vanity and those who do not know that their visual acuity is not sufficient will not be covered. A compulsory sight-test for drivers might be preferable.

There is a much more subtle definition of externality than that underlying the argument conducted so far. It must be recognized that many people care about the amount of health care others receive. The interdependence of utility of different consumers has to be taken into account in the particular situation of a health care market. It is acknowledged that in this situation consumers derive utility from the provision of health care either free of charge or at subsidized prices to those whom they consider to be in need. This argument is at the heart of most of the arguments for intervention in health care markets, developed notably by Titmuss.[44] However, even if the provision of spectacles free of charge or at reduced prices to members of the German national health insurance system is rationalized in this way the objections raised previously remain: the practical implementation will either be uneconomical or ineffective.

2.2.2 Natural Monopoly.

Natural monopoly may occur in a local market which is so small that only one provider may supply it. An often cited example is the general practitioner in a remote rural area. It cannot be denied that such a case may exist for spectacles but it is very unlikely to be so common as to cause market failure. On page 6 it was shown that a local monopoly can occur in only a fraction of local markets. Even if the argument is extended to cover local oligopoly only 29 % of consumers are affected. Furthermore, the power at the disposal of the local monopolist or oligopolist is severely restricted because search costs are not very high in the case of spectacles. In most cases they consist of the cost of transport and time spent to reach the nearest city-centre. Moreover, alternative arrangements are feasible; i.e. in the highlands of Scotland travelling opticians supply the population with glasses. In Germany, in remote areas spectacles are often supplied by jewellers or watchmakers as a sideline, so that even very small markets can be supplied.

2.2.3 Asymmetry of Information.

In health care economics it is acknowledged that the patient makes the initial decision to contact a doctor of his choice; but typically the doctor makes the decision on how much health care at what cost shall be administered. It is often argued that the ensuing market failure warrants correction by some outside agency, presumably the government. Market failure of this kind is possible in the case of spectacles. To provide an example: it is extremely difficult to envisage what a corrective lens of high power will look like in a particular frame. The consumer has to rely almost completely on the optician's advice as to the appropriate frame to house such a lens and to the possibilities - often at considerable cost - to reduce the discomfort and unsightly appearance by way of "fringe treatments". [45] The underlying asymmetry may well be exploited by the provider and may provide an explanation of discrepancies of costs and prices in the case of spectacles. What one should expect as a consequence of this asymmetry of information, however, is second or even first degree price discrimination of the type which Fritz Machlup has termed personal discrimination with the more or less self-explanatory subheadings, "haggle-every-time", "size-up-their-income" and "measure-the-use".[46] This is the pricing behaviour to be expected in a market for health care services. In a famous article Reuben A. Kessel[47] showed how this situation gives rise to differential pricing. He describes how a surgeon has no reservations about charging differential prices for the same service, namely an appendectomy, to rich and poor patients. In the case of spectacles, however, this type of price discrimination is not observed: the same prices are charged to all consumers and these prices are the same all over Germany.

The asymmetry of information therefore does not in itself provide an adequate explanation of the pricing structure. On the other hand it does support the view that some intervention in the market might be in the "public interest". The political economic theory of regulation would be supported if it could be shown that regulation in the "public interest" occurs and has been used by industrialists to "capture" the administrative agencies set up for their implementation which in turn enabled the profession to charge monopolistically inflated prices. Such regulation might take the form of entry requirements.

In chapter 1 describing the economic characteristics of the optical profession it was shown that entry into the profession is indeed limited by the qualification requirement and that this statutory requirement has been fortified in practice by the requirement to hold the college degree in addition. Thus it could be argued that Stigler's theory of regulation is supported. A closer look at the entry barriers reveals, however, that they are far too weak to explain the extraordinary pricing structure.[48] Another possible source of monopoly power was shown to be the right of licensure conferred upon the guilds not by law but in practice by the fact that they negotiate the conditions under which spectacles are supplied under the national health system and supervise their execution. It was shown, however, that their disciplinary power derived from this right is too weak to serve as an explanation for the pricing structure; the guilds do not possess the right to exclude firms as long as these firms fulfill the formal requirements.

Another explanation of the pricing structure must therefore be sought. A clue is given by a further interesting feature of the pricing structure to which attention has been drawn already.[49] It was shown that considerable price discrimination exists between the prices of the basic variety of spectacle lenses charged to private patients and charged to members of the sickness funds which administer the German national health service. It is one of the main contentions of this study that the existence of uniform prices in conjunction with price discrimination can only be explained with an extension of Stigler's theory which was first clearly stated by Richard Posner.[50] This theory shows that under regulation it is frequently the case that a favoured section of consumers is provided with goods and services well below cost while the remaining, unfavoured part of the public is "taxed" by having to pay prices far in excess of marginal cost. This theory shall therefore be described in some detail.

Chapter 3

THE OPTICAL PROFESSION AND THE THEORY OF TAXATION BY REGULATION.

In every-day language monopolies are sometimes said to "tax" their customers by extracting "high" prices. It is in conformity with this use of language that regulatory authorities can be said to impose taxes upon industries which they regulate by allowing them to charge prices above marginal cost for some of the goods and services they supply. The proceeds from such taxes then go to subsidise goods and services which are priced below marginal cost and would therefore either not be supplied at all or only at reduced quantities under a competitive environment. As the prices of these goods and services are lower than the competitive level, output of the industry will be expanded not only beyond what it would be under monopoly but beyond what it would reach under competition as well. Richard Posner goes to some length to emphasize that it is one of the major objectives of government regulation to make possible this provision of "internal subsidies":

> whereby unremunerative services or goods are provided, sometimes indefinitely, out of the profits from providing other goods and services."[51]

Posner goes on to argue that:

> "To understand properly this and other phenomena we must assign another important purpose to regulation. We can call it "taxation by regulation."[52]

It is not always easy to identify taxation by regulation or internal subsidisation. Internal subsidisation not only requires differential pricing, but also that the lower priced items be provided at prices which do not cover marginal cost properly computed. The problem is perhaps most fruitfully addressed by first exploring what <u>does not</u> constitute internal subsidisation.

3.1 THE THEORY OF TAXATION BY REGULATION.

Very often differential pricing has its origin in the normal profit-maximizing behaviour of a seller with some monopoly power who sees a chance to increase his profits by price discriminating. Such opportunities are ubiquitous in a market economy. Whenever customers can be divided up into different groups with different price elasticities these differences can be exploited by applying different mark-ups on marginal cost.

It is not always easy to distinguish such practices from legitimate charging of differential prices for what only superficially appear to be homogeneous goods. An example would be resort hotels which charge lower prices off-season than in-season. These rebates are economically justified insofar as revenue raised from off-season customers makes a contribution to cost which would not be forthcoming if a uniform rate were charged. The matter has been fully and admirably discussed with respect to peak load pricing in electricity supply and distribution. Electricity at peak and off-peak times gives rise to different capacity costs. Price differences are justified by these cost differences.[53]

It is now recognized that it may even make economic sense to sell some commodities below marginal cost in a competitive market. There is still support for the view that it makes sense because such sales can be regarded as advertising costs which will, however, only be carried to the point where the marginal cost of the advertisement equals marginal revenue from the resulting increased turnover in other goods sold above marginal cost. This is the well-known case of the super-market or national chain selling at less than wholesale-price. The same reasoning applies for instance to the sale by Kodak of cameras below marginal cost in order to increase the sale of profitable instamatic films.

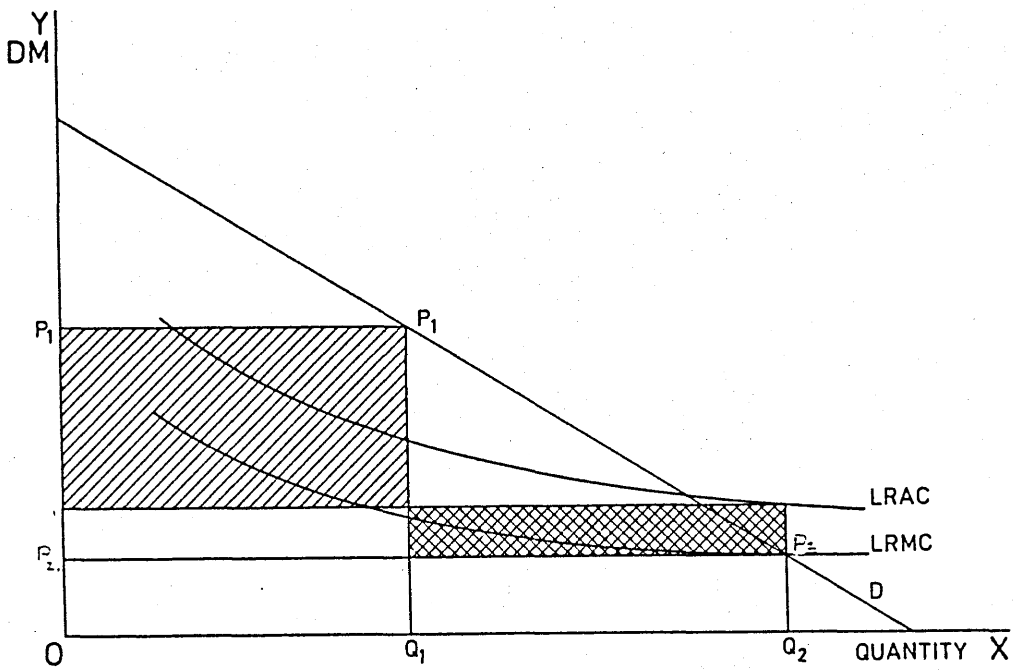
A more sinister example is that of predatory pricing with the aim of ousting competitors and then making a monopoly profit which more than outweighs the previous losses. John D. Rockefeller was accused and convicted of such practices[54], a case which received enormous publicity and has found its way into popular knowledge.

However, conditions in which such strategies pay are not easily met and much of the debate and allegations on this point may have to be relegated to economic folklore, as recent studies have revealed.[55] In all these cases, it makes no business sense in the long run to sell anything below marginal cost. This reasoning is only common sense as a seller can always increase profits or diminish losses by discontinuing any loss-making activity. Therefore these types of price discrimination do not constitute taxation by regulation as defined by Posner. There is, however, another type of price discrimination, associated with either natural monopoly or with a regulatory environment which has been the subject of much debate. This is the case of price discrimination in conjunction with increasing returns.

This case may be illustrated in the following figure taken from Scherer[56]

Fig. 1

Marginal Cost Pricing and Price Discrimination under Increasing Returns.



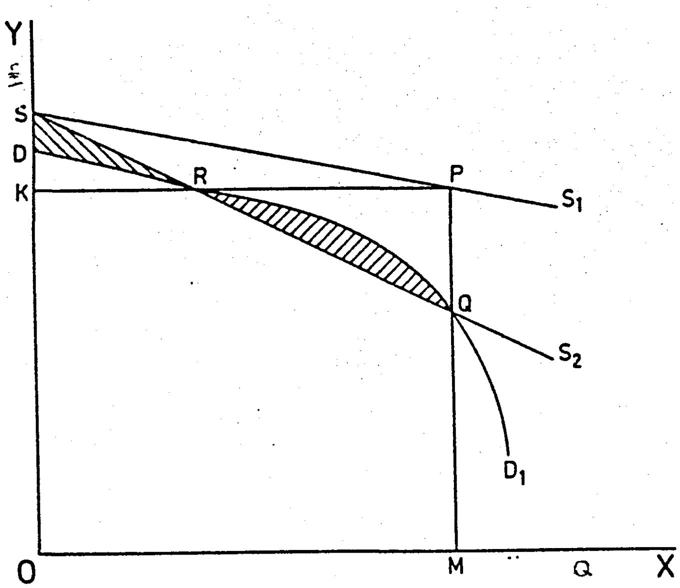
LRATC is continuosly falling and consequently LRMC lies continuously below LRAC. It is desired to charge price P_2, where LRMC cuts the demand curve. At this price quantity X_2 is provided, but at a loss. One way of making up for that loss is to divide customers into two groups, if this is feasible. Those customers represented by demand curve DD' with reservation prices higher than P_1 are charged price P_1, taking quantity Q_1 off the market and yielding a profit shown by the simply shaded area. The rest is charged price P_2 equal to marginal cost and takes quantity (Q_2 - Q_1), thereby incurring a loss represented by the doubly shaded area., which is compensated for out of the profit. Scherer is careful to conclude dryly:

"the result of such price discrimination, often used in public utility industries, is the simultaneous attainment of allocative efficient output levels and financial self-sufficiency.[57]

Although the statement is correct for his assumptions more subtle analysis is clearly required. Such analyses are in abundant supply; for instance Kahn[58] covers the debate admirably. Ultimately all the authors attempt to find a justification for price discrimination under conditions of increasing returns. This family of arguments goes back to the notion that price discrimination allows regulated industries to pluck the fruits of increasing returns to scale and thereby to produce consumers surplus as a free good, so to speak. The argument started with appendix III of Pigou's economics of welfare. In paragraph 26 an intriguing diagram is shown[59].

Fig. 2

A Diagram by Pigou.



The supply curve of a commodity is SS_1 sloping from left to right indicating increasing returns to scale. Demand curve DD' for the said commodity lies continuously below SS_1. Therefore neither under simple monopoly nor under perfect competition would the commodity be produced. Pigou draws a second supply curve SS_2 , such that at any price such as Q on that curve total cost of output such as OM would be covered assuming first degree price discrimination were practiced, because then area SQMO = area KPMO. If demand curve DD' is of such a shape that it cuts SS_2 in a point such as Q, then, under perfect price discrimination output OM will cover its cost of production, provided area RQ > area SRD. This is the famous case of railway services provided to thinly populated areas where demand would not be sufficient to provide enough revenue when a uniform price is charged, but are viable under a system of price discrimination. This argument is used to justify differential pricing under regulation in a number of other cases.[60] It is true that such conditions may be plausibly argued to exist for some railway lines in the 19th century in America's mid-west, but more often than not these claims are exaggerated. The conditions under which this model is applicable are extremely stringent. The model is more likely to be correct the steeper the slope of SS_1, i.e., returns to scale have to be pronounced, and the less steep DD' is at higher prices i.e., demand has to be more elastic at high prices than at lower prices. The satisfaction of both these conditions simultaneously is a strong requirement which is not easily fulfilled. But, as empirical estimation, particularly of the demand curve is difficult, those who invoke this argument can always claim the benefit of doubt.

All cases which are made for price discrimination on welfare grounds are built around the original suggestion by Pigou that price discrimination will yield results superior to perfect competition under conditions of returns to scale and if demand curves are of a particular shape. They cannot, however, lay claim to universal applicability. Posner's model of taxation by regulation on the other hand provides a perfectly adequate, simpler and empirically verifiable explanation of discriminatory pricing policies under regulation.

What speaks most in favour of his model is the empirical evidence which can be brought to substantiate it. Recently, compelling evidence has been compiled about pricing behaviour by interstate-airlines subject to regulation by the Civil Aeronautics Board.[61] This evidence shows that the CAB set airfares for short trips between smaller cities which did not cover marginal cost, because it deemed it desirable that such towns "should have their fair share of traffic". To compensate for this loss it allowed airlines to charge prices far in excess of marginal costs on routes such as that between New-York and Miami, where demand conditions permit such prices. These discrepancies between costs and prices were not established by the traditional type of cost inquiry which is always open to doubt mainly because of the difficulty of allocating joint costs, but by irrefutable empirical observation. Costs per passenger -mile of unregulated airlines flying inter - state and not subject to CAB regulation were compared to costs of air-lines flying intra - state and therefore subject to CAB regulation. The costs of unregulated airlines are 32 to 47 percent lower than costs incurred by inter-state airlines regulated by the CAB for compatible distances.[62].

Posner discusses further evidence. He supplies two case studies which are particularly suited to make his point. One of them concerns the introduction of cable television in the U.S. Private companies supplying cable television services are granted an exclusive franchise for a given area. Obviously, there is the possibility that subscribers to cable television may be charged monopolistically inflated prices. The traditional view of regulation would suggest that rate regulation would be employed by municipal authorities to put a curb on such prices. Instead, municipalities charge franchisees fees which normally take the form of a percentage of revenues or the provision free of charge of channels for educational purposes and for the use by other public services such as fire-departments. Both of these fee systems have the effect of reducing the profits of cable companies and also raise the prices of cable television to consumers above what they would be under unregulated monopoly. Posner concludes:

> "A tax is imposed on cable subscribers for the benefit of whoever watches the dedicated channels or partakes of the revenues

> generated...... Taxation by regulation can explain otherwise completely puzzling observations."[63]

Posner's second case concerns international telegraph services. U.S. companies providing international telegraph services, including teletype, and transmission of computer data are regulated by the Federal Communications Commission. Following a technological innovation by AT&T which installed under-sea cables capable of producing telegraph communications at a cost considerably below that of the international telegraph companies using their traditional methods. AT&T was prevented by the FCC from competing with the established companies outright. Only a few years later communication satellites introduced even cheaper means of sending telegraph services. The Commission again forbade Comsat, the satellite company, to compete. In the course of an ensuing enquiry it turned out that the telegraph companies provided those services in the provision of which AT&T and Comsat proposed to compete, at a price which was nearly 100% above cost (it was actually the leasing of standing lines to large users). Although this fact was known to the FCC the telegraph companies were merely required to make some small price reductions but it did not allow competition from AT & T and Comsat. Posner goes on to explain that this persistent, indeed dogged behaviour of the FCC cannot be explained either by supposing that the Commission acted in the public interest nor by the opposite contention that the FCC had been "captured" by the telegraph companies. Clearly, it cannot be in the public interest to prevent a cheapening of services. But also, the capture theory does not provide an answer since both the international telegraph companies and AT&T and Comsat are client industries of the Commission. As AT&T and Comsat are the bigger companies one would expect their influence to prevail before the Commission. Posner's explanation is that the telegraph companies provide ordinary telegraph services at a loss. These losses are compensated for by monopolistic profits from leasing standing lines to large users. This is precisely that market segment in which the competition was proposed. The Commission is therefore seeking to protect a particular class of customers. These customers are not big business but mainly small firms such as travel agents, some importers, even tourists and their families. These groups would have been hurt had the AT & T and Comsat been allowed to compete in the large user segment of the market for this would have compelled the telegraph companies either to raise their prices charged to the other groups or even to abandon these services altogether.

The two case studies bear out the main reason for cross-subsidisation. Some industries or customer groups, can, if they are sufficiently strong and vociferous, successfully exert pressure to obtain legislation favourable to themselves. This may take the form of low prices for goods or services required by them. Once favours are granted it is extremely difficult to remove them.

3.1.1 Taxation by Regulation and Price Discrimination.

Posner does not explicitly address a most important question which arises in this context. The cross - subsidisation may take place between different products sold by the same seller or it may take the form of the sale of the same product by one seller to different buyers at different prices. Posner's cable television case bears out the difference well.

When the providers of cable television are charged a franchise fee by a municipality this results in prices higher than what they would be without the fee. Posner argues that the proceeds are used to pay for other goods and services produced by the municipality; these goods and services are therefore provided more cheaply than would be the case in the absence of franchise fees. The cross - subsidisation takes place between different goods and services. On the other hand, when certain television channels, for instance those used for educational purposes, are provided free of charge and the remaining channels are consequently provided at higher prices, then the same good or service namely provision of cable channels is provided at different prices. The cross - subsidisation then has taken the form of price discrimination.

In the case of spectacle lenses it was shown that the same products, namely lenses of basic quality are sold at different prices to members of the compulsory funds and to private patients. This is a clear - cut case of price discrimination and cross - subsidisation in the same vein as in the examples given by Posner is to be suspected. It is, however, likely that this is not the only instance of cross - subsidisation hidden in the price structure of spectacles. There is another feature in the pricing structure which merits attention.

There is an enormous range of spectacle frames and lenses on the market. Frames range in quality and price from the simplest variety made of plastic and selling at DM 40.0 to hand - made varieties made of solid gold costing several thousand deutsche mark with literally thousands of different varieties in between these two extremes. The variety in lenses, although it cannot be measured in thousands, is also considerable. Spectacle lenses of a particular power come in different qualities which are described in detail in chapter 5 on product differentiation later on in this study ,i.e., they may be made of plastic instead of the usual mineral glass, they may be tinted, may change their shade in bright light, etc. These additional features command, of course, higher prices than the basic quality. Those consumers who are members of the compulsory sickness funds do not have to be content with the simple quality of frames and lenses which their funds provide free of charge. They may choose any frame and any type of lens provided they are willing to pay the "private" price. In that case they do not even lose the sum of money paid by their funds; the amount which the fund pays is deducted from the "private" price and billed by the optician to the fund directly. Approximately 70% of all buyers choose better frames or better lenses or both. The prices of these better quality frames and lenses are unregulated. It must be suspected that cross - subsidisation occurs between the varieties which command "private" prices and the basic varieties provided by the compulsory funds at regulated prices. But to show this cross - subsidisation empirically is not an easy task, and in an attempt to do so some difficult questions have to be answered. For instance, the cross - subsidisation between the basic quality of lenses sold at prices higher than those for the same quality sold to the compulsory sickness funds is obviously a case of price discrimination. But, if there is cross - subsidisation between the better quality frames and lenses and those sold at regulated prices, it is not obvious that this constitutes price discrimination, too. The accepted definition of price discrimination states that price discrimination is the sale of the same commodity at different prices by one seller. The different varieties of spectacles sold to the funds and sold privately are, however, not strictly the same commodity but rather different varieties of the same commodity. This and other questions which will pose themselves in the course of this study cannot be answered without a thorough understanding of some new developments in the theory of price discrimination. A description of these developments will therefore be attempted in the next chapter.

Chapter 4

THE THEORY OF PRICE DISCRIMINATION.

4.1 HISTORICAL DEVELOPMENT OF THE THEORY.

Traditionally, price discrimination is defined as the sale of the same good to different buyers by the same seller at different prices. This is the definition provided by A.C.Pigou. His "Economics of Welfare" [64] was the first exhaustive treatment of the subject and can be regarded as the standard text even today. Refinements were added by many well known scholars, but the basic treatment of the subject did not alter substantially till very recently. To name only the most important contributions; Joan Robinson[65] set up an intricate mathematical model showing precisely under which conditions output of the discriminating monopolist will remain the same or will be less or more than that of the monopolist charging a uniform price. Paul Samuelson[66] can be said to have given the theory its final formulation in which it has entered the modern textbook, while Fritz Machlup[67] added a vivid and exhaustive categorisation of types of price discrimination which may be encountered in real life. Although there has always remained some interest in the theory of price discrimination because it is important in legal cases, most notably in connection with the Robinson-Patman act in the United States, relatively little work was done in this field following the seemingly exhaustive treatment in the late 4o's and early 5o's. However, in the original formulation by Pigou and Robinson as well as in writings which appeared after the second world war and in textbook accounts of the theory more complex (and perhaps more meaningful) cases of price discrimination are alluded to. Over the last decade or so a very sophisticated and specialized literature dealing with some of these more complex aspects has developed. In his recently (1983) published "Economics of Price Discrimination"[68] L. Phlips gives the first overview of these new developments, which, although very specialized and somewhat fragmentary have nevertheless greatly enhanced the possibilities of applying the theory of price discrimination in empirical investigations. The following short outline of the theory of price discrimination attempts to combine the traditional approach with these new ideas.

4.2 PREREQUISITES OF PRICE DISCRIMINATION.

Telser[69] has stated very clearly which four conditions have to be met in a market if price discrimination is to be possible:

1. Some monopoly power must be present.

2. It must be possible to sort out customers

according to the intensity of their demand.

3. Demand must not be transferable between markets either totally or to some degree.

4. Demand elasticities must differ in the different markets.

4.2.1 Monopoly Power.

Monopoly power must be present because under conditions of perfect competition price discrimination could not exist, even if the market could easily be divided into different segments. As Joan Robinson has pointed out:

> "each section of the market demand would be perfectly elastic and every seller would prefer to sell in that section of the market in which he could obtain the highest price. The attempt to do so, of course, would drive the price down to the competitive level, and there would be only one price..."[70]

Originally monopoly in the sense of one single seller dominating a market for a good with no close substitutes was deemed necessary. Gradually, however, it is becoming realized that a downward sloping demand curve is all that is needed. Oligopolists and monopolistic competitors can all price discriminate.[71]

4.2.2 Market Segmentation.

In order to be able to engage in price discrimination the firm must be able to separate its total market into a number of submarkets. It must be possible to identify separate groups of customers who can be treated differently in terms of price. As mentioned earlier it is here that F. Machlup[72] made a most important contribution to the theory of price discrimination. In a rather unorthodox manner he describes the economic behaviour of price discriminating monopolists by giving labels to typical business practices which are very humorous but always "hit the nail on the head", while at the same time providing a classification which seems to have captured all conceivable guises in which price discrimination may occur in practice. If different prices in the different submarkets are to be charged arbitrage must not be possible. Customers who are charged lower prices must not be able to resell them to those who are charged higher prices. Often cited example are service industries, i.e. the doctor's or lawyer's clients cannot resell the services rendered to them.

4.2.3 Different Demand Elasticities.

It will only be profitable for the firm to engage in price discrimination if the demand elasticities in the several submarkets are indeed different (assuming marginal cost to be unchanged by the allocation of output between markets).

4.3 TYPES OF PRICE DISCRIMINATION.

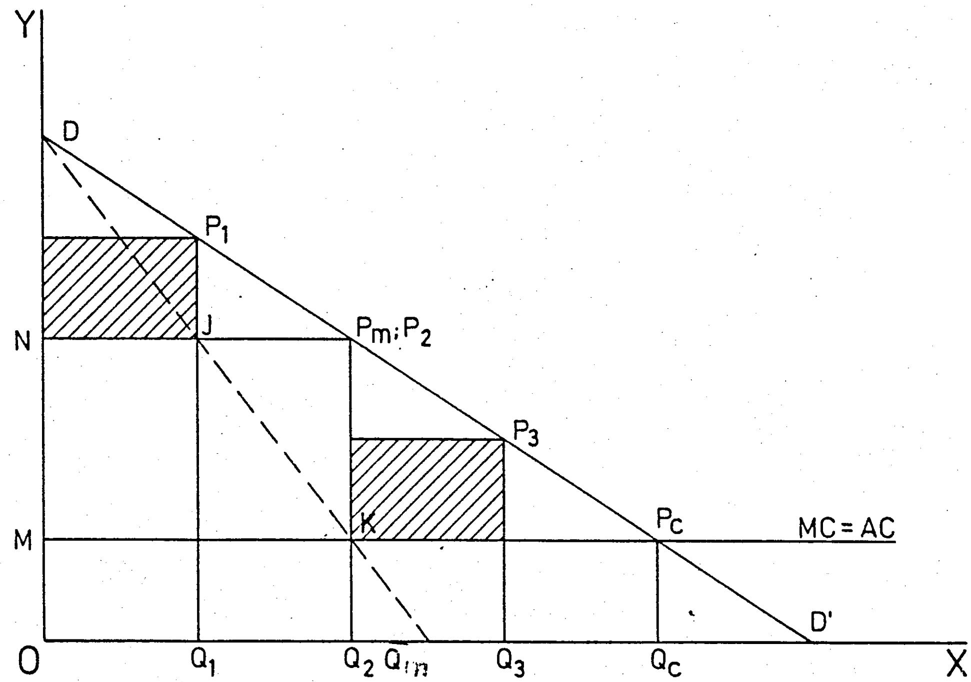
Following A.C.Pigou it has become customary to distinguish between 3 types of price discrimination, i.e. those of the first, second and third degree.

4.3.1 First and Second Degree Price Discrimination.

The best starting point is perhaps a description of second degree price discrimination. In this case the market is divided into several blocks of consumers. Consumers making up any one block are willing to pay more or less for the good on offer than members of other blocks, i.e. they have different reservation prices.

Fig. 1

Second Degree Price Discrimination.



Consider Fig. 1. Line DD' is the standard demand curve. Marginal revenue curve is the dotted line. Line MC shows the marginal cost curve which in this case is assumed to be constant and equal to average cost. In the case of a single price policy price would be set by a monopolist at Pm and quantity sold would be Qm. Under price discrimination prices charged would be P1 for quantity Q1, P2 for quantity Q2 - Q1 and so on. A monopolist pursuing a single pricing policy would sell quantity Qm at price Pm; profit would then be represented by the rectangle N Pm K M. Under a policy of second degree price discrimination profits will be greater by an amount which is represented by the shaded areas. Triangles such as P, Pm J1 represent consumers' surplus which remains even with second degree price discrimination. From figure 1 it can further be seen that the more perfect the degree of price discrimination i.e. the more the monopolist succeeds in dividing up his market into more and more submarkets, the smaller becomes the area covered by these triangles i.e. the more consumers surplus is taken away. The limiting case would be that in which all consumers surplus has been taken by the monopolist and this would coincide with perfect or first degree price discrimination. A further point, well recognized by Pigou is that under second degree price discrimination output approaches the competitive level.

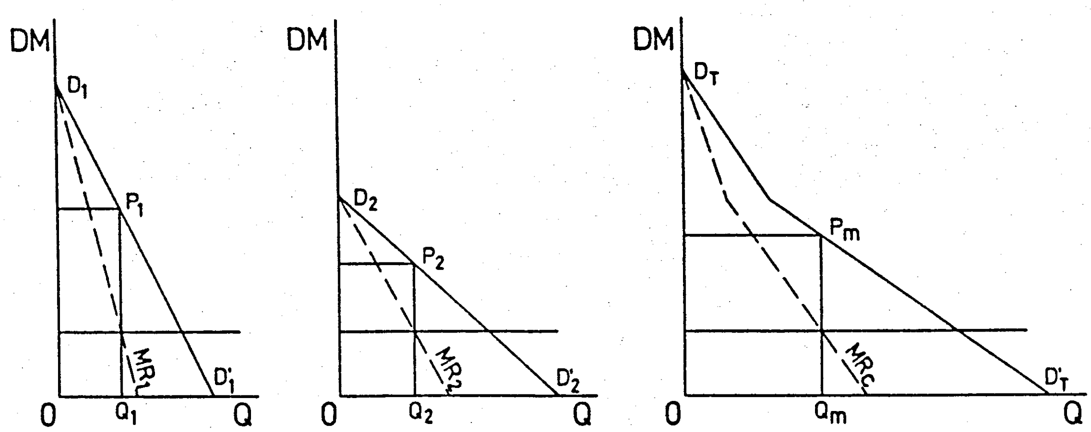
This last point is important from the point of view of welfare theory. Under first and second degree price discrimination the optimal set of prices is such that the price for the last unit (for first degree discrimination) or of the last block of units (under second degree discrimination) sold is equal to, or very nearly equal to, marginal cost. As output then approaches the competitive level, under the criterion of Pareto efficiency first and second degree price discrimination are optimal or approach optimality conditions, respectively. The only difference between these outcomes and the competitive solution concerns the distribution of income. Under competitive conditions all consumer surplus is left with consumers; under a regime of price discrimination buyers are stripped of part or all of their consumers surplus which goes to the price discriminator.

4.3.2 Third Degree Price Discrimination.

Third degree price discrimination is quite different. Instead of dividing consumers into groups which are characterized by their common range of reservation prices, under a regime of third degree price discrimination consumers are split into groups according to some characteristic which they have in common, i.e. students get cheaper theatre tickets: they can be readily identified, can be expected to have more elastic demand functions and, what is most important in Pigou's view discrimination in their favour will not arouse public resentment.[73] Diagrammatic representation of the equilibrium in third degree price discrimination is shown in Fig. 2.

Fig. 2

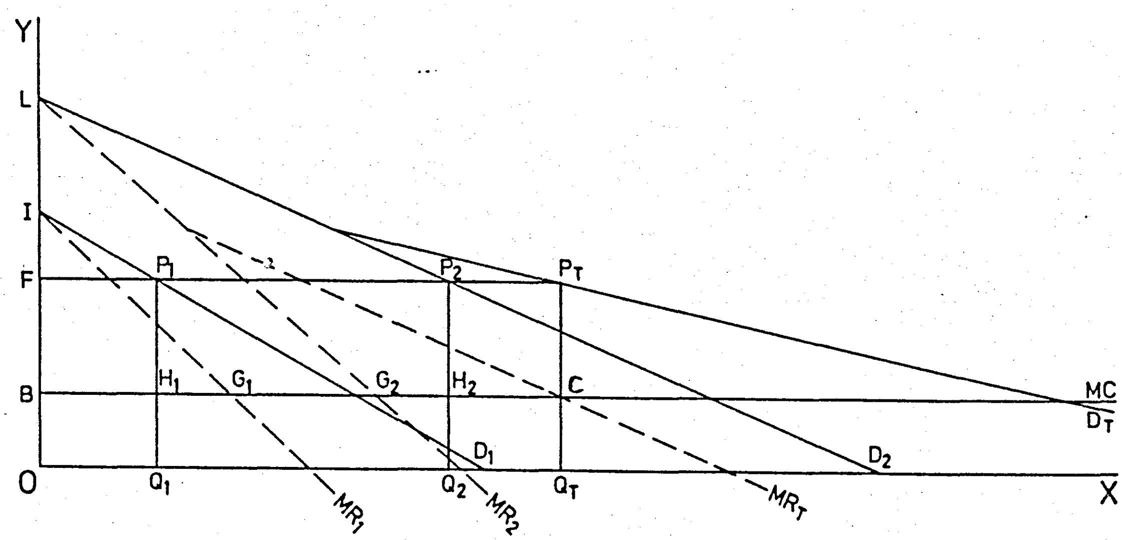
Third Degree Price Discrimination.



The above diagram is well known and a version of it can be found in almost any textbook of economics. It shall therefore not be discussed here in detail. Prices are such that marginal revenue equals marginal cost (here assumed to be constant). In the case of two products discriminatory price P_1 in the submarket having the more inelastic demand schedule will be higher and price P_2 in the more elastic market will be lower than the single monopoly price. In contrast to the case of more perfect discrimination under the assumption of linear demand curves the level of output under third degree price discrimination and under monopoly with a single price policy are the same, however. Consider Fig. 3:

Fig. 3

Output under Third Degree Price Discrimination with Linear Demand Functions.



A commodity is sold in two different markets with demand curves D_1 and D_2. Aggregate demand is then represented by the vertical summation of D_1 and D_2 =

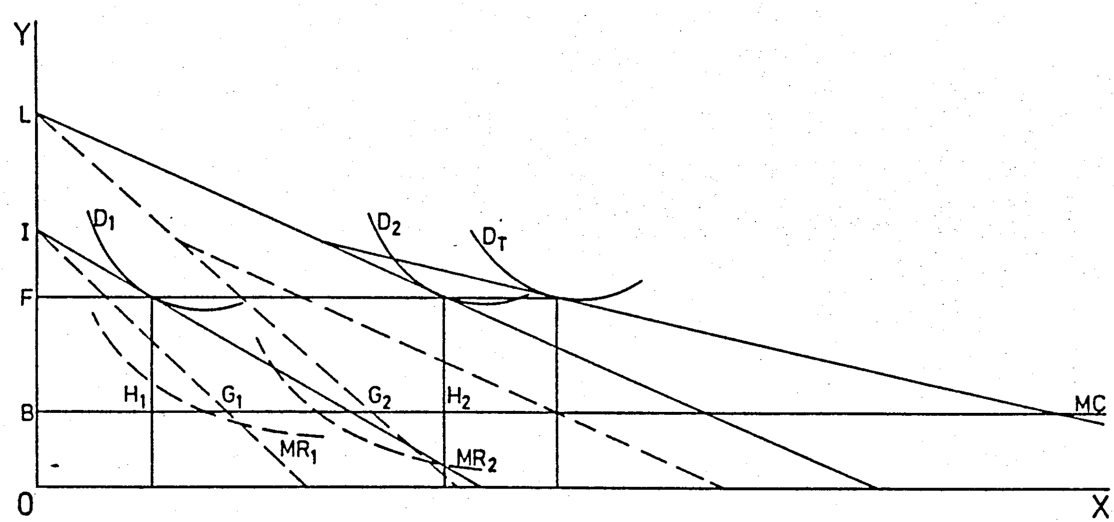
Dt. Marginal cost is assumed constant and represented by the line MC. A uniform price policy would result in an equilibrium output Qt at price Pt, which can be envisaged as consisting of the two market clearing prices P_1 and P_2 for demand curves D_1 and D_2. In essence the seller in pursuing a single-price policy is being guided by the price elasticity of the total demand for his output. On this basis he has made the profit-maximizing decision with respect to price and output.

In any instance in which the total market can be divided up into submarkets with different demand elasticities this is not, however, a truly equilibrium condition, for, in the more elastic market marginal revenue will be greater than marginal cost whereas in the less elastic market it will be less. Provided he can do so the monopolist will react by increasing output in the more elastic market from BH_1 to BG_1, lowering the price from P_1 to that price on D_1 directly above G1 (not shown). In the market in which demand is less elastic he will reduce his output from BH_2 to BG_2 and raise his price from P_2 to that price on D_2 which is directly above G_2. By these adjustments marginal revenues will be equated in each market and will also be equal to marginal cost.

Further, $B\ H_1 + B\ H_2 = BC$ and $B\ G_1 + B\ G_2 = BC$. Hence $H_2\ G_2$ must equal $H_1\ G_1$. The increase in output in the more elastic market is exactly offset by the decrease in output in the other market and total output is unchanged.[74] The result can be generalized algebraically to the case of n markets and to non-linear demand and supply curves. Whereas for linear demand curves output remains unchanged even in the case of n markets, it has been shown by Joan Robinson,[75] geometrically, and algebraically by Schmalensee[76] that with nonlinear demand curves output may be larger in the case of third degree price discrimination than it would be under single-price monopoly. It could therefore be argued in defense of the observed price discrimination in the market for spectacles that this pricing policy is superior to non - discriminatory pricing. However, the conditions under which this would be the case are quite precise and when they are fully understood it will become rather obvious that they are not easily met in practice. Consider Fig. 4.

Fig. 4

Output under Third Degree Price Discrimination With Non-linear Demand Functions.



In Fig.4 the straight line demand functions of Fig.3

are shown as lines tangent to three convex demand functions. The effect of convexity in the more elastic market is to move G_1 to the right. The effect of convexity in the less elastic market is to move G_2 to the left. Thus the effect on output in both markets is greater with convex demand curves than with linear ones. Thus, whether or not total output is affected will depend on the degree of convexity of D_1 and D_2. Only if the more elastic demand curve D_1 is also more convex than is the less elastic demand curve D_2 will total output increase. An additional influence would be exercised by a rising or falling marginal cost curve, a situation which is not shown in the figure. A rising marginal cost curve decreases the magnitude of the increase in output, but cannot altogether prevent it. The explanation is that output must increase if marginal cost is to be greater. A downward-sloping marginal cost curve will have the opposite effect of increasing output. The marginal cost curve can be so negatively sloped that the prices under price discrimination are lower in both markets. This result is often advanced as generally applicable to some markets (for instance electricity). However, such state of affairs can only occur if the demand function in the more elastic market is more convex and if the the slope of the marginal cost function is sufficiently negative. A negatively sloped supply function, or increasing returns to scale alone are not sufficient to permit the conclusion that price discrimination results in greater output and lower prices than would a uniform pricing policy.

Pigou stressed the point that first and second degree price discrimination are rare occurrences in practice. Indeed, he argued:

> "...in real life the third degree only is found."[77]

Although examples of real world first and second degree price discrimination readily come to mind - for instance the doctor who charges his patients discriminatory fees according to their income - Pigou dismisses these instances as exceptional cases. He points out the obstacles which prevent the necessary bargaining at the individual level which would have to take place if first, or even second degree price discrimination were to succeed. As main obstacles he cites:

1. "the enormous expense and trouble",[78]

2. "offending the public sense of justice",[79]

3. and the possibility of "bribery of agents",[80]

Pigou's authority is such that this contention has never really been challenged. Phlips, it is true, questions it,[81] but rather feebly. It will be one of the main contentions of this study to show that second degree price discrimination does play a significant role in the pricing behaviour of firms and is indeed essential to an understanding of pricing behaviour in the German optical industry. This may seem a very strong statement, but it is hoped to show in the course of the discussion that this contention is compatible with the generally held views and that it is nothing but a logical extension of the accepted theory of price discrimination once product differentiation is taken into account.

4.4 PRICE DISCRIMINATION COMBINED WITH PRODUCT DIFFERENTIATION.

Any attempt to generalize the theory of price discrimination for the single-product case to the firm producing differentiated or multiple products raises difficulties of definition. Price discrimination is traditionally defined in terms of the single product firm.

> "It is the act of selling the same article, produced under a single control, at different prices to different customers..."[82]

Joan Robinson herself and subsequent writers point out that some degree of differentiation of products may exist, but to them the case of price discrimination is in the main restricted to products being produced at either identical costs or at cost differences which are negligible for all practical purposes.

4.4.1 Third Degree Price Discrimination and Product Differentiation.

If the costs of differentiating one variety of a good from another variety of the same good are more significant than those negligible differences assumed by traditional theory, then the firm can still be regarded as a single product firm, provided it produces only one line of products. An example is a Volkswagen "Golf" in the standard specification and a "GTI" version. In other words, price discrimination is not necessarily confined to the simple case of the same good sold at different prices in separate markets. It is natural to extend the definition to cases where additional characteristics are provided at additional cost. Prices in excess of additional cost would also constitute price discrimination. In discussions of spatial economics, particularly "basing point pricing" this fact has been recognized for a long time. Its general applicability, however, has only gradually and rather recently been recognized. L. Phlips explicitly extends the definition of price discrimination as follows.

> "two varieties of a commodity ... sold (by the same seller) to two buyers at different net prices, the net price being the price (paid by the buyer) corrected for the cost associated with the product differentiation".[83]

Similar definitions can be found in Scherer,[84] Ekelund and Hulett,[85] and Demsetz.[86]

This extended definition may, if care is not taken, give rise to ambiguities. Phlips himself realizes:

> "price discrimination is likely to be a ubiquitous phenomenon , as most firms probably sell several varieties in separate

markets under monopolistic conditions."[87]

It might, therefore, appear that any price which deviates from marginal cost would constitute price discrimination according to this definition. It is the very essence of the theory of monopolistic competition to argue that, as product differentiation gives every firm its own, downward-sloping demand curve, price must be expected to deviate from marginal cost.

But two different cases have to be distinguished. Consider, first, a particular dealer of motorcars who offers extensive after sales service, prompt delivery, better terms for trading-in used cars etc. These services are characteristics offered as a bundle with the motorcars and a particular dealer's prices will reflect the costs of providing them. They have to be taken into account when comparing one dealer's prices with discount prices quoted by another seller who only offers rudimentary additional services. The prices of the first dealer may be in excess of marginal cost but this would not constitute a case of price discrimination, as this requires that one seller sells different varieties in different markets at different net prices. Thus, the proper example of price discrimination would be the case in which the dealer referred to above offers a "budget" model, the price of which perhaps does not even include sufficient provision for the cost of additional services, and a "de luxe" model offered at a price in excess of such costs.

Clearly, in this latter case our definition of price discrimination applies. The equilibrium condition for a discriminating monopolist is not altered. Profit is maximized by setting prices in the several markets such that marginal cost and marginal revenue are equal in each market. Taking the example of the "Volkswagen "Golf", if demand elasticity for the "GTI" version is less elastic than that for the standard car, then, if the seller is a profit maximizer the price for the more sophisticated version will necessarily exceed the sum of the price of the standard version plus the additional cost of the additional characteristics. This can be seen from Fig. 5.

Fig. 5

Third Degree Price Discrimination with Separate Cost:

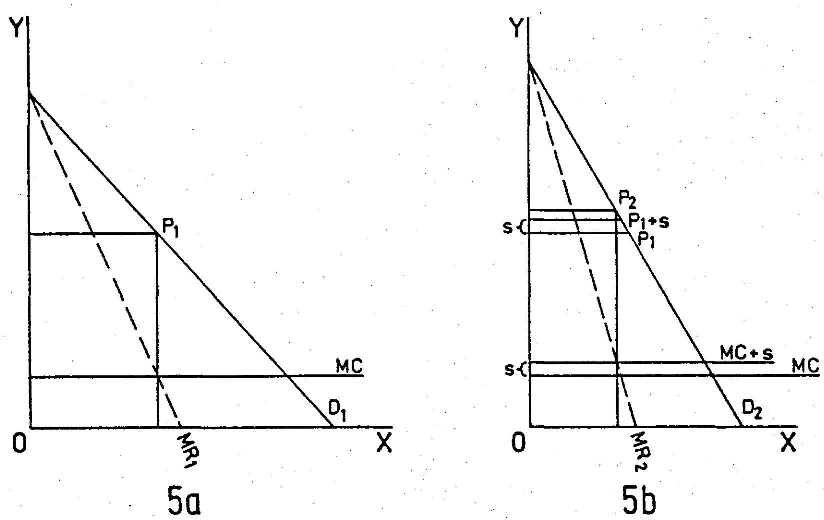


Fig. 5a shows the equilibrium price P_1 charged by a monopolist facing demand curve D1 and cost curve MC (again assuming AC = MC) for the "standard" version. Fig. 5b exhibits a more inelastic demand curve D2 faced by the same seller for the more sophisticated version. Cost in this case is greater by the additional cost for additional characteristics, shown by the distance s. Here equilibrium price P_2 at which marginal cost MC+s equals marginal revenue is higher than price P_1+s which would be the price of the standard version plus the cost incurred by providing the additional characteristics. Therefore, it is possible to say in common sense terms that the buyer of the improved version has been "discriminated against".

So far only third degree price discrimination has been discussed. But since it has already been shown that second degree price discrimination is likely to occur in the market for spectacles, it is now necessary to consider second degree price discrimination in more detail.

4.4.2 Prices, Cost and Output with Second Degree Price Discrimination and Product Differentiation.

4.4.2.1 General remarks.

It was mentioned earlier that Prof. Pigou in his classical treatment of the subject[88] emphasized the rare occurence in practice of second and first degree price discrimination. Louis Phlips, however, wonders "whether Pigou was correct in stating that first degree discrimination is of academic interest only".[89] What can be said of first degree discrimination will apply a fortiori to second degree. Indeed, Prof.

Phlips gives a hint in his preliminaries:

> "second degree price discrimination typically arises when self-selection devices are used.[90]"

and goes into the matter further in his treatment of product selection and surplus extraction through second-degree price discrimination.[91] But recognition of the practice of second degree price discrimination is much older. An example is the practice of "price skimming" first mentioned by Joel Dean.[92] This practice consists in asking a very high price at the introduction of a product with novelty appeal and thereby extracting consumer surplus from that group of consumers with the highest reservation prices. By lowering the price in a second period the group with the next highest reservation prices is "skimmed", then by lowering the price again another group is reached and so on. In Germany, quite an interesting literature on pricing new products has appeared.[93] In The U.S. a model incorporating different consumer "types" was developed by F.M. Bass and found wide-spread interest.[94]

All the models mentioned here are only applicable under rather special circumstances and appear to be of relatively minor importance when compared to another aspect: the possibilities opened up by second-degree price discrimination through product differentiation. Again, this field has been worked before, notably by German economists, for instance H.v.Stackelberg.[95] The authors who quite explicitly addressed the problem which is of central interest to this study, however, are Herbert and Marlies Jacob. They developed a model of second-degree price discrimination when products are differentiated at a cost.[96] The following exposition of price differentiation with product differentiation follows the Jacobs' article very closely.

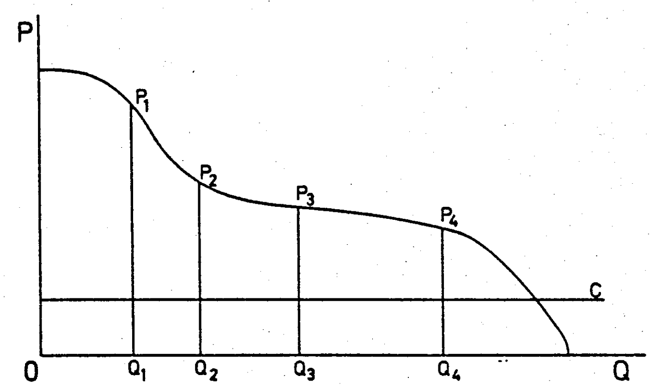
Before the model of second degree price discrimination with product differentiation can be described it is important to be quite clear about the essential difference between second and third degree price-discrimination. With third degree price discrimination buyers are split into two or n subclasses which are distinguished from each other by some attribute on the buyer's side which is outside the influence of the monopolist.

To give an example: The market for theater tickets can be divided up into 3 separate markets for, say, students, old-age pensioners and the ordinary public. Each group will contain a mixture of all sorts of different reservation prices. When these are ordered hierarchically, three different demand "curves" will have established themselves. As can be expected in the example given, these curves will exhibit different slopes and setting a different price in each market will maximize profits. In this case some buyers will be excluded from buying although their reservation prices are actually charged in adjacent markets. This exclusion is a result brought about by dividing markets not according to relative height of reservation prices but according to some arbitrary characteristic, which has, however, to be used because dividing markets according to reservation prices is not possible.

With second degree discrimination the situation is quite different. Here, the monopolist perceives all buyers as being ranked in hierarchical order of their reservation prices.

Fig. 6

Market Division with Non-Linear Demand Curve and Second Degree Price Discrimination.



Let the assumption be made that a firm selling a single product faces these reservation prices ordered hierarchically. Let it further be assumed that buyers are divided into subgroups according to their reservation prices in such way that if there are two groups all members of the first group will have reservation prices higher than those of the second group. If there are n groups the first group will have higher reservation prices than the second group, the second higher ones than the third and so on to the n-th group. Jacob and Jacob now ask what will be the optimal set of cost, output and prices in such a situation. They answer the question in steps. First, they derive a model under extremely restrictive assumptions. These assumptions are successively relaxed to make the model more realistic, but also, of course, more complicated. A model is finally arrived at, which, it will be shown can usefully be applied to the market for spectacles in Germany.

4.4.2.2 A simple model of second degree price discrimination with product differentiation.

The demand curve is defined as:

$$P = f(Q);$$

with the inverse function

$$Q = g(P)$$

The assumptions under which the first model is arrived at are:

Markets shall be separated such that at price P_1 quantity Q_1 will be taken, at price P_2 quantity taken will be Q_2-Q_1 and at price P_n quantity $Q_n-(Q_n-1)$ (See: fig. 6). The demand curve remains the same whether one price, two prices or n prices will be set. The marginal cost curve will be assumed to be constant. Then,

$$TC = C \; . \; Q_n \tag{1}$$

where, C = cost per unit, and TC = total cost.

Price differentiation is for the moment assumed to be costless.

Under these assumptions the following profit function can be defined:

$$\Pi = P_1 . Q_1 + P_2(Q_2 - Q_1) + P_3(Q_3 - Q_2) + \ldots P_n(Q_n - Q_{n-1}) - C.Q_n \tag{2}$$

As Q depends on P, i.e. Q = g(P), then,

$$\Pi = P_1 . g(P_1) + P_2 \left[g(P_2) - g(P_1) \right] + \ldots + P_n \left[g(P_n) - g(P_{n-1}) \right] - CQ_n \tag{3}$$

A system of equations is obtained which defines the optimal set of prices $P_1 - P_n$.

$$\frac{\delta \Pi}{P_1} = P_1 . g'(P_1) - P_2 . g'(P_2) = 0$$

$$\frac{\delta \Pi}{P_2} = P_2 . g'(P_2) + g(P_2) - g(P_1) - P_3 . g'(P_2) = 0$$

$$\vdots$$

$$\frac{\delta \Pi}{P_n} = P_n . g'(P_n) + g(P_n) - g(P_{n-1}) - C . g'(P_n) = 0 \tag{4}$$

solving for P_1 to P_n:

$$P_1 = \frac{- g(P_1)}{g'(P_1)} + P_2$$

$$P_2 = \frac{g(P_1) - g(P_2)}{g'(P_2)} + P_3$$

$$\vdots$$

$$P_n = \frac{g(P_{n-1}) - g(P_n)}{g'(P_n)} + C \tag{5}$$

4.4.2.3 Second degree price discrimination with linear demand functions.

In general form the model derived so far can be written as:

$$P_i = \frac{g(P_{i-1}) - g(P_i)}{g'(P_i)} + P_{i+1}) \qquad (6)$$

where, i = 1, 2, 3,......, n

The function $g(P_i)$ is completely general. Normally, however, in discussions of price discrimination linear demand functions are used. Algebraically they take the form:

$$P = a - bX \qquad (7)$$

with the inverse function:

$$X = \frac{a - P}{b} \qquad (8)$$

In equation (5) let P_1 be the artificial price at quantity 0 and P_n the price at that quantity where price = cost. Equation (4) can then be rewritten:

$$P_1 = \frac{a + P_2}{2}$$

$$P_2 = \frac{P_1 + P_3}{2}$$

$$\vdots$$

$$P_n = \frac{P_{n-1} + C}{2} \qquad (9)$$

Substituting (7):

$$P_1 = \frac{na + C}{n+1} \qquad (10)$$

$$P_2 = \frac{(n-1)a + 2C}{n+1} \qquad (11)$$

$$P_n = \frac{a + nC}{n+1} \qquad (12)$$

These equations have some interesting properties which can be depicted geometrically as in Figure 7.

Fig. 7

Second Degree Price Discrimination Compared to single Monopoly Pricing.

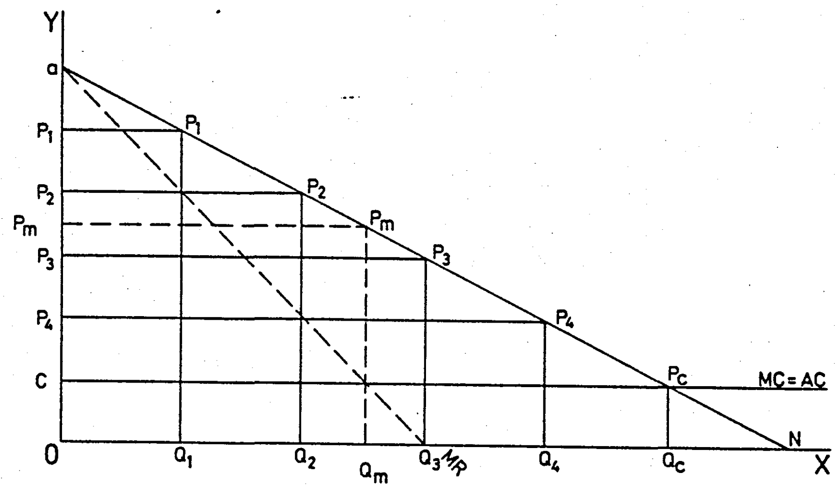


Fig. 7 is drawn assuming: $a = 17$, $c = 2$, $n = 4$. where line CC = LRMC when MC is assumed to be constant[97] and line aN = demand curve. Then according to equations (9) to (12):

$$P_1 = \frac{4 \cdot 17 + 2}{5} = 14$$

$$P_2 = \frac{3 \cdot 17 + 4}{5} = 11$$

$$P_3 = \frac{2 \cdot 17 + 6}{5} = 8$$

$$P_4 = \frac{17 + 8}{5} = 5$$

From the equations and also from the figure (As$(P_2 - P_1) = P_2 - P_3 = P_3 - P_4 = 3$) it can be seen that for profit-maximization distance a-C on the y-axis must be divided up into n+1 equal parts; also, assuming linear demand functions profits are maximized when quantities sold at these optimal prices are equalized:

$$Q_1 = Q_2 - Q_1 = Q_3 - Q_2 = Q_4 - Q_3$$

Total quantity sold becomes larger, though at a diminishing rate the greater is n. At the limit where n approaches infinity P_n becomes equal to C and output Qc equals output under perfect competition, a result which plays an important role in welfare economics. Profit becomes at the limit equal to the area of triangle a Pc C. As this triangle represents consumer surplus in the case of perfect competition it can be seen that second degree price discrimination carried to its limit, namely first degree price discrimination, captures total consumers surplus, but also results in the same quantity of output as would be the result under perfect competition.

4.4.2.4 A Numerical Example.

Price Pm set by a non-discriminating monopolist is determined by the intersection of the marginal revenue curve and the (marginal) cost curve. Jacob and Jacob compare quantities sold and profit realized by the simple monopolist to quantities sold and profits realized by the price discriminating monopolist. The simple monopolist achieves a profit which is given by the formula:

$$\Pi = \frac{(a - c)^2}{4b}$$

The discriminating monopolist who is able divide his market into 2 segments achieves profits of:

$$\Pi = \frac{(a - C)^2}{3b}$$

when he is in a position to achieve a three-fold splitting of his markets, then:

$$\Pi = \frac{(a - C)^2}{8b}$$

Accordingly, profit with two prices = 133 1/3 % of profit achieved with a single monopoly price, with 3 prices it is 150 % of the single monopoly profit. Therefore the discriminating monopolist achieves profits 33% higher[98] than that realized under non-discriminating monopoly. When n=3 the increase is 50% in both quantity and profit.

Price discrimination of the second degree appears, therefore, to be an extremely profitable strategy; it must be remembered, however, that the assumptions of the model are highly simplified. As already mentioned, Jacob and Jacob go on to modify their assumptions step by step and these modifications which introduce increasingly realistic assumptions will be discussed in the following sections.

4.4.3 The Incorporation of Separate Costs into the Model.

If a seller offers several varieties of the same good in the market, then he may combine price discrimination and product differentiation. This calls for some additions and changes in the assumptions:

1. When several varieties of a commodity are produced, then it can no longer be assumed that these different varieties have the same costs: differential costs must be expected. In other words, additional characteristics imply additional separate costs.

2. When a change in a commodity is brought about by product differentiation, i.e. when additional characteristics are added to a basic commodity, then it is very likely that the reservation prices are affected, i.e. the reservation prices become higher and the curve P = f(Q) will change.

3. When additional characteristics are added to a commodity then the assumption that the demand curve does not shift its position is no longer realistic.

4.4.3.1 The general case.

A model will now be analysed which takes account of the first change in the basic assumptions. It is now assumed that different varieties of a commodity imply different costs.

As in the previous model a fixed demand curve is assumed. Markets are divided among groups of consumers as in Figure 6, page 63 At Price P_1 quantity Q_1 is taken, at price P_2 quantity $Q_2 - Q_1$ is taken, etc. Average costs are assumed to be constant. Average costs for variety A = C + s_1 for variety B = C + s_2 for variety C = C + s_3 etc. s_1, s_2, s_3 ... may be positiv, negative or zero. Average costs may now be higher, smaller or equal to the average costs of the single undifferentiated product. There is no cost inderdependence. Given these assumption the profit function of the firm becomes:

$$\Pi = P_1Q_1 + P_2(Q_2 - Q_1) + P_3(Q_3 - Q_2) - (C + s_1)\, Q_1 - (C + s_2)(Q_2 - Q_1) - \dots (C + s_n)(Q_n - Q_{n-1}) \quad (13)$$

by rearranging:

$$\Pi = (P_1 - s_1)Q_1 + (P_2 - s_2)(Q_2 - Q_1) + \dots + (P_n - s_n)(Q_n - Q_{n-1}) - CQ_n$$

or:

$$\Pi = P_a.Q_1 + P_b(Q_2 - a_1) + \dots + P_n(Q_n - Q_{n-1}) - C.Q_n \quad (14)$$

This is the same equation formally as the profit function in the preceding section. Profitmaxizing prices are therefore derived in the manner already described. When the original expressions (P_1 - s_1) (P_2 - s_2) etc. are substituted for P_a, P_b, ...P_n then the following simultaneous equations are obtained:

$$P_1 = \frac{-\, g(P_1)}{g'\,(P_1)} + P_2 + (s_2 - s_1) \quad (15)$$

$$P_2 = \frac{g(P_1) - g(P_2)}{g'(P_2)} + P_3 + (s_2 - s_3) \quad (16)$$

.
.
.

$$P_n = \frac{g(P_{n-1}) - g(P_n)}{g'(P_n)} + C + s_n \quad (17$$

4.4.3.2 Price and product differentiation with linear demand functions.

As in the preceding section a linear demand function is assumed of the form:

$P = a - bQ$

Following the argument in the preceding section, therefore:

$$P_1 = \frac{a+c}{2} + \frac{s_1}{2} \tag{18}$$

$$P_2 = \frac{P_1+C}{2} \tag{19}$$

and,

$$P_1 = \frac{2a + C}{3} + \frac{2s_1}{3} \tag{20}$$

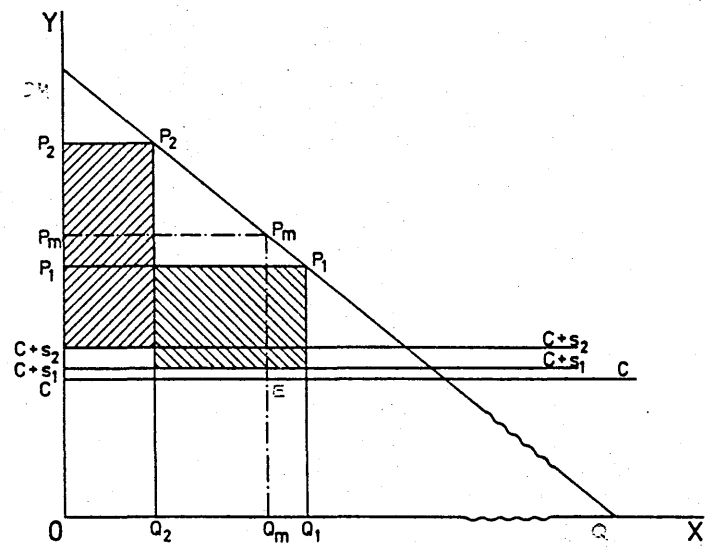
$$P_2 = \frac{a + 2C}{3} + \frac{s_1}{3} \tag{21}$$

4.4.3.3 A numerical example.

The situation is shown geometrically in Fig.8.

Fig. 8

Second Degree Price Discrimination with Product Differentiation at a Cost.



As can be seen from Fig.8 monopoly profit without price discrimination will be the area P_m P_m E C. Monopoly profits under a regime of price discrimination are shown by the shaded areas. It is interesting to note the large change in profits associated with a comparatively small change in separate costs incurred. An everyday example of this effect are shirts which command a large increase in price if a small label of a well-known designer is added; the cost of which is almost negligible. Jacob and Jacob give a numerical example.

Let a = 20, c = 10, b = 1, s_1 = +1, s_2 = +14.

When there is no differentiation,

Monopoly price, $P_m = 150$

Monopoly quantity, $Q_m = 50$

Monopoly profit $\Pi = 50(150-100) = 2500.$

With differentiation, from (20) and (21)

$$P_1 = 166\ 2/3 + 9 = 175\ 2/3$$

$$P_2 = 133\ 1/3 + 5 = 138\ 1/3$$

$$Q_1 = 24\ 1/3$$

$$Q_2 = 37\ 1/3$$

and, profit will be

$$\Pi_1 + \Pi_2 = 37\ 1/3(138\ 1/3 - 101) + 24\ 1/3(175\ 2/3 - 114) = 2894\ 1/3$$

Hence, through price differentiation combined with product differentiation at a cost the monopolist has increased quantity sold to 61 2/3 i.e. increased it by 24% and increased profits by approximately 16%.

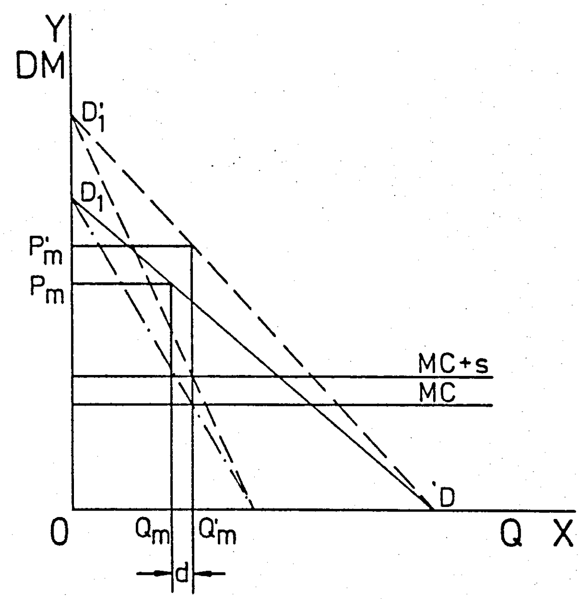
Although the two newly introduced varieties caused higher costs compared to the original quality produced, the strategy paid its way by increasing both output and profit substantially though not as much as when no additional costs had to be incurred.

4.4.4 The Model with Demand Changes taken into Account.

So far the impact of product-differentiation and price discrimination on output and profit have been considered under the assumption that the introduction of varieties with additional characteristics would not change the reservation prices of consumers. A moment's reflection shows that this is a very unrealistic assumption. When, for instance, more horsepower is added to a car, at least some buyers will be prepared to pay a higher price for this than for the standard version. The situation is illustrated in figure 9.

Fig. 9

Second Degree Price Discrimination with Product Differentiation: Demand Changes taken into account.



In figure 9, for expository purposes, the situation shown is that faced by a simple monopolist. With the introduction of additional characteristics at additional cost, cost rises from MC to (MC+s). This was the assumption made in the preceding section. Monopoly price is then Pm provided there is no change in buyers' reservation prices. Now assume such a change does occur. The original demand curve D_1 D is no longer applicable; it has changed to D_1' D. It is important to note that the change considered here implies both an increase in the intercept a, and a change in the slope b. Both changes are a consequence of the assumption that the reservation prices of consumers increase. But it is not assumed that the total quantity demanded increases, too. This may seem a rather severe restriction on assumptions. However, it will be shown later that this assumption is not unrealistic in the case of spectacles, because here regulation will cause the quantity demanded to change very little. In the situation depicted in figure 9, quantity Q'_m and Price P'_m will both increase implying increased profits. If the monopolist can price discriminate further by introducing 2 to n varieties then, with the addition of every new variety, profits can be increased.

4.4.4.1 The general case.

From figure 9 it can be seen that not only profits but also quantities sold are increased. This increase in quantity shall be denoted by d. Then,

$$d = Q'_m - Q_m \qquad (22)$$

d can be visualized as the additional quantity which the entrepreneur thinks he can sell because of the introduction of an improved product. Later it will be shown that this concept opens up interesting possibilities of empirical verification.

Returning now to the case of n varieties of a product these changes in quantity sold will be denoted by:

$$d_1, d_2, d_3, \ldots d_n$$

and n separate costs by

$$s_1, s_2, s_3, \ldots s_n$$

Applying the same reasoning as in the preceding section, i.e. formulating the profit function and optimizing it, the optimal set of n prices will again be obtained:

$$P_1 = \frac{-g(P_1) - d_1}{g'(P_1)} + P_2 + s_1$$

$$P_2 = \frac{g(P_1) - g(P_2) - d_2}{g'(P_2)} + P_3 + (s_2 - s_1)$$

$$\vdots$$

$$P_n = \frac{g(P_{n-1}) - g(P_n) - d_n}{g'(P_n)} + C + s_n \qquad (23)$$

Generally, for the ith price:

$$P_i = \frac{g(P_{(i-1)}) - g(P_i) - d_i}{g'(P_i)} + P_{i+1} + (s_i - s_{i-1}) \qquad (24)$$

4.4.4.2 The model with linear demand functions.

Again, one can assume linear demand functions of the form:

$$a = P - bQ$$ and its inverse.

Then for the two-goods case

$$P_1 = \frac{2a + C}{3} + \frac{2s_1 - s_2}{3} + \frac{2bd_1 + bd_2}{3} \quad (25)$$

$$P_2 = \frac{a + 2C}{3} + \frac{s_1 + s_2}{3} + \frac{bd_1 + bd_2}{3} \quad (26)$$

The second and third terms of these equations show respectively;

1. The influence of separate costs of additional characteristics on price and thereby profits.

2. The influence of the change of demand induced by the change in quantities sold on the market when additional characteristics are added to products. This can be considered as the change in the quality of the industry's output.

As before, a very simple numerical example shall be calculated to illustrate the point. Assume the introduction of two new varieties to replace a formerly undifferentiated product. A linear demand function for the undifferentiated product is assumed:

$$P = 90 - 1$$

marginal cost = average cost = 18

increases in quantity: $d_1 = 4$, $d_2 = 10$

increases in separate cost $s_1 = 2$, $s_2 = 12$.

If total demand is assumed unchanged, then only the first two terms in the equation go into the estimation of the optimal prices.

$$P_1 = 180 + 18 + 4 - 12 = 63\ 1/3$$

$$P_2 = 90 + 36 + 2 + 12 = 46\ 2/3$$

With changes in demand taken account of from (25) and (26):

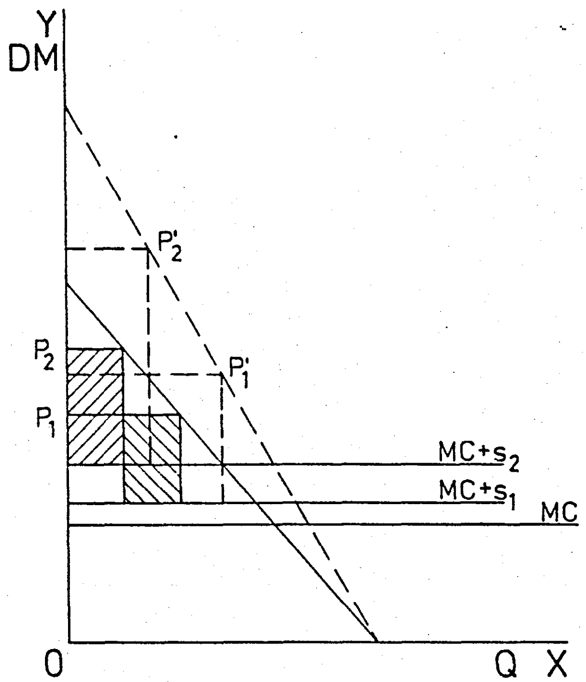
$$P'_1 = 180 + 18 + 4 - 12 + 8 + 10 = 69\ 1/3$$

$$P'_2 = 90 + 36 + 2 + 12 + 4 + 10 = 51\ 1/3$$

The result is shown graphically in figure 10.

Fig. 10

Single Monopoly Pricing: Effect of Demand Changes



When changes in the reservation prices are taken into account, profits at prices P'_1, P'_2 are equal to the rectangles bounded by the dotted lines. These can be compared to the smaller profits achieved under the assumption that no change in demand took place shown in the figure by the rectangles bounded by full lines. The result can be verified algebraically by multiplying the prices P_1, P_2, P'_1, P'_2 by quantities Q_1, Q_2, Q'_1, Q'_2.

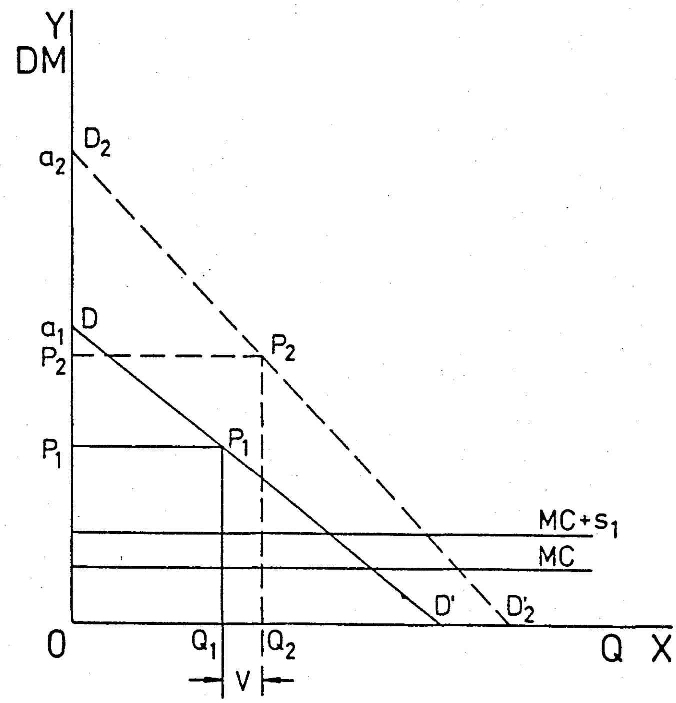
The incentive to price discriminate is therefore greater when the assumption of an increase in reservation prices as a consequence of product differentiation at a cost is added.

4.4.5 Price Discrimination and Product Differentiation when Changes in Quantity Demanded are taken into Account.

What has been said so far is valid under the assumption that the number of buyers demanding the product under observation does not change when qualities are varied. This assumption, again, is unduly restrictive, although it will be seen later on that in a regulated market like that for spectacles, this seemingly artificial condition may well come very close to reality. It is now proposed to consider the effect of dropping this assumption.

Fig. 11

Single Monopoly Pricing: Effect of Changes in Quantities Demanded Taken into Account.



In Fig. 11 the situation is shown for a simple monopolist. It is assumed that he starts off by producing a single homogeneous good at constant cost MC. His optimal price will be P_1 at which quantity Q_1 is produced. Let us assume that he tries to increase his profits by introducing a superior quality of the product which entails additional cost s_1 which is also constant. An increase in reservation prices will cause the demand curve to cut the vertical axis at a_2 instead of a_1, an effect that has already been described. But, additionally, there is reason to expect that more buyers will now demand the product as they are lured away from competing products because of the superior quality of the newly introduced variety of the good under observation. Therefore quantity Q + v can be sold where v denotes the increase in quantity caused by additional buyers demanding the new variety. The shift in reservation prices and the increase in quantity demanded will have the combined effect of shifting the demand curve to the right as shown. The profit function in its general form has now to be changed:

$$\Pi = (p-s)\ [g(p) + v\ (s,p)] - c[g(p) + v(s.p)]$$

In this equation s stands for the additional cost caused by the introduction of a new variety. s may be positive or negative, as it is quite conceivable that the introduction of an inferior quality implying less additional cost may serve to increase profits. (p-s)g(p) measures the change in price under the assumption of no change in reservation prices when a new variety is introduced, and v(s,p) measures the change in quantity, which is due to the combined effect of a change in reservation prices and a change in the number of buyers. It should be noted that a change in v caused by a change in reservation prices cannot be distinguished from a change in v due to an increase in the number of buyers demanding the good after quality changes.

The explanatory variables in the equation are s, v and P. Prices and quantities are the dependent variables and have to be optimized. Profit-maximizing prices and quantities can then be calculated if function g(P) is estimated and if v, s and P' are known.

Because of the extreme complexity of the resulting equations, only the simplest case, namely the two-goods case will be considered. If two varieties are introduced instead of a single product, let changes in quantity sold be denoted by v_1 and v_2, and changes in cost by s_1 and s_2. v_1 and v_2 depend on prices P_1 and P_2, on separate costs s_1 and s_2 and on the prices of competing products which will be denoted by P'_1 and P'_2, as the latter will determine the increase in the number of buyers which is induced by product-differentiation. Hence:

$$V_1=V_1(P_1, P_2, s_1, s_2, P'_1) \tag{27}$$

$$V_2=V_2(P_1, P_2, s_1, s_2, P'_2). \tag{28}$$

For two varieties, then, the profit function should be written:

$$\Pi = g(P_1, P_2, s_1, s_2,) = (P_1-s_1)\left[g(P_1) + V_1(P_1, P_2, s_1, s_2, P'_1)\right]$$
$$+ (P_2-s_2)\left[g(P_2) - g(P_1) + V_2(P_1, P_2, s_1, s_2, P'_2)\right] - C.Q$$

It would be quite futile to hope that with the help of such an equation profit maximizing prices and quantities could be calculated in real life situations. If this is true of only two varieties what point is there in extending the equation to more than two varieties. A very similar formula is often described in textbooks of managerial economics.[100] A mathematical approach has been suggested by Urban.[101] His treatment, however, concerns multiple products produced in variable proportions. The complexity usually leads to the abandonment of any attempt to calculate profit-maximizing prices for multiple products in a formal way. Textbooks of managerial economics usually end their chapter on multiple product pricing by merely drawing attention to the practical difficulties of finding the optimal structure of prices. No link is established with the theory of price discrimination and the possibility of product differentiation is not explicitly taken into account.

PRICE DISCRIMINATION IN A DYNAMIC CONTEXT.

So far the argument has been conducted under the assumption that the discriminating monopolist is free to set his prices and his output at will. In reality, of course, such conditions will probably never be found. They are just a conceptual limit used in describing the structure of a market in which monopolistic elements dominate, just as the case of perfect competition is the conceptual limit of a market structure in which competitive elements are preponderant. Fortunately, recognition of competitive elements does not invalidate the argument conducted so far but can easily be incorporated into the model. It is true that in a competitive environment a situation as described in Jacob`s model cannot be sustained. But looked at in a dynamic context it becomes obvious that there is a tendency towards price and output solutions suggested by the model. An analogy can be drawn with the role which Schumpeter assigns to monopoly in the process of economic development. He describes how the innovative entrepreneur attempts to make what in a static sense may be called monopoly profits by introducing new products or varieties.

With time these profits are eroded by imitators.[102] But the innovation and its beneficial effects persist. Lipsey gives an example of the development in the market for ball-point pens which describes the process very well.[103] Thus, in a static sense monopoly simply enables the entrepreneur to extract monoply profits from consumers. In a dynamic context profits are an incentive to innovation. Similarly, in a static context price discrimination is a means to increase profits. In a dynamic context it is an incentive to innovative product differentiation.

Concerning the market for spectacles it is quite normal, therefore, to expect a certain degree of product differentiation which is due to the normal incentives exerted by the profit opportunities which arise from such a strategy. But for spectacles more can be said. Posner's model of taxation by regulation predicts that the regulatory authorities set the prices for certain products or varieties of products below marginal cost. It follows that there is an absolute necessity to make up for the consequential losses. To achieve this end the regulator permits or even assists in setting prices for unregulated products or varieties of the same product above cost in order to allow compensation for the loss incurred in the regulated section of the market. The model of Jacob and Jacob demonstrates how price discrimination of second degree is a realistic strategy if product differentiation at a cost is used for its implementation.

The model not only emphasizes the presence of product differentiation strongly; even more: product differentiation is a necessary assumption underlying the more sophisticated versions of the model. It should therefore be expected that a high degree of product differentiation exists in the market for spectacles.

But there are two further important reasons for this expectation

1. the normal incentive exerted by profit opportunities afforded by price discrimination.

2. the necessity to make profits from the sale of differentiated varieties of a product in order to pay for losses incurred by having to sell certain varieties at a loss because their prices are set by regulatory authorities below marginal cost.

The conditions for profit maximization underlying the model are, however, essentially static. The degree of product differentiation is assumed to be given. Looked at in a dynamic context an analogy can be drawn to the role which Schumpeter assigns to monopoly in respect to product innovation. In a static sense monopoly simply enables the entrepreneur to extract monopoly profits from consumers. In a dynamic context monopoly profits are an incentive for innovation. In a static context second degree price discrimination is a means to make profits. In a dynamic context it is an incentive for innovative differentiation of products.

The model does not merely emphasise the role of product differentiation; for the more sophisticated versions it is a necessary assumption. It must, therefore, be shown that product differentiation is an integral feature of the market for spectacles and this is the next task to be addressed.

Chapter 5

PRODUCT DIFFERENTIATION.

5.1 THEORY OF PRODUCT DIFFERENTIATION.

Product differentiation can be defined as:

> "the extent to which basically similar products vary in quality or other attributes".[104]

The idea goes back to Chamberlin's Theory of Monopolistic Competition[105] where the concept was used in order to define an industry which was envisaged as a group of firms producing closely substitutable products.

But the concept has also proved useful in studies concerning consumer choice. Recent work on the subject has been associated mainly with the names of Lancaster,[106] Griliches[107], Spence[108] and Schmalensee.[109] Lancaster and Spence provided insights into the theoretical aspects of consumer choice, Griliches opened up very useful avenues for empirical investigation, while Schmalensee's account of the ready- to-eat-breakfast-cereals industry, was the forerunner of a multitude of empirical applications.

A contribution which has not been widely recognized so far but is of vital importance to this study was made by Louis Phlips who suggested the concept of vertical and horizontal product discrimination following work done by Pilati.[110]

Lancaster was dissatisfied with the traditional approach to consumer theory which assumes that people evaluate the utility of, say, apples and pears and then decide how much they want to buy of each. He suggested that commodities are not bought for the sake of the commodities themselves but rather for the characteristics that they convey. In his view each good provides an array of characteristics and a good is best viewed as the bundle of attributes contained within it. An apple conveys to the person who eats it a certain quantity of nutrition as well as a certain amount of taste, smell amd texture. Lancaster and others used this approach to consumer theory in order to substitute for commodity space, where each dimension corresponds to a specific good, characteristics space in which each dimension represents a specific characteristic such as nutrition, taste, exercise, intellectual diversion, social standing and so forth. Viewing commodities as bundles of such fundamental characteristics opens up very interesting applications in the pure theory of consumer choice, but empirical application encounters the difficulty of putting a quantitative measure to an esoteric concept such as intellectual diversion or taste.

Griliches prepared the way for empirical application. His original study was intended to come to grips with the problem of quality change when constructing price indices.[111]. He rediscovered an important idea first put forward in 1939 by Court, an engineer in General Motors, who deflated increases in car prices to take into account changes in their "quality content". A motor-car is viewed as a basic commodity providing transportation bundled with additional qualities such as length of car, more or less horse-power, interior fittings, weight etc. He argued that changes in these quality characteristics were at least partially responsible for changes in prices and when a price index was constructed such quality changes had to be taken into account.

The two approaches are not incompatible. Whereas it is intellectually more appealing to regard Lancastrian characteristics such as social standing as ultimate objectives of consumption, it is the physical characteristics which give rise to them. They can therefore be regarded as proxies and in empirical observation these proxies are in some way ascertained and can then be interpreted as substitutes for the more fundamental kind of characteristics which Lancaster had in mind.

A good example of this approach is a study by King of the demand for housing characteristics.[112] King estimated prices of housing characteristics such as number of rooms, floor space, insulation, but also quality measures, such as neighbourhood, fire services and garbage collection. He then condensed these characteristics to 4 essentials; basic structure, quality, space and site and estimated by multiple regression their impact on house prices.

In like manner spectacles can be regarded as bundles of physical characteristics which find their expression in the multitude of different materials frames and lenses are made of. These physical characteristics are ultimately desired for the intangible qualities, i.e. social standing, comfort, safety etc. which they convey to the consumer.

5.1.1 Vertical and Horizontal Product Differentiation.

A most important contribution which has hitherto not yet found wide-spread recognition was made by Louis Phlips. According to Phlips there are two types of product differentiation, vertical and horizontal differentiation.

5.1.1.1 Vertical Differentiation.

Vertical differentiation is present when different varieties of a commodity are created by an increase or decrease in the absolute amount of the characteristics which make up a good in the Lancastrian sense. One can say that there is an increase or decrease in "quality".

An example is the difference between a Mercedes 190 and a Mercedes 300. According to theorists like Schmalensee and Pilati the introduction of differentiated products serves to augment a firm's market share. Thus Mercedes probably introduced the model 190 because it felt that the time had come for a small car at a prestigious price. The success proved the marketing managers right. But apart from trying to cover new market segments firms often try to enlarge their market share by introducing intermediate models in that range in which they are strong. Thus Volkswagen in 1983 introduced the "Santana" which is located between its "Passat" and the Audi 100. Examples are not confined to the market for automobiles. Almost any product one can think of, from groceries to household appliances, garments, jewelery or houses, almost any conceivable good is provided in ranges of vertically differentiated varieties.

5.1.1.2 Horizontal differentiation.

Horizontal differentiation can be said to exist when additional characteristics are added to a basic commodity. Phlips cites as one possibility the case where commodities are adapted to special usages. Thus a limousine is transformed into a shooting-break or a coupè. However, in his view the main vehicle used to achieve horizontal differentiation is the offering of a series of options. The customer is then asked to select that combination which best suits his tastes.

In this way customers are seduced into revealing their reservation prices and the door is opened wide to the exercise of second degree price discrimination. As the number of options increases, it is even possible to approach perfect discrimination. As Philips observed:

> "One has the impression that extra options are overpriced, to extract the highest possible price from those who want fancy tyres or extra horse-power."[113]

Fig. 1

Vertical and Horizontal Product Differentiation according to Pilati.

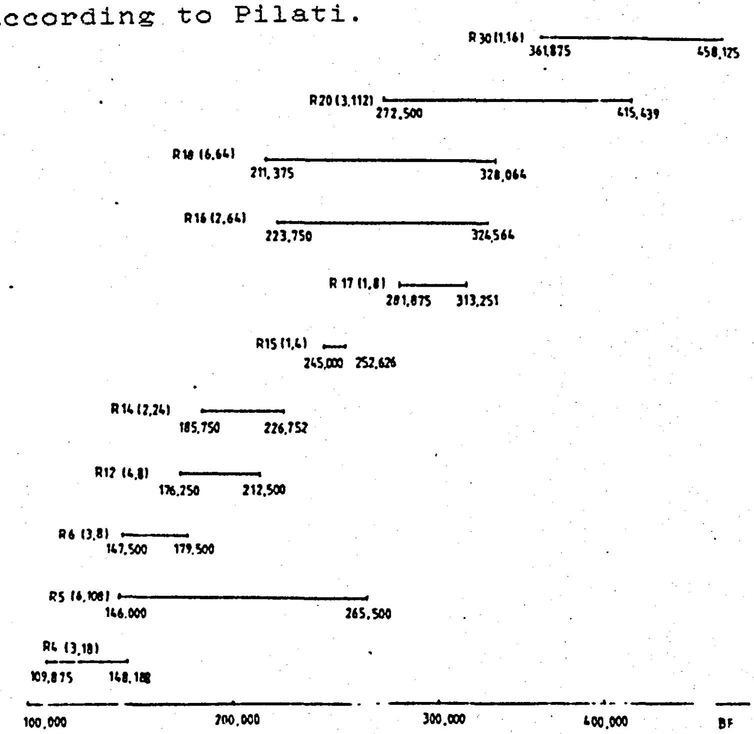


Fig.1 is taken from Pilati, page 66. It represents in a diagrammatic form the choice of Renault cars offered to the Belgian public on the 9th of October 1978. The vertical dimension represents vertical differentiation, each line representing a specific model, i.e. R4, R5, R6 etc. The price of the basic version is given below the beginning of each line. The length of the line represents the price range within which a model including all its varieties and combinations is available. There are three features to the diagram which warrant comment. First, it is interesting to note that no segment of the market is left out. Renault cars are supplied from a price of BF 109,875 to BF 458,125 (approx. Ł 15300 to Ł75300). But, secondly, price ranges overlap. Thus one could buy at BF 1,475,300 particular varieties of the 3 models R4, R5, and R6. At BF 313 251 particular varieties of 4 different models could be purchased, namely of the R17, R16, R18 and R2o. Philps concludes that this fact "constitutes a clearcut case of price discrimination".[114] Thirdly, the lengths of the different lines correspond to different degrees of horizontal differentiation. Apparently the more successful models, notably the R5, R16 and R18 tend to be offered with a wider range of options than others. The same applies to the high end of the market, i.e. the R2o and R3o.

5.1.2 Horizontal Product Differentiation in Spectacles.

This device can usefully be applied to spectacles which are even more differentiated than cars. A pair of spectacles can only have one prescription, the one that corrects the patient's vision optimally. As the dioptric power of a prescription is increased there is more of the characteristic correction of faulty vision being supplied. This is the reason for regarding spectacles of different prescription as vertically differentiated. On the other hand a particular prescription can be made up in a host of physically different varieties. Thus lenses may be made of plastic or silicate glass, may be tinted, phototropic etc., and frames may come in different materials, i.e. plastic, metal, may be differently coloured, designed by a famous "couturier", and so on. Such attributes add characteristics to the basic commodity. Such addition of characteristics constitutes horizontal differentiation according to Phlips and Pilati.

5.1.2.1 Horizontal differentiation in spectacle lenses.

Lenses are differentiated physically by the different raw-materials they are made of and by what may be called various "fringe treatments" such as coatings applied to the lens which add a colour, enhance clarity, make the lens shatterproof etc. Lenses are made either of mineral glass or plastic. The staple product are lenses made of white ophthalmic crown mineral glass. This type of lenses therefore constitutes the "basic quality". This basic quality can, however, be differentiated in a large number of ways.

One way of differentiating lenses is the usage of tinted glass. Tints are defined by their colour, i.e. grey or brown and by the percentage of light absorption. The absorption may be slight(12 -25%)

medium (< 5o%) or large >5o%).

Whereas formerly tinted glass with high and medium percentage of light absorption was quite common, nowadays only the slight shades are used. Higher shades are obtained by the aesthetically superior method of coating white glass with a colour surface and will be described together with other "fringe treatments."

The shades are one of the main methods of differentiation and the process of differentiation in this respect has a long and interesting history. In the 192o's the firm of Zeiss, Jena, obtained a patent on a tinted glass which absorbs infra-red light and brought it onto the market under the trade-name of "Uropal." Great advantages were ascribed to it. It cut down glare, made for increased visual acuity and protected the eyes from harmful invisible radiation. Although no objective proof of these claims could be offered except that it would protect people exposed to excessive infra-red radiation such as is found in the tropics or in glass-works, the glass was a great success. Rival firms brought lenses on to the market which exhibited a slight pink tint. These lenses did not even absorb infra-red radiation, but the protective qualities came to be ascribed to them. As the pink variety was aesthetically much more pleasing than the greenish Zeiss lens it made eventually such inroads on their sale that Zeiss was forced to introduce a slight pink tint under the name rosé which now accounts for over 80 percent of its sale of slightly shaded lenses. Thus one observes the astonishing result that a product the "healthiness" of which was never properly established was superseded by an imitation which did not eve possess the properties which gave rise to the original claim. The effect can be likened to the placebo effect of drugs. Whatever the medical pros and cons, to the economist this is an example of an additional characteristic. A relatively new development is photochromic glass which opened up a whole new range of possibilities for differentiating a particular lens power. Photochromic glass "automatically" tints in sunlight and clears in the shade. The first patent was taken out in 1964 by Corning Glass Works for borosilicate glass. The British firm of Chance-Pilkington holds a patent for another variant, aluminophosphate glass. These two types of glass have different properties. The borosilicate glass changes colour more rapidly, whereas the aluminophosphate variety has a slower reaction time but compensates for this by obtaining a more aesthetically pleasing colour. It is also less temperature dependent; a disadvantage of the photochromic effect is that it is decreased in high temperatures. Additional types of photochromic glass have been introduced by the three main competitors in the field, i.e. Corning Glass Works of the U.S., Chance-Pilkington of Great Britain and Schott of Germany. Thus there exist nearly twenty different varieties of photochromic glass on the market today. A further type of differentiation is related to the refractive index of the glass or plastic. For prescription purposes one of the most important properties of the raw material of which a lens is made is its refractive index, which for the basic opthalmic crown glass is 1.523. The refractive index determines the relative thickness which a lens will take for a particular prescription. The higher the refractive index the thinner the lens. It is possible to make glass of higher index than 1.523, but unfortunately such glass has an undesirable side-effect: vision becomes slightly blurred towards the edges of the lens, mainly because of colour aberrations. The cosmetic effect is, however, such that, for high-powered prescriptions, high-index glass is preferred. High refractive index glass is on offer for very strong lenses (above 1o diopters) by all lens suppliers.

In 1983 the German firm of Carl Zeiss introduced a lens which combines a higher index with only slight disadvantages of the kind described. This lens is offered as an alternative to the normal ophthalmic crown glass in medium power ranges. Zeiss' competitor, Rodenstock, is offering at the same price a variety which cuts out harmful radiation from TV and, now a growing part of the market, computer screens.

Until about the end of the second world-war glass was the only material used to make spectacle lenses. The first firm to make ophthalmic lenses of plastic material was Combined Optical Industries of Slough, England. They used Polymethyl Methacrylate, and marketed a range of lenses under the trade name Igard.

Polymethyl methacrylate or PMM, as it is usually referred to in the trade, is rather soft and hence liable to abrasion. These lenses were not particularly successful. They contained a negative new characteristic, namely softness.

The situation, however, has been changed, to an extent at least, when an improved version came on to the market. It was a product of the war effort. When an American company, the Columbia Southern Chemical Co., experimented with allyl diglycol carbonate to produce plastic windshields for aircraft, one of the experiments. Charge Number 39, proved to be a material well suited not only for windshields but also for spectacle lenses. CR 39 was registered as its trade name and it has become known by this name in the optical industry. The technique implied in making ophthalmic lenses from CR 39 was developed by Dr. Graham of Amorlite Co. in California. In Europe his method was improved upon by Essilor of France who began selling a series of plastic lenses under the trade name of Orma 1000 in 1956. In Germany plastic lenses never accounted for more than 8% of the market till 1978 when a method was invented to coat plastic lenses with an antireflex coating which made these lenses both scratch- resistant and better-looking.

Anti-reflex coating is a so - called "fringe" treatment of lenses which has become one of the main vehicles of enhancing spectacle lenses and therefore an important new method of differentiation. Mineral glass and to a lesser extent also plastic can be coated in high vacuum with extremely thin (approximately. 5mikron) layers of metal-compounds. These layers essentially serve two purposes:

- They reduce reflection,
- they colour the lens.

No lens is completely transparent; it reflects some of the light incident upon it, which may be diverted into the eye, causing discomfort such as glare etc. These reflections also conceal the wearer`s eyes thus creating an unsightly and isolating effect. Anti-reflex coatings reduce reflection up to 12-fold. In 1983 53% of all spectacle lenses supplied in Germany were anti-reflex coated. Anti-reflex coating of spectacle lenses was developed by Carl Zeiss in 1959. It took competitors several years to master the technique. Zeiss improved their method steadily and are regarded to this day as leading in quality as well as having pioneered most of the advances in this field, i.e. antireflex-coatings of different degrees of efficacy. Apart from becoming more and more scratch-resistant, coatings nowadays come in "ordinary" (4-fold decrease of reflection) "medium (6-fold decrease of reflection) and "super" (12-fold decrease of reflection) quality.

With any anti-reflex coating there remains a residual "colour tinge" the "blueness" perceived in coated lenses, for instance camera lenses. A change in the residual tint gave rise to another differentiation introduced by Zeiss in 1984; the "golden" anti-reflex coating.

The other application of ultra-thin metal layers on spectacle lenses pioneered by Zeiss is colour-coating. The Zeiss specific variety known as Umbra is still marginally superior to its nearest competitor`s. Nevertheless, all lens suppliers produce competitive qualities of colour coating today.

A very popular combination is slight tints with anti-reflex coating. This offers the ultimate in efficient function and aesthetic appearance. The tint may be a slight pink but this is hardly noticeable and takes the "bespectacled" look away from spectacle lenses. It may be a slight brown, grey or violet giving the sophisticated effect of eye shades. For technical reasons variations of colour are somewhat restricted with mineral glass but any colour can be obtained in plastic lenses by controlled dipping into the desired colour mix. Special effects are arrived at by making colours by graduating the colours from the upper to the lower half of the lens. The latest craze is lenses which show different colours in their upper and lower half.

Another major feature of differentiation is the size of lens. In the late sixties it became fashionable to wear out-size lenses. The industry at first had to make such lenses to order at immense cost. But it responded to the new fashion by mass-producing outsize lenses as soon as they caught on. Prices, however, have not come down very much from their original level, and lens size therefore constitutes another significant method of differentiation.

The list of differentiation techniques would be incomplete without mentioning the little monograms that can be engraved on lenses and the fancy bevels which add more exotic feature.

This short account paints a vivid picture of the many physical characteristics which can be added to the basic variety of a prescription lens. No mention has been made so far of those more fundamental characteristics which Lancaster clearly had in mind. The categorisation of such characteristics is necessarily a highly subjective matter, but the establishment of appropriate categories may not be an unsurmountable task. The following categories suggest themselves: comfort, aesthetic appeal, novelty appeal, safety, "healthiness". But these ultimate characteristics have to be derived from the physical characteristics. King, in his housing study has shown how this can be done. He derived four ultimate, Lancastrian characteristics such as convenience, standing, comfort etc. from twenty-four physical characteristics such as location, quality of garbage collection, size of garden etc. With spectacles, however, a particular difficulty has to be faced: one physical characteristic may give rise to several of the Lancastrian characteristics. It would therefore be necessary to assign absolute values to these intangibles. There is a major question as to whether the positive possibilities outweigh the uncertainties necessarily attached to such efforts. It is proposed here to discard this possibility in favour of using the observable and often measurable physical characteristics outlined in this section.

5.1.2.2 Horizontal differentiation in spectacle frames.

The basic function of a frame is to hold the lenses in the correct position, firmly and comfortably in front of the ~~fullfilment's~~ eyes. But the fullfilment of this very basic function still allows considerable scope for product differentiation. Frames may be made either of metal or plastic. They may be physically differentiated also by their colour, weight, shape etc.; by being designed for special purposes e.g. sports frames, children's frames, safety frames, folding spectacles, lorgnettes, make-up spectacles to name the varieties most commonly met, while a further, perhaps the most important feature differentiating frames, however, is the attachment of a trade-mark or designer's name to it.

Plastic is a generic name covering a variety of perhaps thousands of chemical compounds, only about half a dozen of which are used in frame-making. Different technologies have to be used with different plastics giving rise to differences in various technical properties and the aesthetic appearance of frames depending on what kind of plastic has been used in their manufacture.

Until about 196o the predominant plastic materials used in frame-making were cellulose acetate and cellulose nitrate. These materials came in sheets up to 6mm thick in a limited range of mostly semi-transparent colours and colour patterns. To make frames from these sheets, they were first cut into slabs of appropriate size and frames were made by cutting, milling the final shape and polishing the final product more or less by hand.

Increasingly refined methods of cutting and milling were introduced so that the original flat appearance of frames has now given way to a three-dimensional effect somewhat on the lines of artistic ivory - cutting. Innovations were made not only in the actual processes of cutting and milling but also in the process of manufacturing the raw-material. The original process of producing patterns of various colours was one of stacking sheets of different colours in a criss-cross fashion, bonding them together and then cutting them again vertically. Thus imitations of genuine tortoise-shell were eventually produced, but variations in colours and patterns were introduced gradually. An important innovation was the extrusion of acetate sheets giving rise to an almost infinite variety of different colours and patterns.

These innovations were made not by frame makers but by the producers of acetate, most notably by Dynamit Nobel of Troisdorf, Germany, who were the first company to make extruded material. Others soon followed with their own methods and in this process of innovation many smaller makers either ceased to produce or merged with others. Today there are only six makers of acetate sheet in Europe:

1. Dynamit Nobel of Troisdorf, Germany.

2. Mazzucchelli Celluloid of Castiglione, Italy, who took over the huge celluloid plant owned by Rhone Poulenc in France and today are the largest producer in the world.

3. LA.ES. of Figliaro, Italy.

4. Optinova of Venegano, Italy.

5. Courtaulds, Ltd. of Derby, England.

6. Bayer A.G of Leverkusen, Germany, who manufacture sheets of cellulose proprionate rather than of cellulose acetate.

About 40% of spectacle frames are made from metal. Metal frames should be corrosion resistant, light, strong and adjustable to the individual wearer's head. One of the most important properties is corrosion resistance which was traditionally achieved by making metal frames of "Gold Filled" also known as Double. Double consists of a base of metal such as bronze or nickel onto which a layer of gold alloy is bonded by heat and pressure so that the materials become physically inseparable. There are different varieties of Double according to thickness and fineness of the gold layer giving rise to differentiation in the final product.

With the high price of gold in recent years a spurt of innovation in the manufacture of metal frames set in giving rise to almost endless opportunities for differentiation. Frames are now made from pure nickel or various nickel alloys and are corrosion-protected by chromium plating. Chromium plating can be of a silverish colour or grey and even black (when combined with chromium oxide). When plating is used the designer has much more freedom to produce shapes and forms which might be difficult or even impossible to produce in Gold Filled with the necessity to preserve the gold skin intact. Thus an array of new models emerged made of metal which appealed to the younger and more fashion-conscious consumer who had hitherto scorned metal frames because of their "stodgy" image.

Galvanic plating has in turn been superseded in recent years as metal frames were coated with a thin layer of coloured plastic material. In this way metal frames can be produced in all colours of the rainbow. If the plastic used is transparent it can be dyed afterwards in two or more different colours on different sections of the frame.

In the account of frame making mention has so far been made only of the "giants" in the trade, Rodenstock and Zeiss of Germany, Anger of Austria and Essilor of France. As far as frames are concerned these companies do exert great influence and their market share is considerable although no exact quantitative estimate can be made due to lack of data. The author's informed guess would put it at less than 20%.

Judging from their sheer numbers independent suppliers must have the greater share of the market. There are 3 large suppliers besides those already mentioned, Metzler, Menrad and Silhouette and approximately another 125 smaller independent suppliers, mostly wholesalers, but also manufacturers who deal exclusively or partly in spectacle frames.

Wholesalers buy their frames mainly from manufacturers in Italy and France, and recently also from the far East. Italy and France have a very lively and innovative frame-making industry consisting mainly of smaller firms which tend to cluster in certain regions. In France they are located in the Jura, with Oyonnax and Morez as the frame making cities, and in Paris. In Italy the industry is concentrated in and around the Valle di Cadore in the Italian Alps and around Milan. These firms tend to be very innovative producing thousands of new models of plastic as well as metal frames per year.

Often new methods of production and new fashions are not introduced by big firms like Rodenstock or Zeiss but by these smaller companies usually run by owner-entrepreneurs. Thus, coating of metal frames by means of coloured plastic originally came from the small firm of DESIL in the Valle di Cadore. The fashion of making frames in the style of the thirties also originated in Italy.

The latest fashion impetus came from an outsider, a

Swedish company, Polaris, who brought an eight-hole rimless frame onto the market with facetted and tinted plastic lenses. Lens shape, facetting and lens colour (often two-tone) are part of the style and can be widely varied so that the customer may style his individual eyewear. Within a few months several dozen competitors brought similar frames onto the market and the fashion has now passed its peak.

An interesting new development is the appearance on the market of many collections of frames sold under a specific name which may be that of a haute couture house, a film star or a sports celebrity. The method was introduced by the innovative Wilhelm Anger, inventor of the Optyl frame, who secured the famous name of Dior for his collection. Dior frames exhibit the DIOR logo rather conspicuously on the templates thus adding "Leibenstein" snob appeal much as a "Hermes" or "Dior" sign on a silk scarf or the famous crocodile on sports shirts. It is widely believed in the trade that Christian Dior had no part in the design of his spectacle collection which is perhaps just as well as a line actually designed by the famous couturier Pucci was rather a fiasco. Very successful lines besides Dior were a sunglass range by "Porsche design" and "Nina Ricci". The latest addition to the field is "Cartier" who were the first to "launch" their appearance in the optical field by inviting fashion reporters to Tunis where they met pop star and now spectacle promoter Elton John, sporting his new "Cartier" glasses. "Cartier" frames retail for approximately L150.0 and are produced and sold by

Essilor, the leading French Optical company. A no-name frame of similar quality would retail at less than half that price. These successes have produced their crop of imitators and a list of "haute couture" and similar collections together with the companies manufacturing them is given in TABLE 2.

TABLE 1.

Frame Collections sold Under Name of Fashion House.

Name	Manufacturer or Distributor	City and Country
Alfa Romeo	Liven Intern.	Milan, Italy
Balenciaga	S.A.M.P.	Annecy, France
Cartier	Essilor	Creteil, France
Charles Jourdan	Hennert	Bois-le-Roi, France
Christian Dior	Optyl	Munich, W.Germany
Dunhill	Optyl	Munich, W.Germany
Emilio Pucci	Grasset	Oyonnax, France
Givenchy	Vertex Optical	Driffield, England
Gloria Vanderbilt	Zyloware	Long Island, USA
Gucci	Modissa	Porto Mantovano, Italy
Guy Laroche	Grasset	Oyonnax, France
Jacques Fath	Serrano	Boissise-le-Roi,France
Jean Patou	Societe Gome	Bois-Colombes, France
Lanvin BK	Optic	Paris, France

Maggy Rouff	Opt-Art	Paris, France
Nina Ricci	S.A.M.P.	Annecy, France
Paolo Rossi	Fedon Occhiali	Cadore, Italy
Pierre Cardin	Styloptic	Paris, France
Rochas	S.A.M.P.	Annecy, France
Sophia Loren	Zylowware	Long Island, USA
Ted Lapidus	L'amy Jeune Fils	Morez, France
Yves Chantal	Marwitz & Hauser	Stuttgart, W.Germany
Yves St. Laurent	Plastinax	Oyonnax, France

5.1.3 Vertical Product Differentiation in Spectacles.

Spectacles are differentiated vertically in three ways:

1. According to dioptric power
2. According to whether a new frame is included or whether lenses are dispensed into a frame supplied by the customer.
3. According to whether the prescription dispensed is single or multi focus.

5.1.3.1 Product differentiation between lenses of different power.

There is an enormous range of values which an optical prescription may take. Firstly, a person requiring visual correction may be either short-sighted, or long-sighted. Lenses correcting short-sightedness are concave and designated by a minus sign. Hyperopic lenses are convex and designated by a plus sign. The power of spectacle lenses, whether plus or minus, is specified in diopters, which are the units of measurement. One diopter is defined as the power of a lens of focal length 1 meter. Spectacles are normally dispensed in 1/4 diopter intervals from zero power to approximately. +/- 20 dpts. This adds up to 20 x 4 x 2 = 160 possible lens powers. For pricing purposes this number is reduced considerably. First of all plus and minus lenses are sold at the same prices thus reducing the number of possibilities by half. Furthermore, spectacle lenses are divided up into ranges of equal prices. Thus, lenses from power 0 to power 1.75 constitute the first range, those of 2 to 3.75 the second and so on. The first range is denoted by the abbreviation +-2, the second by +-4 and so on. Table 1 shows price ranges and corresponding prices for spherical lenses of basic quality.[115]

TABLE 2.

Price Ranges of Spherical Lenses.

RANGE (DPTS.)	ABBREVIATION.	PRICE.(DM)
0 < 2	+-2	11.45
2.25 <4	+-4	12.40
4.24 <6	+-6	15.60
.	.	.
.	.	.
.	.	.
10.25 <13	+-13	27.45
13.25 <16	+-16	38.50
16.25 <20	+-20	55.10

Source: Recommended Retail Price List, Rodenstock Lens Manufacturers, Munich, 1984.

The matter becomes, unfortunately, more complicated because of the necessity to correct for astigmatism. This condition is present when an eye has different refractive errors in different meridians. Astigmatism occurs very frequently. It may normally take values between + 0.25 and + 6.0 dpts, It is also corrected for in steps of 1/4 dpts. Astigmatism usually occurs together with the condition of short or longsightedness. This kind of refractive error is then denoted by two numbers, the first for the spherical and the second for the astigmatic component. If the astigmatism lies between 0.25 and 2 dpts, then the abbreviation for the resulting lens power is +-2/2, +-4/2 etc. where the first number denotes the strength of the spherical and the second number that of the astigmatic component. If the astigmatic component lies between 2.25 and 4 dpts the abbreviation is: +-2/4, +-4/4, +-6/4 etc. and for lenses with a toric component between 4,25 and 6 dpts the abbreviation is: +-2/6, +-4/6, +-6/6 etc. and there is a fourth range for cylindrical power > 6 dpts. Following this categorisation price ranges of spherical and toric lenses are 4 x 8 = 32 in number. Price ranges for astigmatic lenses are shown in table 2.

Price Range for Astigmatic Lenses

RANGE (DPTS)	ABBREVIATION	PRICE (DM)
0 < 2	2/2	17.85
2 < 4	4/2	19.85
4 < 6	6/2	26.0
6 < 8	8/2	33.15
8 < 10	10/2	42.20
10 < 13	13/2	52.65
13 < 16	16/2	63.80
16 < 20	20/2	73.85

Source: Recommended Retail Price List of Rodenstock Lens Manufacturers, Munich, 1984.

This number is doubled again because pairs of human eyes do not necessarily fall into only one of those categories. A person may require - 2.0 dpts. in his right eye and - 2.5 in his left. Price for his two lenses will then not be 2 x 11.45 = 22.90 but 11.45 + 12.40 = 23.85. Alternatively it may consist of values - 4.0 for the one eye and - 6.25 spheric combined with + 1.5 toric. Price will then be category +-4 = 12.40 + category +- 8/2 = 22.10 = 34.50. Fortunately, differences of more than 2 diopters are extremely rare, so that in practice the number of prices for a pair of lenses is just more than doubled to approximately 70.

5.1.3.2 Further instances of vertical product differentiation in spectacle lenses.

A form of vertical product differentiation arises out of whether a new frame is provided or not. This may at first sight seem surprising. But if it is accepted that a pair of spectacles without a frame is a non-entity, only the combination of frame and lenses allows a prescription to fulfill its purpose, the inclusion of a new frame does not add any additional characteristic to any pair of spectacles being supplied. It does, however increase "quality" as, presumably, a new frame is preferred to having to make do with the old one and that, according to the definition offered above, is a sign of vertical differentiation.

5.1.3.3 Vertical differentiation according to whether lenses supplied are single- or multi-focus.

A third way in which spectacles are differentiated vertically is by being single - or multi - focal. This contention, again, may seem surprising. Around the age of 45 the human species exhibits the first signs of "presbyopia", which is caused by the flexible lens within the human eye losing its flexibility and thereby causing the eye no longer to be able to focus close up. Reading matter becomes blurred and reading is rendered increasingly difficult. This fault is compensated for by wearing a pair of convex lenses, the well known "reading glasses". For a person who also requires a pair of glasses for distance the convex power has to be added onto the power he needs for distance. With these glasses, however, he can only see close up. He therefore needs two different pairs, one for distance and another one for reading. In order to save him the trouble of having to exchange two different pairs of glasses, perhaps hundreds of times per day, both prescriptions are incorporated into one lens, the bifocal lens.

It is also possible to incorporate a third focal power into one lens which will then enable the presbyopic individual not only to see clearly at a distance and close up but also at an intermediate range. This third distance may be incorporated into the lens in such a way that the focal power of the lens increases continuously from its distance value to the reading value. Such a lens is termed varifocal.

All lenses with more focal power than one are for this study considered under the heading of multi-focal. This type of lens constitutes a vertically differentiated commodity from single-focus lenses, because, provision of more than one focal power is possible by providing either two pairs of different power or one pair of multi-focals. The alternative multi-focals does not add a new characteristic, it adds "quality" through the convenience of not having to change glasses when one wants to see clearly at near.

5.1.4 Horizontal and Vertical Product Differentiation Combined.

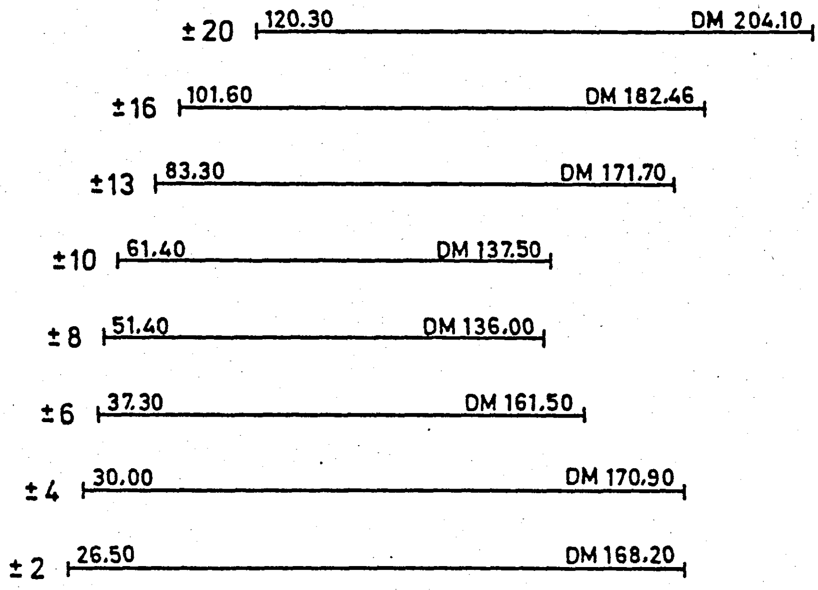
It is now possible to arrange different varieties of spectacles according to vertical and horizontal product differentiation in a two-dimensional graph as suggested by Pilati. On the vertical axis lenspowers are shown and on the horizontal axis all the different varieties in which each lens power may be supplied. A difficulty is posed by the fact that spectacles are differentiated vertically not only according to lens power but also according to whether they are supplied including a new frame or not and according to whether they are single or multi-focal. This difficulty can be surmounted by drawing four different graphs for

1. Single focus spectacles without frames;
2. Single focus spectacles including frames;
3. Multi-focus spectacles without frames;
4. Multi-focus spectacles including frames.

Fig. 2 shows as an example single-focus spectacles supplied without frames.

Fig. 2

Vertical and Horizontal Product Differentiation in Spectacles.



Source: Recommended Retail Price List of Rodenstock Lens Manufacturers, Munich, 1984.

Dividing up spectacle prices into 4 categories and depicting them in 4 2-dimensional graphs is somewhat awkward and it will later be shown how in a 3-dimensional representation all spectacle prices can be incorporated into only one graph.

In the first section of this study it was shown that neither traditional price theory nor most versions of the theory of regulation provide a satisfactory explanation of the rigid pricing structure observed in the market for spectacles. It was further shown that Posner's theory of taxation by regulation opens up avenues worthy of further exploration. This theory in turn leads one to suspect the presence of cross-subsidisation. Such cross-subsidisation might be achieved by means of price discrimination. A discussion of modern developments in the theory of price discrimination led to the conclusion that, in contrast to a widely held opinion, not only third but also second degree price discrimination might afford a viable strategy to achieve this end. But such a strategy is only possible if the product, namely spectacles, can be split up into a great number of highly differentiated varieties, albeit at a cost. Next, some theoretical and empirical aspects of product differentiation were addressed. The theoretical discussion concerning product differentiation highlighted a feature which will be of great importance in later parts of this study. It is the possibility to differentiate products vertically as well as horizontally. In the empirical part of the survey it was established that a high degree of vertical as well as horizontal product differentiation does in fact exist.

All the prerequisites for an empirical estimation of price discrimination in the market for spectacles have now been assembled. Next, empirical research which has been done in the field will be introduced and it will be discussed whether the methods used there can be usefully applied to the market of spectacles. It will be shown that the "hedonic" method using the Lancastrian characteristics framework can be used to demonstrate the existence of price discrimination in the market for spectacles. A critical discussion of the hedonic method and of its application , however, will reveal severe methodological shortcomings of the method. While it is very useful in estimating demand relationships, cost estimation by this method poses considerable problems. Alternative methods of cost estimation therefore are explored and will be used to test for the existence of price discrimination as predicted by Posner's theory of taxation by regulation. The next section will address the threefold task outlined above and,

- Describe the hedonic method.
- Apply the method to the case of spectacles.
- Explore the theoretical soundness of the hedonic method.

Chapter 6

PRICE DISCRIMINATION AND HEDONIC DEMAND AND COST FUNCTIONS.

6.1 HISTORICAL DEVELOPMENT OF THE THEORY.

The Lancastrian characteristics framework has been used extensively in so-called "hedonic" demand studies, when differentiated products had to be analysed. The method had been pioneered by Couts in 1939, but fell into oblivion until it was rediscovered by Griliches in 1961.[116] Products are viewed as bundles of characteristics. They are differentiated in so far as they contain different "amounts" of the characteristics making up the product. Some characteristics may be absent in particular differentiated products or "models". Thus a motor-car is characterized by its brake-horsepower, passenger area, length, fuel consumption, type of gear change, quality of interior fittings etc. It is argued that the price of a particular model of car is a function of the characteristics embodied therein.

$$P = f(BHP;\ PA;\ F;\ L;\ BR;\ G)$$

where P = price, BHP = brakehorsepower, PA = passenger area, F = fuel consumption BR = power-assisted brakes, G = 5-gears (or not).

If a suitable data set is obtainable, then, by multiple regression of the dependent variable price, on the "explanatory" variables, brakehorsepower, passenger area etc. a regression equation can be obtained as follows:

$$P_i = a + b_1\ BHP_i + b_2\ PA_i + b_3\ F_i + b_4\ L_i + b_5\ BR_i + b_6\ G_i + u_i$$

where a = intercept, b_1 to bn are coefficients of the independent variables BHP to G and u_i = disturbance term.

The coefficients of the independent variables can be taken as the implicit prices of these characteristics. Thus, in a study by Cowling and Cubbins.[117] the following results were obtained:

Explanatory variable	Coefficient
Constant	2.3554
BHP	0.00075643
PA	0.00002242
F	-.0037334
L	0.0019591
BR	0.10640
G	0.058276

The price of a car is then made up of $2355.4 + $0.75643 times bhp + $0.02242 times passenger area in cubic inches - $37.334 times fuel consumption per 100 miles etc.

The method was used originally by Griliches to improve consumer price indices by taking into account quality changes, which could now be measured. As mentioned above, in the U.K., Cowling and Cubbin used hedonic demand functions in 1971 to describe the

British car market. Ohta was another author to use the approach in a study of the U.S. electrical generator manufacturing industry,[118] and, together with Griliches, [119] he describes interesting aspects of used-car prices where demand influences are not distorted by monopolistic elements. It has already been shown in the section on product discrimination that the hedonic approach found intensive applications in studies of housing demand by King,[120] Straszheim[121] and McLennan,[122] to name only a few. Thus King estimated prices of such characteristics as double glazing which corresponded very accurately to the actual cost of such characteristics. On the whole, housing studies, however, estimate prices of intangibles such as quality of location, distance from work, influence of racial preponderance etc. which are not amenable to direct verification.

Rosen, in 1974[123] studied the problem more formally. He formulated a theory of hedonic prices where in multi-dimensional characteristics space an equilibrium set of implicit prices guides both consumers' and producers' decisions. His theory presupposes a competitive framework in which these implicit prices reflect both the marginal cost of supplying a unit of characteristic and the marginal valuation consumers place on them. However, if there are monopolistic elements present in the market, then each firm has its own downward-sloping demand curve and the price may diverge from the marginal cost. It must then reflect the consumers' marginal evaluation rather than the marginal cost of production..

Triplett[124] spells out this point very succinctly. He considers this a severe draw-back of the hedonic method.

6.2 APPLICATION OF THE HEDONIC METHOD AS A TEST FOR PRICE DISCRIMINATION.

However, this divergence also opens up possibilities of testing for price discrimination and cross subsidisation in markets where product differentiation is present. This idea was behind early attempts to establish the existence of price-discrimination, for instance by Bryan,[125] Shneorson,[126] and Heaver[127] who attempted to prove the presence of price-discrimination in the common rates charged by shipping companies who are organized in so-called "conferences".

A similar approach was taken in studies concerning the U.S. trucking industry, for instance by Spady and Friedlaender[128], who estimated a hedonic cost function and Ferguson et al. who did the same for the railway industry.[129]

A good example of this approach is to be found in a study by Deakin[130] who was one of the first proponents of this application. He regressed freight rates for different types of cargo quoted by maritime conferences on selected characteristics of the transported goods which he considered might have an influence on the conference rate. He distinguished between demand and cost characteristics.

Demand characteristics were such attributes as might conceivably have a (positive or negative) correlation with demand elasticity. Such a characteristic might be value per ton, implying that a high per unit value would go hand in hand with a low elasticity of demand, just as in the case of Marshall's derived demand,[131] enabling the conference to charge a higher price. A negative influence would be exercised by a characteristic such as strong competition for freighting of the good in question from charter carriers, a characteristic taken account of as "charter potential."

Cost influences would find expression in characteristics such as ease of loading, need for refrigeration, need for careful handling, dangerous cargo, etc.

Regression of prices on characteristics did indeed reveal that about 66% of differences in freight rates could be explained by demand influences, whereas cost influences had only a minor explanatory power. From this evidence Deakin concluded that, rates being mainly influenced by demand factors, particularly by per unit value, freight rates were discriminatory.[132] Of all the studies mentioned it can be said that they report one interesting aspect unanimously: demand related factors are the principal determinants of price and cost factors play only a minor role. The authors stop at this point of their research and offer no further substantiation of their claims.

It would be desirable, however, to come to a quantitative estimate of the price-discrimination effect. What are costs of individual differentiated commodities and how do they compare to prices actually charged? Or, to put it in another way, what would prices be if they were truly cost related?

Zerby and Conlon[133] in a study of conference liner rates in the Australian outbound trade published in 1983 attempt to answer this question by constructing a table of implicit freight rates derived from the kind of regression analysis mentioned above, the implication being that such prices would come about under competitive conditions. By calculating implicit prices and comparing them with the prices actuallly charged they attempt to show in numerical terms the extent of price-discrimination present.

Zerby and Conlon used data relating to 1972-73 exports of Australian goods shipped to Europe, Japan and the Arabian Gulf region respectively as classified by the Australian Export Commodity Classification. They explain differential prices of differentiated "commodities", i.e. per ton-rates charged for the transportation of particular differentiated goods, i.e. grain, machinery, meat etc. by two types of explanatory variables. The first type are cost variables, i.e. ease of loading, port efficiency and the second type are demand variables i.e. value of freighted goods, charter potential etc. In their study they isolate the following cost related factors which might conceivably influence prices actually charged:

index for ease of loading (IEL)
index for port efficiency (IPE)
dummy variable for special handling (SH)
dummy variable for hazardous cargo (HC)
dummy variable for refrigerated cargo (RC)

Demand related factors are:

value of the freighted good (VFG)
index of shippers bargaining advantage (ISBA)
index of volume and availability (IVA)
index of charter potential (ICB)

Abbreviations are given in the brackets. Thus, the n x 1 vector of observed prices, P, is explained by the n x 5 matrix of cost variables and the n x k vector of demand variables. Multiple regression will yield an ordinary least squares estimate of the coefficients of vector b and g and the intercept a in the equation:

$$\underline{P} = \underline{a} + \underline{b}'X + \underline{g}'N + \underline{u}. \qquad (1)$$

which Zerby and Conlon have written down in matrix notation. In the notation so far used in this study the equation would be written:

$$P = a + b_1 IEL + b_2 IPE + b_3 SH + b_4 HC + b_5 RC + g_1 VFG + g_2 ISBA + g_3 IVA + g_4 ICB + u \qquad (2)$$

where P = price, IEL, IPE, SH, HC, RC are the cost variables and VFG, ISBA, IVA and ICB are the demand variables and u = disturbance term.

Zerby and Conlon now go on to calculate the marginal costs of transportation of the various goods. This is done in two steps. They argue that the revenue contribution from the demand related variables, i.e. the g's in equation (2) should be left out. The first step consists in calculating the "separate" cost SC_i of each individual rate from the coefficients b_i and adding the constant term a.

$$SC_i = a + b_i X_{ij} \qquad (3)$$

Note that value of the intercept, a, is considered a cost-related factor and that only the cost variables with the magnitude estimated by the coefficients b_i have gone into the calculation. That part of revenue which is due to the demand variables g_i thus is not accounted for. These are included later.

Next, total revenue is divided into three parts: that part due to the intercept, that part due to the cost variables and that due to the demand variables. The result is shown in table 1:

TABLE 1.

Revenue Contributions of Cost and Demand Variables. (Millions of $A)

Actual revenue	$110.47
Revenue contribution of hedonic cost variables	$42.113
Revenue contribution of intercept	$48.751
Revenue contribution of hedonic demand variables	$2.915

Now a "scale factor" is calculated such that the missing part - revenue due to the demand related variables - is added onto the cost-based price. This is done by dividing total revenue by the sum of the revenue contributions of the intercept and the cost-related variables. This can be expressed in a formula:

$$k_2 = \frac{\sum P_i Q_i}{\sum\sum b_i X_{ij} Q_i + a \sum Q_i}$$

where b and a = coefficients derived from the multiple regression.

The scale factor works out at:

$$k_2 = 1.216$$

The second step in Zerby and Conlon's calculations is now performed. "Separate cost" of transportation of each transported good estimated according to formula (2) is multiplied by k_2 in order to arrive at the "implicit" prices i.e. the rates at which goods are transported. According to Zerby and Conlon these implicit rates are those which would come about under pure competition. They calculate these "implicit" prices according to the formula:

$$P_i = K_2(a + b_i X_{ij}) \qquad (4)$$

Table 2 shows implicit rates (column 2) for shipment to Europe of selected goods derived by Zerby and Conlon displayed alongside actual rates (column 1).

There is a further column showing implicit rates as percentage of actual rates (column 3) and a column showing implicit rates as percentage of longrun average cost derived by a non-hedonic estimate in an earlier article by the authors (column 4).[134]

TABLE 2.

Actual and Implicit Rates Compared.

	(1) Actual Rates	(2) Implicit Rates	(3) %Implicit /Actual Rates	(4) %Implicit /LRAC
Machinery	156.48	114.14	72.9	39.0
Meat products	102.73	90.38	88.0	59.4
Dairy products	86.05	77.24	89.8	70.9
Fresh fruit	69.26	71.59	103.4	88.1
Wool	68.00	77.22	113.6	89.7
Other crude mat.	57.33	62.81	109.6	106.4
Other food prod.	46.27	60.97	131.8	131.8
Nuts and seeds	26.21	41.49	158.3	232.7
Dried fruits	21.31	37.24	174.8	286.3
Minerals, ores	18.09	23.56	130.2	337.2
Grain	11.96	45.84	383.3	510.0

Source: Zerby and Conlon,"Joint costs and Intra-Tariff cross Subsidies," Journal of Industrial Economics. 1983.

The table shows some interesting features. Some rates, those for machinery, meat and dairy products are well above cost. For others, fresh fruit, wool, crude materials, costs and rates approximately coincide. But there are some rates which are well below costs, for instance dried fruit which is being transported at a rate approximately 45% below cost and, most notably, grain, the rate of which covers only about 30% of its cost.

Another interesting feature is the discrepancy between LRAC estimated conventionally and the cost estimated with a hedonic specification. Zerby and Conlon estimated in a separate study[135] LRAC to be A$ 61.0 per tonne. Comparison of columns (3) and (4) shows that recognition of differential costs by a hedonic specification indicates a discrepancy between actual and implicit rates that is much smaller than would appear from the much cruder, conventional cost estimate.

6.3 AN EMPIRICAL APPLICATION OF THE METHOD IN THE MARKET FOR SPECTACLES.

Next, the method proposed by Zerby and Conlon will be used to estimate the implicit prices of spectacles and to compare them with the prices actually charged. It is to be noted here that later on in this study reservations will be made concerning the method used by Zerby and Conlon and improvements will be suggested. Nevertheless it is an accepted method and it was felt that the exercise of estimating cost based prices by this method would help to clarify the improved method ultimately to be used in this study.

In order to undertake the task a random sample of 450 sales records was obtained from one of the writers' 5 optical practices in West-Germany. Randomness of the sample has been ensured as far as practically possible by obtaining a complete set of records for a specified time period (6 weeks).

Each record contains the following information:

- An identification number. This allows a check against the original record if a value in the dataset as shown on a computer printout appears to be very improbable.

- Dioptric power of lens. (Technical terms such as this one and also the following have already been explained).

- Whether the lens is toric.

- Whether the lens is multifocal.

- Price of the pair of lenses.

- Price of the spectacle frame (if applicable).

- Raw material price of the lenses.

- Raw material price of the frame (if applicable).

The cost and demand variables now have to be selected. In the case of spectacles such variables come to mind easily. In freight rates it is unit value which has great influence on demand. With spectacles a similar influence can be attributed to the value of raw material. Likely cost influences are:

1. whether the prescription is toric. This characteristic influences costs at the workshop level.

2. When spectacles are supplied including frames this entails additional costs for display and the costs of the time spent in serving the customer.

3. A further cost factor would be the sight-test because this involves additional labour-time and cost of equipment and room costs.

The information contained in the records is set up in 7 columns. The prices of spectacles can be read directly from the records, as can raw material prices. The other variables have to be represented by dummy variables (1= yes, 0 = no). The variables are shown in the following list. (names given in brackets)

1) Dummy variable for lens being toric. (TORDUM).

2) Dummy variable for lens being multifocal. (MULTDUM).

3) Dummy variable for frame included in the pair of spectacles sold (FRIDUM).

4) Raw material price of frames and lenses. (RAWCOST).

5) Total price of pair of spectacles as charged to the customer. (RETPRICE).

PRICE was taken as the dependent variable and regressed against the 4 "explanatory" variables RAWCOST, TORDUM, MULTDUM, FRIDUM.

$$P = a + b_1 RAWCOST + B_2 TORDUM + B_3 MULTDUM + B_4 FRIDUM + u$$

The result of the regression is shown below.

TABLE 3.

Regression Results.

VARIABLE	REGR. COEFFICIENT	t-VALUE
RAWCOST	2.42	119.39
TORDUM	3.95	1.76
MULTDUM	23.67	6.55
FRIDUM	23.40	8.73
CONSTANT	24.81	

ADJUSTED R^2 = .9839.

R^2 is .9839. This implies that the correlation between the explanatory and dependent variables is nearly perfect. Such a result is very rare in empirical studies and might lead one to suspect multi - collinearity. However, the partial correlation coefficients, i.e. the measure of correlation between each explanatory variable taken separately and the independent variable suggest that this is not the case. The T-ratio of RAWCOST is significant at the 99.9% level. The T-ratios of MULTDUM and FRIDUM at the 99% level of confidence whereas TORIC is significant at the 90% level.

The individual prices of pairs of spectacles can now be calculated in the following manner: Take common cost which is given by the value of the intercept, multiply the raw material price by 2.42 and add it to the value of the intercept. Then add DM 3.95 if the lenses are toric; DM 23.67 if the lenses are multifocal and DM 23.4 if frames have been supplied together with the lenses.

The influence of each variable can be shown by calculating the price of three pairs of spectacles; one at the low end of the price scale, one at the mean of the sample and one at the high end of the price scale using the coefficients derived from the hedonic regression.

TABLE 4.

Contribution to Price of the Hedonic Demand and Supply Variables.

	DM	%	DM	%	DM	%
INTER CEPT	24.81	19.6	24.81	10.0	24.81	4.7
actual RAWCOST	(30.53)		(74.03)		(202.00)	
2.42 x RAWCOST	73.88	58.6	179.15	71.3	488.84	86.6
TORIDUM	3.95	3.2	-.-	-.-	3.95	.7
MULTDUM	-.-	-.-	23.68	9.4	23.68	4.2
FRIDUM	23.4	18.6	23.4	9.3	23.4	4.1
TOTAL	126.05	100	251.04	100	564.28	100

The columns show for each variety the absolute amounts in DM contributed by each demand and cost variable. A second row shows the contributions as percentage of the total price of each individual pair of spectacles. The most interesting feature is the influence of the demand variable. It is derived by multiplying the actual cost of the raw materials by 2.42.[136] It can be seen that the influence of the demand based variable, i.e. RAWCOST, is the principal determinant of price, as it accounts for 58.6 %, 71.3 % and 86.6 % of the respective total prices. This can be interpreted as being proof of price discrimination. Roughly, this is the method employed, for instance, by Deakin[137], Bryan[138] and Shneorson.[139]

However, it is also possible to go a step further and construct cost based prices for spectacles in the manner pioneered by Zerby and Conlon. With spectacles these prices are calculated slightly differently. They are made up in the same way as far as the constant is concerned. The constant is the basis of the price of each variety. Separate costs are then added as estimated by the multiple regression. In the case of spectacles additional data are available concerning 2 categories of separate cost which is not available in the freight rate data. A cost category which Zerby and Conlon do not have to pay attention to simply because it does not exist for freight rates on international routes is value added tax. It is taken here account of by deducting VAT from total revenue. The second cost category is the actual cost of rawmaterial. To avoid any confusion, it is necessary to be quite clear about the double role which RAWCOST plays in the estimation of spectacle prices. On the one hand RAWCOST multiplied by the coefficient derived from the regression is a measure of the influence which RAWCOST has on the actual price of spectacles. This is 2.42 times its value in money terms. On the other hand, the price of raw material is in fact a separable cost attributable to products, but this time expressed in money terms. It is only in the second sense that RAWCOST goes into the calculation of a cost-based price. The calculation of cost based or, to use the terminology of Zerby and Conlon, implicit prices proceeds in the two steps. The first step consists in adding the value of the raw material and the values of the estimates of the coefficients from the hedonic regression to the value of the intercept. This first step in the calculation of the cost-based prices of the three examplary pairs of spectacles is shown in Table 5.

TABLE 5.

Cost Based Prices of Spectacles, First Step in Calculation.

	LOW PRICE	MEAN PRICE	HIGH PRICE
INTERCEPT	24.81	24.81	24.81
RAWCOST	30.53	74.03	202.0
FRIDUM	23.4	23.4	23.4
TORDUM	3.59	-.-	3.59
MULTDUM	-.-	23.68	23.68
	82.33	145.92	277.48

When all individual prices are calculated in this way they will not add up to total revenue, as explained before in the exposition of the Zerby and Conlon method. Therefore the second step is made. According to these authors it consists in the estimation of a scale factor, k_2, such that by multiplication of the individual cost-based prices by the factor total revenue is accounted for and by employing this factor to arrive at the implicit prices. This factor is calculated according to Zerby and Conlon by the formula:

$$k_2 = \frac{\sum P_i Q_i}{a \sum Q_i + \sum\sum t_i X_{ij}}$$

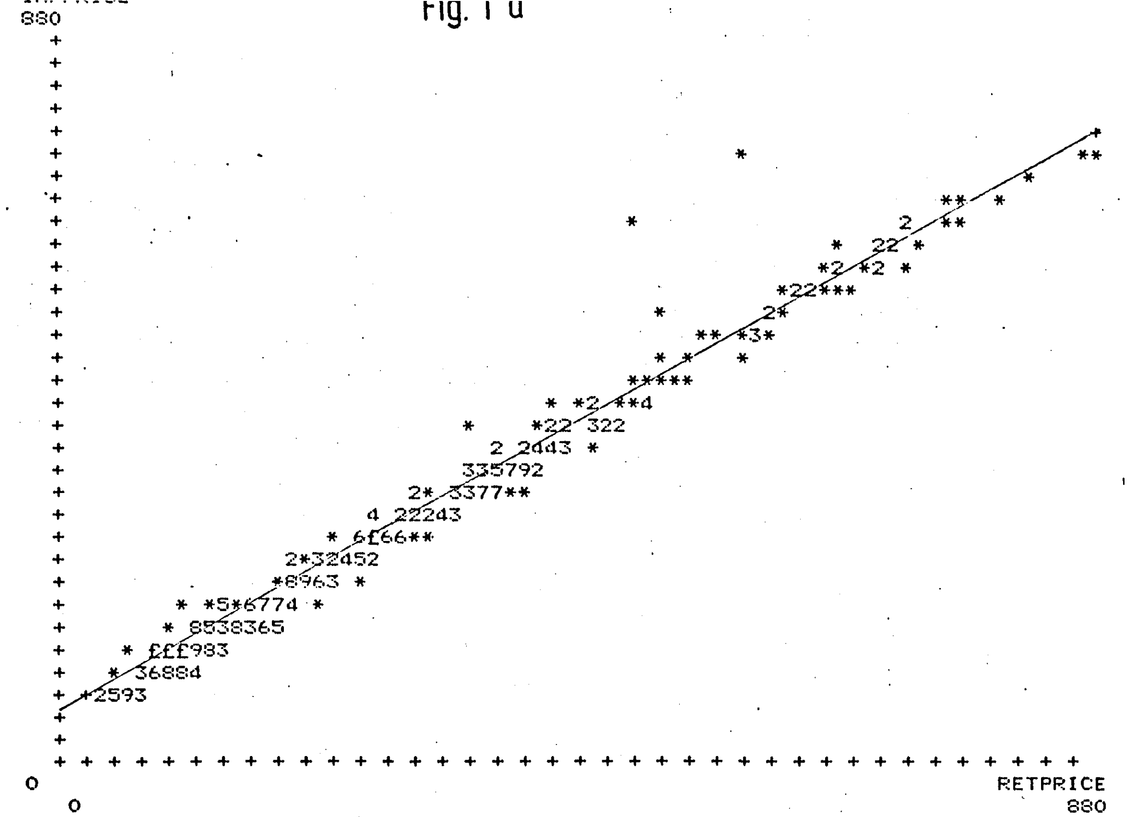
The factor k_2 was duly calculated and found to be 1.661. In the next step implicit prices of all the individual pairs of spectacles were calculated by multiplying the cost figures calculated in the first step in the manner suggested by Zerby and Conlon by k_2 and then adding VAT. These "implicit" prices were matched to actual prices. Following the method suggested by Zerby and Conlon the resulting pairs of actual and implicit prices were then ordered in ascending order of actual prices yielding 450 pairs of prices. In Table 6 every tenth pair is displayed.

Actual and Implicit Prices of
Every Tenth Pair of Spectacles.

COUNT	ORDACT	ORDIMPL
1	13.25	50.78
10	31.05	99.51
20	44.00	64.31
30	61.40	76.54
40	64.50	110.43
50	67.85	112.97
60	72.70	116.38
70	73.45	123.69
80	73.60	123.65
90	76.35	118.95
100	78.70	96.38
110	84.00	99.25
120	89.85	135.23
130	95.05	132.12
140	106.10	108.03
150	112.40	119.24
160	123.15	158.68
170	136.00	135.85
180	149.50	152.15
190	158.70	178.22
200	168.00	177.73
210	177.00	190.56
220	184.35	194.98
230	198.00	172.72
240	213.80	190.62
250	233.30	230.02
260	241.00	242.37
270	248.60	245.44
280	259.90	242.04
290	277.30	255.70
300	300.10	306.00
310	322.35	298.90
320	340.10	321.90
330	352.30	318.55
340	359.00	325.50
350	371.80	336.23
360	385.00	346.78
370	398.80	394.12
380	419.00	378.18
390	450.60	409.04
400	490.70	413.12
410	569.60	743.01
420	605.50	546.55
430	659.80	610.89
440	713.80	599.68
450	876.40	751.00

where,
COUNT = CASENUMBER, ORDACT = Price actually charged sorted in ascending order, ORDIMPL = "Implicit" price of ORDACT.

A pattern similar to that reported by Zerby and Conlon in their comparison of actual and implicit freight rates emerges. At the low end of the price scale the price actually charged is DM 13.20. The calculations, however, imply that a price of DM 69.0 is the implicit price. At Count 101 the discrepancy has decreased to some extent but the actually charged price is still considerably below the implicit price. At count 220 almost exactly at the mean of the sample, actual and implicit price are almost equal. From then on a discrepancy opens up in the opposite direction; the implicit prices are now below the actual prices. This discrepancy widens the higher the actually charged prices become. If it is assumed that the implicit prices calculated according to the method suggested by Zerby and Conlon are indeed cost-based, then, in the lower half of the price scale for spectacles actual prices do not cover cost, whereas in the higher price scale they exceed cost. The existence of price discrimination in the market for spectacles has then been proven and a numerical measure has been put on it by using the device of estimating cost-based prices by the method suggested by Zerby and Conlon. The actual and implicit prices can can also be depicted graphically. This is shown in Fig. 1.



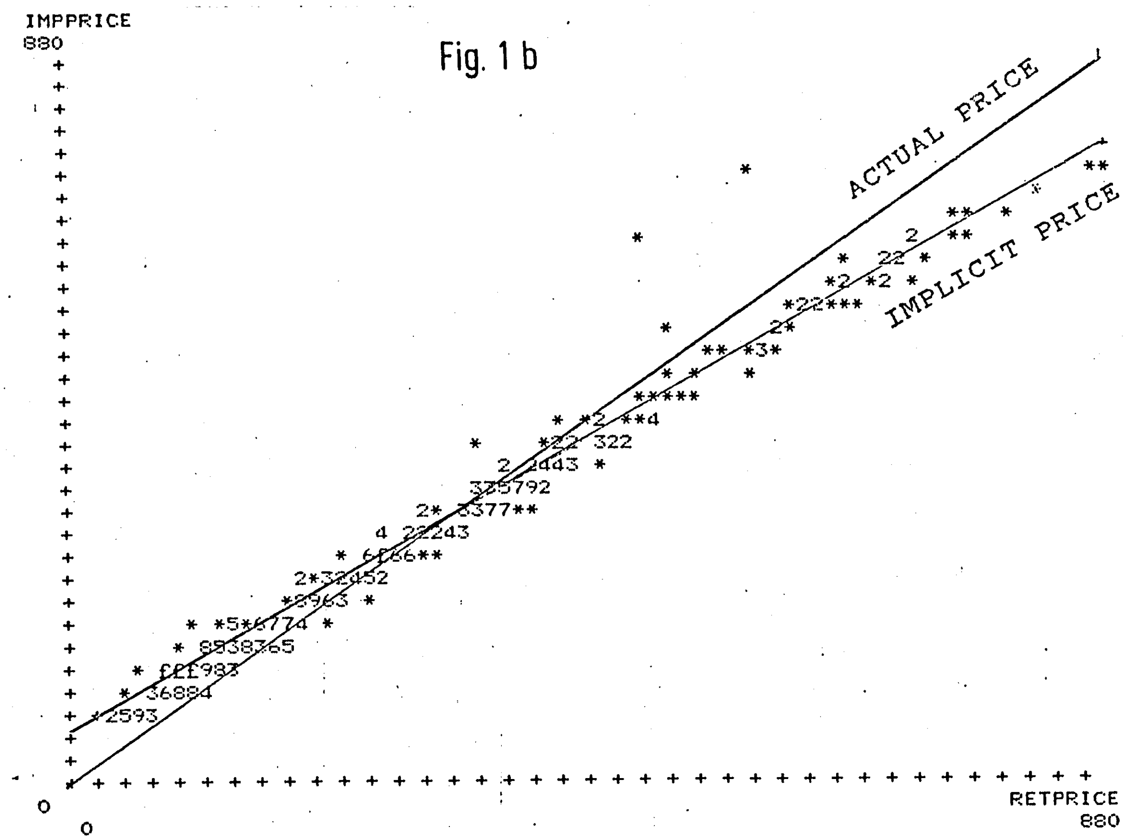


Fig. 1a shows a scatterplot of the implicit prices with their regression line. Implicit prices are measured along the vertical axis and actual prices along the horizontal axis. In Fig. 1b the line of actual prices is added.[140] It now becomes even more evident that at the low end of the price scale the implicit prices ly below the prices actually charged in the market, i.e. these items are sold at prices which do not cover cost. The discrepancy becomes smaller with increasing actual prices until at point b actual price = implicit price. Beyond this point profits are made.

6.4 CRITICAL APPRAISAL OF THE HEDONIC METHOD.

It is necessary now to consider in some detail a number of objections to the principles underlying the hedonic method in general and the Zerby and Conlon approach in particular. These objections apply to:

1. Cost estimation when different varieties of a commodity are produced.

2. Incorporation of the distinction between horizontal and vertical product differentiation and between second and third degree price discrimination.

3. Estimation of cost-based variables in a monopolistic environment.

6.4.1 Cost Estimation when Different Varieties of a Commodity

are Produced.

The regression equation obtained from regressing the independent variable on one or several "explanatory" variables almost invariably results in an intercept or constant term of considerable magnitude in addition to the estimates of the coefficients of the "explanatory variables". This is generally a puzzling feature of hedonic regressions. Usually, the constant term is interpreted as representing common cost. Hay and Morris discuss the point.[141] Zerby and Conlon have difficulties with the intercept, although they do not admit to it explicitly. They distinguish between separate, or, in their terminology, "separable", and common costs. Separable costs to them are those costs which find expression in the calculation of the cost-based variables. This can be expressed mathematically.

As total revenue = separable costs + common costs + profits, then:

$$\sum P_i Q_i = \sum\sum SC_{ij} Q_i + e \qquad (5)$$

where P_i = price of the i-th commodity, Q_i = quantity of the i-th commodity, SCi = separate cost of the ith good, SC_{ij} cost of the ith good in its j-th activity and e = residual of common cost and profit.

Zerby and Conlon calculate $\sum\sum SC_{ij}Q_i$, the sum of separate costs from the regression equation. The sum of common costs and profit is then the difference between total revenue and the sum of separate costs. This difference is denoted by Zerby and Conlon as the residual e. They treat the residual e, which contains them both, as a cost factor. The problem of allocation however, they attack in two steps. First, in effect, they treat the constant term (intercept) in the regression equation as a separate cost. Their sum of separate cost, then is:

$$\sum SC_i = a \sum Q_i + \sum\sum b_i X_{ij} Q_i \qquad (6)$$

Secondly, they estimate the residual e by treating the intercept as a common cost and adding to it the revenue contribution of the demand based variables. Obviously they are not fully aware of the logical contradiction which lies in treating the intercept in the first case as separate cost and in the second case as common cost. It will later be argued that this contradiction is resolved when the distinction between the theory of joint cost and that of price discrimination is fully understood. Leaving this problem aside it is proposed to follow the argument of Zerby and Conlon for the time being.

When the sum of separate costs defined in their manner is calculated then it does not add up to total revenue because the revenue contribution of the demand based variables is left out. As has been shown Zerby and Conlon go on to estimate a scale factor, k_2, by dividing total revenue by the sum of separate costs estimated according to their formula and then multiply the separate cost of each individual good by this factor in order to arrive at what they consider to be its marginal cost. Zerby and Conlon treat the cost figures estimated in this way as the "implicit prices" of the different varieties of the commodity, namely transportation of goods. But thereby they employ a method of cost allocation which has been denounced as lacking any rational basis in almost all discussions of joint cost. P.G.D. Wiles puts the point succinctly:

> "Joint costs are usually inallocable on technical grounds alone, just as the physical product is inallocable between several factors of production."[142]

Zerby and Conlon argue this point themselves:

> "there is no way of justifying them empirically".[143]

However, it is possible to argue that the problem of common cost allocation is not as grave as appears at first sight. To make the matter quite clear it is necessary to address once more a problem which has briefly been mentioned before in this study. It concerns the distinction between the theory of joint production and the theory of price discrimination. This distinction has been very clearly stated by Phlips:

> " To invalidate the concept of price discrimination, it suffices to proclaim that two varieties (of a commodity) are in fact two different commodities. ...... If these commodities result from a "joint" production process, then the theory of joint production is relevant. The latter theory offers an

> alternative analytical framework, . , ... Only a detailed analysis of a particular case will make clear whether a model of price discrimination is relevant or whether one should set up a model of joint production.[144]

Phlips demonstrates the difference in the light of the debate between Taussig and Pigou about the theory of railway rates. Taussig maintained that the commodities transportation of coal and transportation of copper were jointly produced commodities and that therefore their costs had to be allocated according to their demand prices, in the same way in which the respective prices of wool and mutton are determined by their respective demand functions and the marginal cost of providing the joint bundle.[145] Pigou argued that transportation of copper and transportation of coal are the same commodity and that different prices for the two commodities therefore are discriminatory.
In "The Economics of Welfare" Pigou dedicated an entire chapter to the theory of railway rates. He argued that under competitive conditions transportation of copper and transportation of coal would be provided at equal prices. Pigou also argued that differences between different passenger classes are often far in excess of cost differences between these two varieties of the same good and therefore, just as price differences between freighted goods, constitute an effort to collect consumers surplus by way of price discriminating.[146] Phlips goes on to demonstrate that the age old debate is just as valid today by discussing the question of whether air fares are discriminatory or not. In his opinion, price differences between freight and passengers can be explained by the theory of joint production and would

therefore also occur in a competitive environment; differences between tourist and first class service in excess of differences in separate costs, however, are discriminatory and would be absent under pure competition.

Returning now to the discussion of Zerby and Conlon's methods it can be said that the intercept a which is a constant and the same for every differentiated variety is a cost "common" to all varieties and therefore common cost and not a separable cost as implied by the calculation of implicit prices by Zerby and Conlon.

However, it is possible to argue that the problem is not as grave as seems at first sight. A case can be made for the argument that Zerby and Conlon have found a correct solution for an incorrect reason. If the constant term indeed represents common cost then, by apportioning an equal sum to every product as they do in their calculations they employ a defensible method of cost allocation. But this contention needs an explanation which they do not make explicit. Only for single product firms can common cost be allocated by dividing the block of common cost by number of units produced and allocating to each individual product this cost figure.[147] As differentiated goods consist of one common characteristic and are differentiated by containing additional characteristics for every variety, then it can be argued that a rational method of allocation is division of the block of common cost by the number of goods produced and apportioning to each its share of common cost. Inadvertently, then, Zerby and Conlon have applied a defensible solution - but only up to this point. For now they change their procedure. When the sum of separate costs is calculated according to Zerby and Conlon's definition, then it does not add up to total cost because the demand-based variables are left out. Zerby and Conlon, as was shown estimate a "scale factor" k_2 by dividing total revenue by the sum of separate cost - estimated according to their definition - and then multiply the "separate cost" of each individual good by this factor in order to arrive at what they consider its marginal cost.This procedure must be regarded as arbitrary.

There is, however, a defensible solution to this problem. If it is accepted that the output of a firm consists of a single product split up into a number of differentiated commodities then the firm is a single product firm and average cost can be calculated by dividing total cost by the number of units produced.

In the discussion of the model of second degree price discrimination in the presence of product differentiation developed by Jacob and Jacob, and in the extension to product differentiation of Clemens's model of third degree price discrimination developed by the author, it was shown how product differentiation at a cost can be incorporated into the theory of price discrimination. If products are differentiated at a cost, then the cost of each variety consists of the cost of the undifferentiated variety, i.e. average cost and to it there has to be added the separate cost to arrive at the marginal cost of each variety. When there are no separate costs average cost is simply calculated by dividing total cost by number of units produced:

$$AC = \frac{TC}{Q}$$

When separate costs are present then each variety has its own separate cost and average cost is calculated by dividing total cost with separate cost "netted out" by number of units produced:

$$AC = \frac{TC - \sum SC_i}{Q} \qquad (7)$$

Where, AC = average cost, Sci = separate cost of the ith product, TC = total cost per time period, and Q = number of units produced in that time period.

Thus it would appear that the calculation of costs of different varieties can be achieved by a slight change in Zerby and Conlons's method. Instead of calculating AC_i in the multiplicative manner employed by Zerby and Conlon it would appear that a superior method of calculating the marginal cost of different varieties of a product has been found. The marginal costs of different varieties of a product would be found by first calculating AC_i by formula (7) and then adding SC_i calculated from the regression coefficients of the hedonic regression.

However, the matter is more complicated than that. Two important reservations have to be made. They concern:

1. The necessity to incorporate the distinction between vertical and horizontal, and , consequentially, the distinction between second and third degree price discrimination into the model.

2. The nature of cost estimation by the hedonic method in a monopolistic environment.

6.4.2 Incorporation of the Distinction between Vertical and Horizontal Product Differentiation.

It has been shown in Division 4.4.2., in the discussion of the theory of price discrimination that contrary to a widely held opinion second degree price discrimination is a feasible profit-maximizing strategy for firms which exert some monopoly power and are in a position to differentiate between different varieties of products produced or marketed. The discussion showed further that with differentiation between different varieties of a product it is to be expected that additional costs are incurred and that this differentiation at a cost plays a decisive role if second degree price discrimination is to be successfully implemented. Furthermore a model was developed which showed that third degree price discrimination is also a profit-maximizing price strategy which might well be encountered in practice when different varieties of a product are differentiated at a cost.

It has further been shown[148] that products and varieties of a product may be differentiated vertically as well as horizontally. Louis Phlips suggests that horizontal product differentiation goes hand in hand with second and first degree price discrimination, as in this case the market is split into segments horizontally and that third degree price discrimination is associated with vertical product discrimination as then the market is split vertically.[149] It can therefore be suspected that both types of price discrimination may occur together. Quite apart from the well- known implications for welfare theory, i.e. that second degree price discrimination is Pareto- efficient in contradistinction to third degree and that it also plays a central role in the theory of "second best" there is a very practical reason for making the distinction explicit pertaining to the market for spectacles: It has been shown[150] that spectacles supplied under the German National Health system in principle are supplied free of charge but that approximately 80 percent of consumers choose a better quality in which case the National Health payment is deducted from the price of the glasses and therefore constitutes a subsidy payment. In effect, the consumer therefore pays out of pocket only for the additional characteristics, not for the basic commodity - correction of faulty vision. It is therefore the prices of the additional characteristics which determine his reservation prices. As differentiation according to additional characteristics constitutes horizontal product differentiation, then, if there is price differentiation between these products it must be second degree. National Health funds pay differential prices according to the power of the glasses supplied. Differentiation according to lens power was shown to be vertical product differentiation implying third degree price discrimination. The optimal set of prices and output of additional characteristics will therefore be determined according to the model of second degree price discrimination, that for the basic characteristics by that of third degree. It is easy to imagine that in this complicated situation it is imperative to discern between horizontal and vertical price- and product differentiation in order to arrive at an adequate picture of the pricing structure under observation.

6.4.3 Estimation of a Hedonic Cost Curve in a Monopolistic Environment.

It might appear as though the hedonic method affords a satisfactory measure of separate and common costs. The hedonic regression allows one to estimate separate costs for differentiated varieties. But, unfortunately, once the assumption of pure competition is dropped a formidable objection has to be made to the method. Zerby and Conlon recognize themselves that for their cost figures to be taken as implicit prices pure competition is a necessary assumption.[151] This is explicitly stated in the model suggested by Rosen[152] and K.S. Palda[153] raises the point. The coefficients of the demand based variables are a function of the monopolistic power at the disposal of the seller and can therefore only occur in a monopolistic environment. If there were pure competition the coefficients of the demand variables would equal unity. The prices would indeed be cost based and there would be no need to employ a scale factor in order to arrive at the implicit prices. The quantities of goods sold valued at these prices would add up to total revenue in any case. As it is, however, the coefficients of the demand based variables considerably exceed unity. Quite rightly, Deakin, Bryan et alii conclude that demand variables exceeding unity are a sign of price discrimination. They stop at this point, whereas Zerby and Conlon go on to estimate their implicit prices by multiplying the cost variables including the constant term by the scale factor k_2. The explanation they offer is that:

> "The artificial set of prices represents a considerable improvement over estimates of the long - run marginal costs per unit of output with separate costs not taken into account".[154]

The same point is made by other researchers who use the hedonic method.[155] Zerby and Conlon themselves admit:

> "A more inhibiting feature of the method is the explicit assumption that the quantity

> weights remain unchanged with a new, artificially determined set of prices...... the new set of quantity weights is likely to ..... produce a new set of implicit prices."[156]

A further weakness of the method, admitted by Zerby and Conlon, but also discussed by Spady and Friedlaender, are the severe data limitations usually encountered by researchers. They often necessitate the use of proxies and constructed indices. Thus Zerby and Conlon, in order to measure cost influences, use subjectively constructed indices for ease of loading and for port efficiency. The impact of the need for special handling and for refrigeration they assess by using dummy variables. It will be seen later that in the empirical estimation of the demand and cost variables it is not possible to avoid the use of proxies altogether, particularly as there is no realistic substitute for them as far as estimation of a hedonic price schedule is concerned. It will be shown, however, that work measurement according to conventional principles can greatly improve the significance of the cost estimation.

A further point of criticism was raised in a discussion between Y. Barzel and Ohta and Griliches.[157] The hedonic method is essentially "ex post". Separate costs which do not find expression in price differences can never be detected by the investigator. This objection only applies in a monopolistic environment because in pure competition cost differences would necessarily find expression in price differences. Also, the set of characteristics on which the regression is performed has to be guessed by the investigator. No matter how careful he may be in trying to select all the relevant variables, there is always a chance that important variables are left out and that the estimates of the coefficients are consequentially distorted. Nevertheless, it is possible to avoid most of the ambiguities connected with the hedonic method at least as far as the estimation of separate costs is concerned. In order to establish the existence of price discrimination it is sufficient to show that prices of different varieties diverge by more than is justified by differences in separate cost. It is possible to estimate separate costs directly by methods well established in conventional cost accounting.[158] Separate costs are termed "prime" or "direct" costs by cost accountants and measuring them is straightforward. In spite of this, normally, such cost studies are not available for empirical research, either because such studies do not exist or, because they are not made available by firms for obvious reasons. There are no studies available concerning the optical retail trade . However, there was no difficulty in conducting such a study in one of the authors own optical practices.

A much more difficult task is that of disentangling common cost and profit. In any model of price discrimination the assumption is made that pricediscrimination results in a monopoly profit to the price discriminator. In the model of Jacob and Jacob the assumption is made that prices of differentiated varieties of a commodity are made up of three components, namely common cost component, separate costs and a profit component. Thus, profits have to be determined also. Profits are the difference of total revenue and total costs. An attempt to estimate this difference is undertaken in the cost study as a second task. It will be shown that the relevant cost concept is that of long-run marginal cost, i.e. costs under total adaptation and these costs will be estimated in a kind of engineering cost study. This cost estimation is greatly facilitated as it can be shown that marginal costs are constant. It will then be possible to calculate the profit residual. However, in the literature it is acknowledged that this is one of the most difficult undertakings theoretically as well as empirically. The results of such estimation can therefore only be tentative.

It is, however, possible to estimate on a completely disaggregated basis separate costs of each individual differentiated product contained in the sample. It is then possible to compare prices achieved in the market with differences in separate costs, thus to obtain a meaningful measure of price-discrimination and test the predictions of the model of Jacob and Jacob.

6.4.4 Conclusion.

The criticism of the hedonic method suggests two avenues worthy of exploration:

1) A model of price discrimination has to be

developed which incorporates the distinction between vertical and horizontal product differentiation.

2) Separate costs and average costs under total adaptation have to be estimated in a kind of engineering cost study.

These tasks will be addressed in the next two chapters.

Chapter 7

PRODUCT DIFFERENTIATION COMBINED WITH PRICE DISCRIMINATION: THE DISTINCTION BETWEEN HORIZONTAL AND VERTICAL DIFFERENTIATION INCORPORATED.

7.1 HORIZONTAL PRODUCT DIFFERENTIATION AND PRICE DISCRIMINATION.

7.1.1 The General Model.

Pilati's diagram describes very adequately vertical and horizontal product differentiation.[159] In order to show price discrimination, however, it is necessary to incorporate costs into the picture. It has been established how second and first degree price discrimination can be implemented with the help of product differentiation at a cost.

Fig. 1

Second Degree Price Discrimination with Product Differentiation at a Cost.

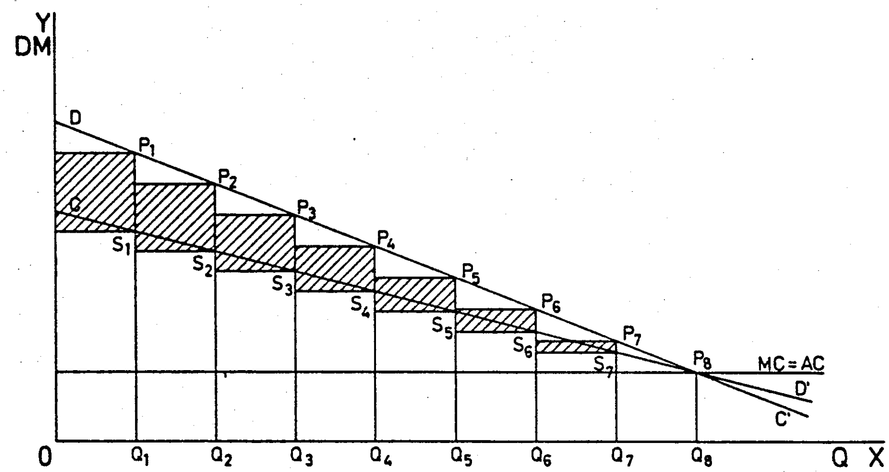


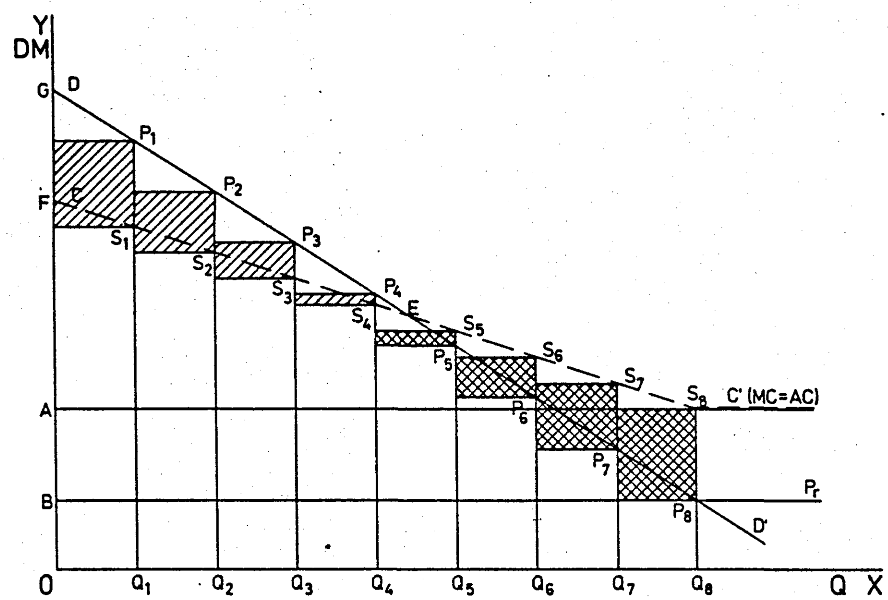
Fig. 1 is drawn following Jacob and Jacob. It illustrates diagrammatically how a rational monopolist would set prices for a line of 8 differentiated products. Prices and quantities of each variety would be determined in accordance with formulae x in paragraph x. which assumes linear demand and cost functions. The lowest price, P_8, will just cover the marginal cost of product 8, which will be the basic variety produced at marginal cost MC, here assumed to be constant and therefore equal to average cost. Variety 7 will entail marginal cost MC plus separate cost S_7 but will be sold at price P_7 which is higher than $MC+S_7$. Variety 6 will be sold at price P_6 where the gap between price and cost is still greater, and this gap will increase with every variety as the vertical axis is approached from right to left. Draw lines joining P_1 to P_8 and C_1 to C_8 to give demand curve DD' and cost curve CC' respectively.

7.1.2 With Price of Basic Commodity Regulated.

Now consider the case where price P_8, i.e. the price of the basic commodity has been set by a regulator below MC. This regulated price is shown as P_r. Such a situation is not compatible with traditional price theory except in very special circumstances, as it contradicts the assumption of profit maximising behaviour. From what has been said concerning taxation by regulation, however, such a situation may well arise in a regulated industry. It is shown graphically in Fig. 2.

Fig. 2

Second Degree Price Discrimination with Product Differentiation at a Cost: Prices for Basic Variety regulated.



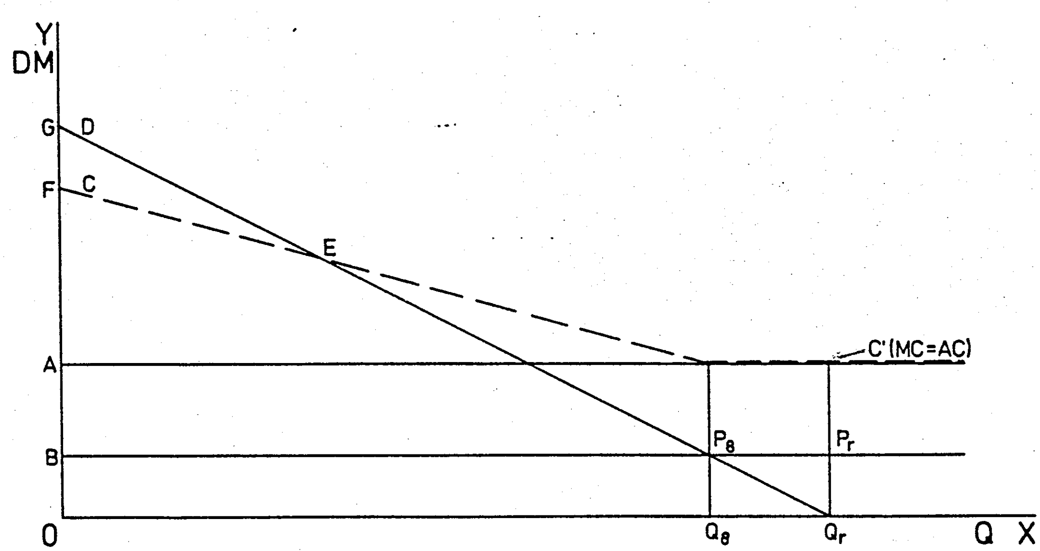
Variety 8 will be provided at price P_8, i.e. at the regulated price P_r which does not cover marginal cost and the quantity sold will be determined by the demand function: It will obviously be greater than the quantity produced in the absence of regulation and will be sold at a loss. The rationale for price discrimination, however, will not be changed by the imposition of a regulated price below cost if the seller is free to offer differentiated products at unregulated prices in the market. If the seller were to offer only the regulated variety then his loss would be equal to area A S_8 P_8 B. By offering differentiated varieties, some of which may even be below MC + S his losses are reduced and may even be turned into profits. Losses are shown in the figure by the doubly shaded areas and profits by the singly shaded areas. In the limiting case of perfect price discrimination his profit or loss would be the difference between triangles G F E and E P_8 S_8. Hence, by the impostion of a regulated price below MC the strategy for setting optimal prices remains the same as in an unregulated market, with the additional condition that prices below marginal cost will be set such that losses will be minimized.

7.1.3 With Regulated Prices and Subsidies.

However, the intricacies of the German National Health system make the situation more complex. The insurance funds provide the basic variety free of charge to the consumer and the price paid by the funds normally does not cover cost.

Fig. 3

Second Degree Price Discrimination and Subsidies.



Assuming that demand curve DD' and cost curve CC' are not changed when provision is free of charge this situation is depicted in fig.3. As the consumer is provided with the basic variety at zero cost, Q_r, quantity demanded, will now be determined by the intersection of the demand curve with the X-axis. If the producer were to provide variety P_r only, losses incurred would equal area A C' P_r B. As discussed above, by setting discriminatory prices for different varieties the producer can either minimize, compensate or overcompensate his losses depending on the demand and cost functions he faces. Assuming linear demand and cost functions and first degree price discrimination, losses or profits will be determined by the difference between areas G E F and E C' P_r Q_3 E. For second degree price discrimination the difference will be an approximation to this.

In Germany, however, the consumer does not have to be content with the basic quality provided by his fund. He is free to choose any frame or any type of lens if he is prepared to pay the "private", i.e. unregulated price. Contrary to practice in the U.K. he does not lose the sum which his insurance fund contributes towards the cost of his glasses. This sum is deducted from the "private" price and paid by the fund directly to the optician. Over 8o% of consumers in Germany choose either a better frame, better lenses or both. To them the insurance payment is in effect a subsidy payment, reducing the price of their spectacles. In Lancastrian terms, the consumer receives a basic commodity, correction of faulty vision, free of charge and buys addtional characteristics at his own expense.

Fig. 4

Second Degree Price Discrimination with Subsidies and Regulated Prices.

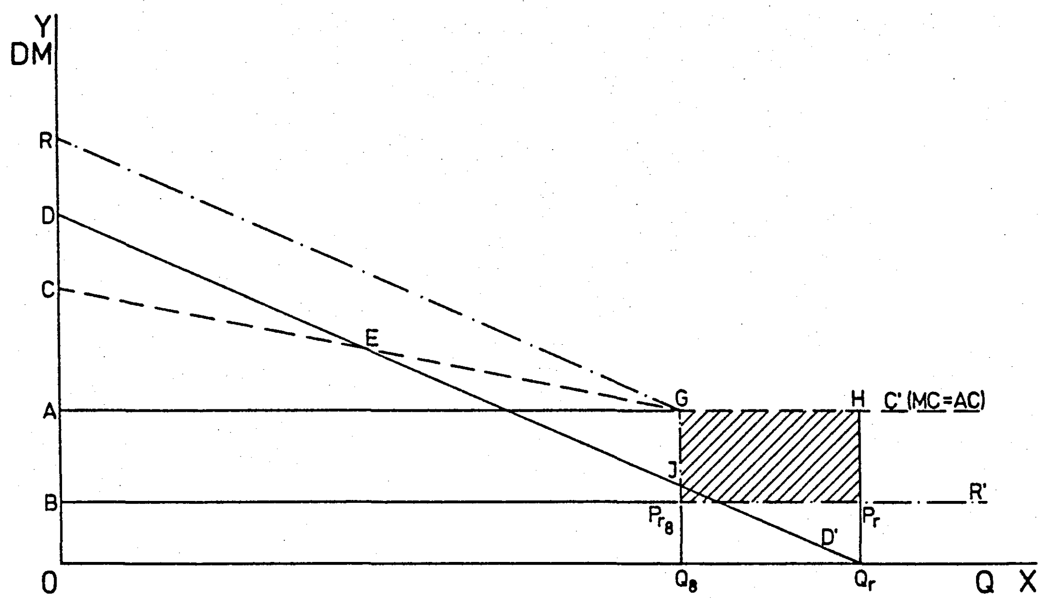


Fig. 4 illustrates this situation. Whereas under normal conditions the demand curve and revenue curve are identical, there now exists a separate revenue curve for the seller. This is curve R R'. It is parallel to the original demand curve DD' and shifted by the amount of the subsidy to the right as far as point G, where RR' has a discontinuity as the seller cannot take advantage of potential reservation prices from this point onwards, because the area is regulated. He is, however free to offer any differentiated variety at prices higher than that set by regulation. By the same argument as before he may compensate or overcompensate for his losses which are equal to area G H P_r P_8 by profits which in the limiting case approach area R G C.

7.2 VERTICAL PRODUCT DIFFERENTIATION AND PRICE DISCRIMINATION.

7.2.1 Some General Considerations.

So far the assumption has been made that different individuals have different reservation prices for horizontally differentiated varieties of a product, and that these differences give rise to second and, in the extreme case, first degree price discrimination. But products are differentiated not only horizontally but also vertically. In chapter 5 it was shown that spectacles are vertically differentiated if they are of different lens power, are multifocus as opposed to single focus or provided either with or without new frames. Price discrimination between vertically differentiated goods is typically third degree as prices are set in various submarkets where marginal revenue equals marginal cost and insofar as price is higher in one market, buyers in that market are excluded who have reservation prices at which they would still be served in another market. The necessary and sufficient conditions for third degree price discrimination are:

1. that trading between vertically differentiated

groups is either impossible or possible only at considerable cost,

2. that there exist differences in demand elasticity between the different markets.

Consider the first condition. Since it is normally the case that consumers require different prescriptions, trading is virtually impossible as glasses of different prescriptions cannot be substituted for each other. As far as substitution between multifocals and singlefocals is concerned, this is also possible only at a cost which is the inconvenience of the alternative of having to use two pairs of single focals with different prescriptions as previously described. Trade between spectacles which include the provision of a new frame and those which do not may also be ruled out as a practical possibility. As regards condition 2), it can be argued on a priori grounds that demand elasticities differ between different groups of customers. For instance, customers requiring a prescription of -1o dpts will have a more inelastic demand curve as a group than those requiring a prescription of only -o.5 diopters, since the first group will be almost blind without correction whereas the second group can get by reasonably well without glasses. Similarly, those who require multifocals would be in a predicament if they had to make do with two different pairs for reading and distance, so that their demand curve will be highly inelastic. It is further likely that that group of consumers who require a new frame with their new prescription either because the old one is rather worn, or because he or she is fashion conscious and desires a change, will have a more inelastic demand curve as a group than those who think they can make do with their old frames. How would the rational discriminating monopolist set prices for these vertically differentiated products? Traditional theory again does not provide a ready answer as it is mainly concerned with the single product case.

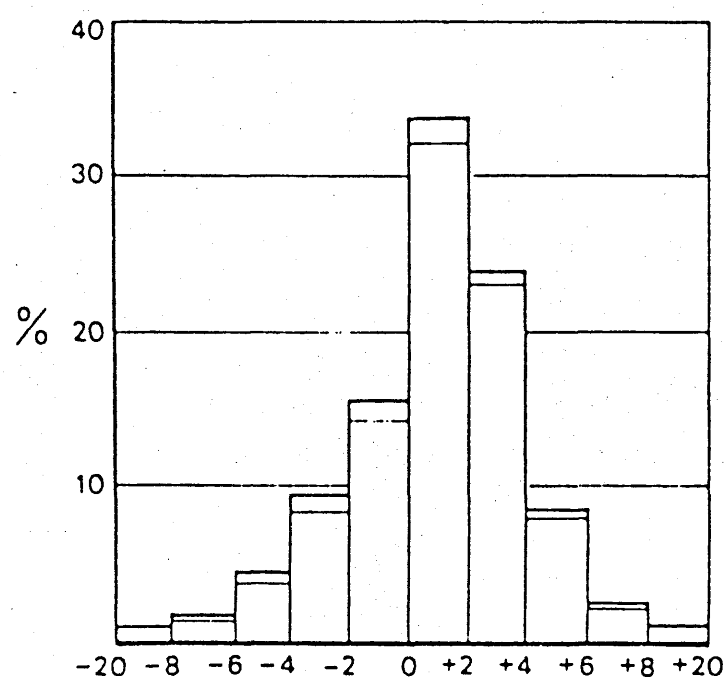
It is true that in contributions discussing problems of public goods and price discrimination, H. Demsetz,[160] Ekelund and Hulett[161] and P.O. Steiner[162] discuss the possibility of price discrimination between different goods sold by the same seller. They derive a formal apparatus for dealing with the problem of price discrimination when goods are in joint supply. Spectacles are not, however, produced in fixed proportions. A joint supply model is therefore not applicable. At one point Demsetz explicitly recognizes the possibility that there may be price discrimination between different goods sold by the same seller and which are produced in variable proportions, but he goes on to state that:

> "whether this can be called price discrimination is a matter of one's perception".[163]

Louis Phlips recognizes the problem explicitly but goes further. He argues that price discrimination should be expected in the multi-product case when products are produced in variable proportions. He goes on to derive criteria for optimal product selection in the 2- and 3-goods case. His approach assumes, however, that the seller is in a position to vary the quality content of his products, at given prices. Such variability, however, is not possible in the case of spectacles. Prescriptions are individually specific. Moreover, the quantity of a particular prescription is predetermined. The incidence of visual errors follows the law of normal distribution, with a peak at value +1.o dpts for spherical values.[164] In Fig. 5 the distribution of visual errors with a cylindrical compenent is shown.

Fig. 5

The Normal Distribution of Visual Errors.



Source: Jalie, M., The Ophthalmic Optician, Jan. 1980.

From the distribution of visual errors it follows that quantities in each powerbracket, i.e. power bracket +- 2.o, +-4, +-2/2 will be predetermined with the larger quantities at the low end of the scale and quantities becoming smaller and smaller as lens powers become higher in value.

7.2.2 An Adaptation of a Model by Eli Clemens.

One model of price discrimination which is applicable to the case of spectacles was described as early as 1951 by Eli Clemens. Fig. 6a recalls his model. However, a major adjustment has to be made if it is to be applied to the case at hand. Clemens assumed that marginal cost is the same for different products offered by a multiple product firm. His model has to be adjusted to take account of different separate costs traceable to different varieties. Once this is done it can then be very usefully deployed. This device is essentially the same as that used in the treatment of separate costs in the second degree price discrimination case discussed by Jacob and Jacob.

Fig. 6

Third Degree Price Discrimination with Product Differentiation at a Cost.

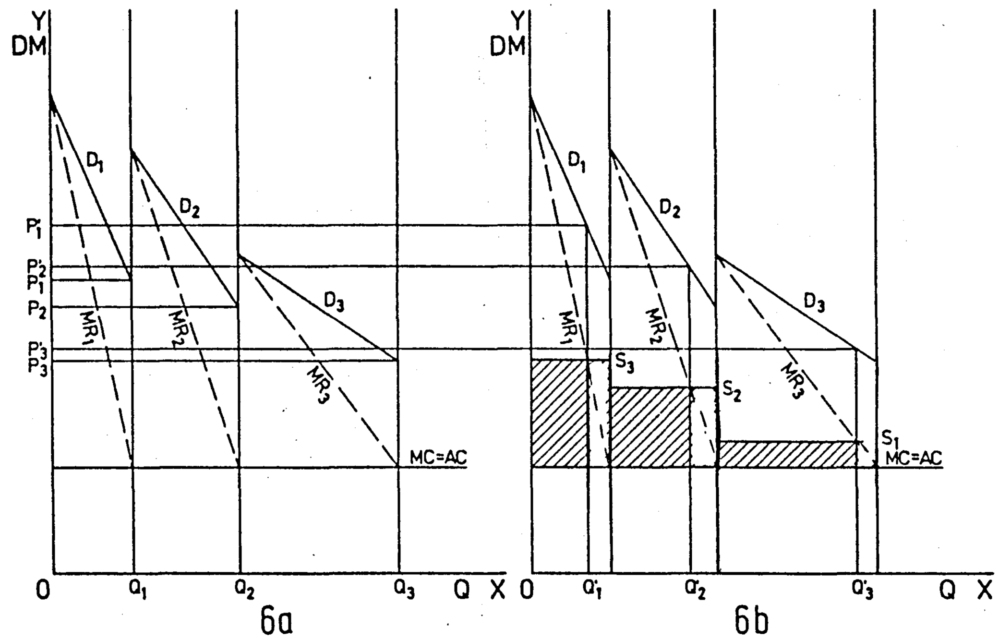
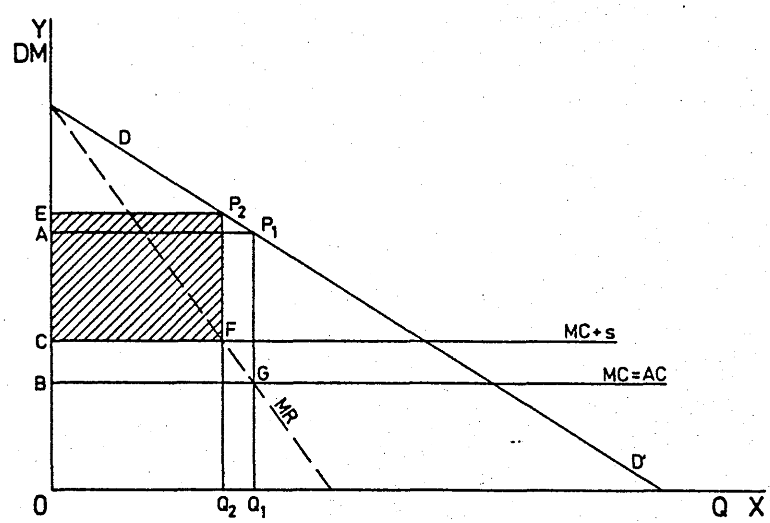


Fig. 6a shows Clemens' original model. Although he claims to deal with the multi- product case his model is more adequately interpreted as depicting a single product firm producing different varieties of the product. That is, labour time expended in the different shop jobs can be treated as differentiated goods. Prices and quantities are then determined by the intersection of the different marginal revenue curves derived from the different demand curves with the common marginal cost curve. In order to adapt this model to the case of different varieties produced at a cost all that needs to be added is the estimate of separate costs for the different varieties produced in the different submarkets. Fig. 6b shows how this additional assumption changes the set of optimal prices. Again, prices and quantities are determined by the intersection of the marginal cost and the marginal revenue curves, but now MC is increased by the separate costs for different varieties shown by the shaded areas. What happens to prices and output when separate costs are explicitly taken account of? This effect is apparent from Fig. 1b. It shows that prices are higher and output lower when additional costs have to be incurred. The question that has to be answered next is what happens to profits when separate costs have to be incurred. The answer is shown in Fig.7.

Fig. 7

Profits under Product Differentiation without Cost Compared to Profits under Product Differentiation with Cost.

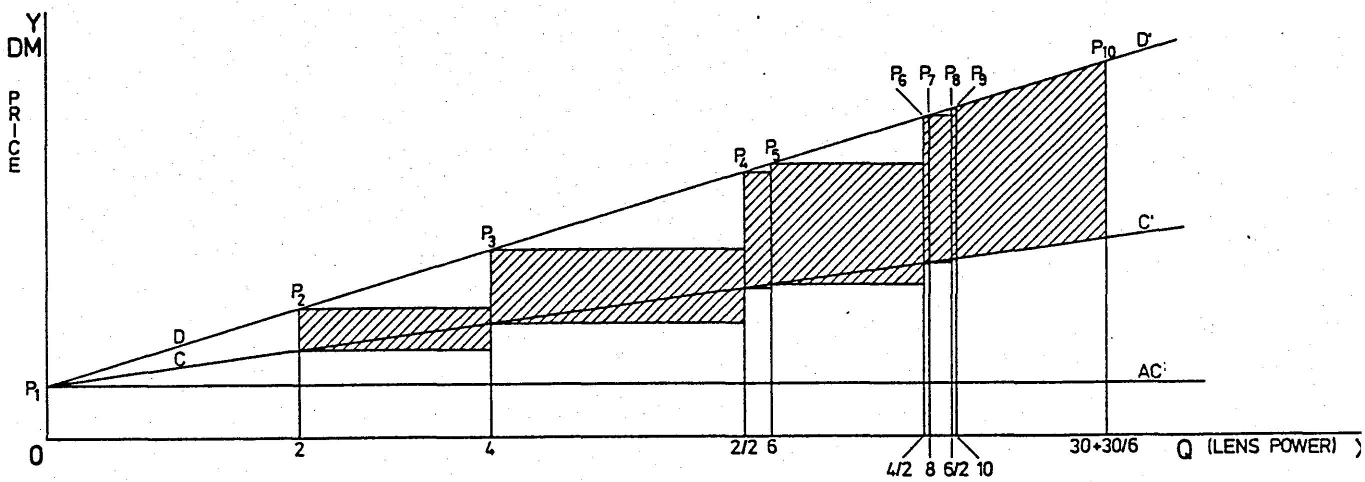


In Fig. 7, for a product produced at MC = AC Price P_1 and quantity Q_1 are determined by the intersection of the MC curve with the MR curve. If separate cost S is incurred the intersection of the MC+S curve with the MR curve now determines price P_2 and quantity Q_2.

Profit at price P_1 equals area A P_1 G B. Profit at price P_2 equals area E P_2 F C < area A P_1 G B seemingly indicating that product differentiation at a cost may not be an optimal strategy. But this argument is not a valid one as separate costs are often inescapable. Consider the case of spectacle wearers requiring prescription +/-2 dpts as opposed to those requiring prescription +/-10 dpts. Raw material price of the uncut lenses is higher, there is more labour time required in the workshop to fit the stronger lenses to the frames, more time is spent with the customer in selecting the proper frame and in after-sales service, etc.. These separate costs are therefore inescapable costs and as they do exist, when demand elasticities differ between the two sets of consumers in question, optimality requires that prices and output should be determined as shown in fig.6b. It then follows that differences in prices P_1, $P_2 \ldots P_n$ are <u>not</u> equal to differences in separate costs and therefore constitute price discrimination. In the case of spectacles even more can be said 'a priori'. Recall the fact that the incidence of refractive errors is exogeneously determined. The quantity of each variety is therefore predetermined. Prices are then the only variable and when profits are to be maximized, then they have to be set such that marginal revenue equals marginal common cost + separate cost and under the assumption that price elasticities are a decreasing function of lens power, i.e. demand is more elastic the lower the lens power, then prices, output and profits for spectacles of different lens power should be as depicted in Fig. 8

Fig. 8

Prices and Quantities of Spectacles Sold under Third Degree Price Discrimination.

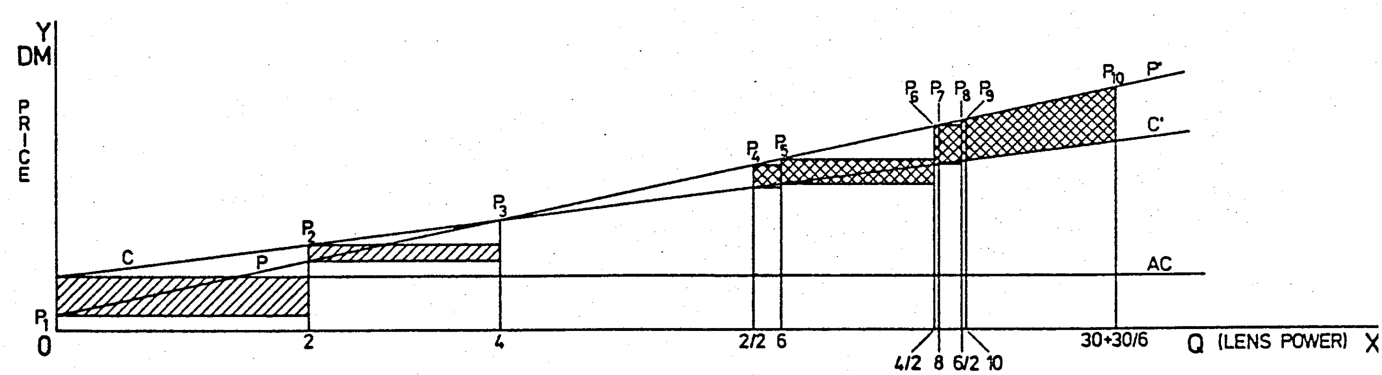


In Fig. 8 an important change is made. In contrast to the diagrammatic representation commonly used since Pigou's original contribution prices are plotted in ascending order of magnitude. [165] In Fig. 8 prices are plotted in ascending order along the vertical axis. Along the horizontal axis the quantities dispensed in each lens power category are plotted. For example, the quantity of spectacles sold in the category lens power 0 to 2 is represented by the distance = - 2 which is the lowest price category. It accounts for 15% of the total number of prescriptions. Thus the distance 0 to 2 represents 13% of the total quantity demanded and provided. The category lens power 2 to 4 is represented on the horizontal axis by the distance from 2 to 4. It accounts for around 13% of total quantity sold etc., and so on. Costs in each power bracket are made up of average cost, here assumed to be constant, and separate cost which increases with lens power. The assumption of predetermined quantities, increasing separate costs with increasing lens power and decreasing demand elasticities with increasing lens power then lead to the situation as shown diagrammatically.

When prices are set by a regulator it can be assumed that prices do not cover cost. The situation is then analogous to that described for horizontal price discrimination and is illustrated in Fig. 9.

Fig. 9

Prices and Quantities of Spectacles Sold under Third Degree Price Discrimination: Regulated Prices for Basic Varieties.



In Fig. 9 prices P_1 to P_{10} on the price line P are prices set by the regulator who has retained the pricing schema developed before regulation. Prices start off far below AC + SC for the lowest-priced variety, and just as in the absence of regulation profits increase with increasing lens power, now losses decrease with increasing lens power until at the high end of the scale a profit is made.

7.2.3 Further Types of Vertical Product Differentiation.

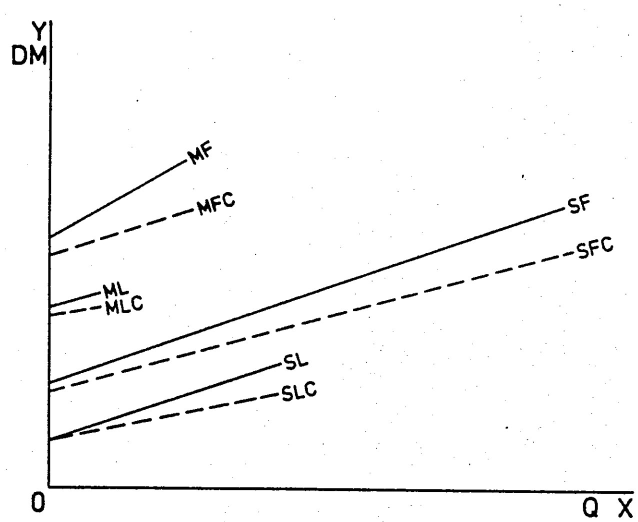
Lenses are not only differentiated vertically according to their lens power, giving rise to a price schedule such as shown in Fig. 8 and 9. They are also differentiated according to whether two lenses are dispensed into the client's frame or whether a new frame is included, and whether they are singlefocal or multifocal, where, again, a new frame may be included or not. Thus spectacles can be divided into further 4 subsets.

1. Single focus lenses supplied without frames
2. Single focus lenses supplied with frames
3. Multi focus lenses supplied without frames
4. Multi focus lenses supplied with frames.

In each of these subsets the of prescriptions are normally distributed as described previously. Scope for price discrimination is given within each set in the same manner and for the same reasons as shown above. But there is also scope for price discrimination between the 4 sets. Consider first the situation which would come about in an unregulated environment. Costs and, consequently, prices would be higher the more quality is contained within each category, i.e. spectacles including a frame will cost more than two lenses dispensed into a given frame and multifocals will command a higher price than single focals, again with the difference of including a frame or not. But, most important, the gap between costs and prices will also differ between the subsets. The situation is pictured diagrammatically in Fig. 10.

Fig. 10

Prices and Costs for 4 Subsets of Spectacles.

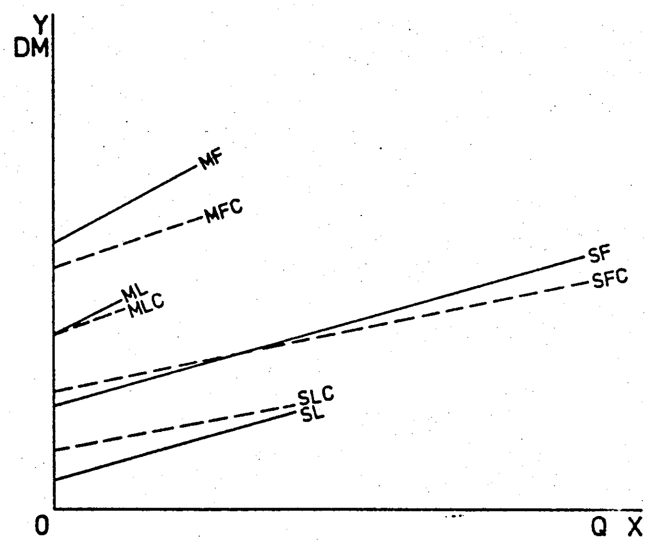


In Fig. 10 prices are plotted along the vertical axis and the quantities of each of the 4 subsets along the horizontal axis. Line SL shows prices and quantities for single focals only, line SF for single focals including frames. As the price of frames is here taken to be that of the basic variety only, the two lines are parallel. Line ML shows prices and quantities for multifocals and line MF multifocals including frame. For each price curve there is a cost curve. Under competitive conditions cost curves and price curves would tend to be identical. But it has already been shown that under circumstances conducive to price discrimination the slope of the cost curves should be less steep than that of the price curves because of price discrimination between different lens powers. Additionally, there is also scope for price discrimination between the different subsets such as multifocals and singlefocals and each of these including frames or not. As demand elasticities decrease from the subset single focal lenses only to the subset single focals + frames to the subset multifocal lenses and the set multifocal lenses plus frame, the distance between the cost line and the price line will increase and in the absence of regulation the outcome should be as shown.

In reality, however, as the prices of the basic varieties which are under discussion are set by the regulator they may or may not cover costs or may even exceed cost. This effect is shown in Fig. 11.

Fig. 11

Prices and Costs for 4 Subsets of Spectacles:
Prices for Basic Varieties Regulated.



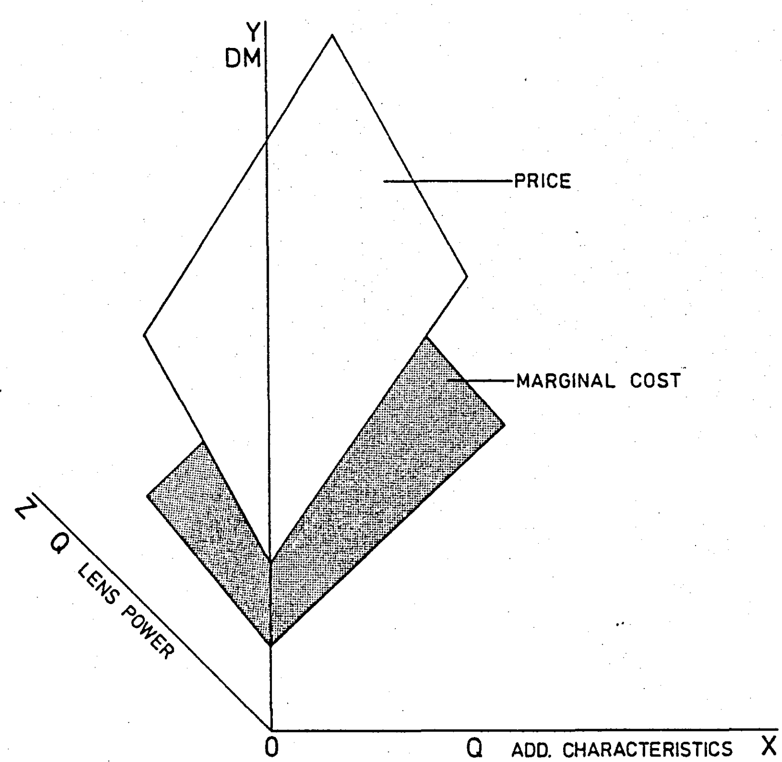
In Fig. 11 the result of a cost study which will be described in detail later is incorporated. Curves SL, SF, ML, MF are the price curves for the basic variety of single focus lenses without frames and with frames, and multifocal lenses only and multifocals including frames. Curves SLC, SFC, MLC and MFC are the cost curves pertaining to the respective price curves. It can be seen that many items do not cover their costs, while for instance multifocals, in the main, more than cover their costs. The differences in length of the price and cost lines of the 4 subset reflects the fact that the four subsets are demanded and provided in different quantities. Single focus lenses including frames, for instance, account for approximately 60% of all sales whereas single focus lenses without frames make up approximately 20% of sales effected. A further 6% are multi focus without frames with multi focus including frames accounting for the remaining 14%.

7.3 HORIZONTAL AND VERTICAL PRODUCT DIFFERENTIATION: THE COMBINED EFFECT.

Every lens power comes in a multitude of horizontally differentiated varieties e.g. tinted, antireflex coated etc. This fact can be allowed for by introducing a third dimension.

Fig. 12

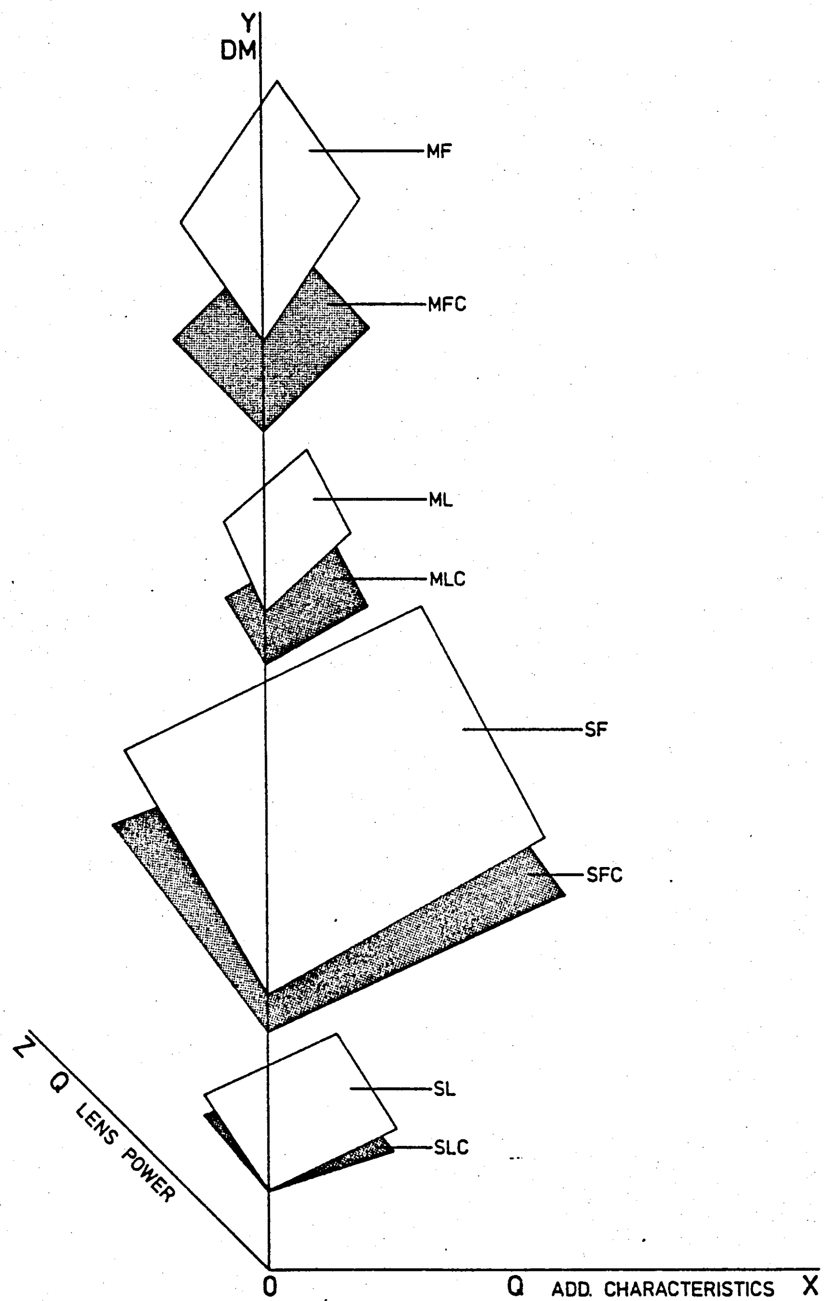
Price and Cost Planes.



In Fig. 12 the prices and costs for the subset single focus including frames are plotted in monetary terms along the vertical axis. Additional characteristics and their quantities are plotted along the X-axis. The quantities of each lens power are plotted along the Z-axis. Costs as well as prices are plotted. This results in a price-plane from which the price of any lens power in any of its horizontal varieties can be read and a cost plane giving costs of each lens power in any of its horizontally differentiated varieties. Lens powers and additional characteristics are ordered in ascending order of magnitude. Consequently, the planes slope upwards along the X-axis and along the z-axis. The cost plane is shown as the shaded area. Costs are made up of the cost of the basic variety denoted by the intercept of the plane with the Y - axis and separate cost. As separate costs are an increasing function of lens power and of the additional cost entailed in horizontal product differentiation the cost plane must slope as drawn, i.e. sloping upwards as one goes along the horizontal axis starting from the origin. Costs are given for each differentiated variety under the assumption of total adaptation and given state of the art. The rationale of price discrimination determines the position of the price plane in relation to the cost plane. From what has been said previously it is to be expected that the gap between cost and price will be larger the lower the elasticity of demand. It will have a minimum at the origins of the price and cost planes, i.e. on the Y-axis, as these points represent the variety with the highest elasticity of demand. As demand elasticities decrease in both directions, i.e. with lens power as one moves along the Z-axis and with more and more costly differentiation as one moves outward on the plane along the X-axis, the price plane is tilted more steeply than the cost plane in both the directions indicated. Pairs of price and cost planes exist for all 4 subsets of spectacles as explained previously and demonstrated in Fig. 10. Just as in Fig.10 the gap between the cost plane and the price plane is always smallest where the planes originate in the Y-axis. But furthermore, this gap can be expected to be larger for spectacles of the basic variety including frames as opposed to spectacles provided without frames because the demand elasticity will be higher in the former case. The same reasoning applies for spectacles with single focus as well as with multi focus lenses. Therefore the gap between price and cost at the origin becomes wider the further one moves upwards on the Y - axis. This is shown in Fig.13.

Fig. 13

Price and Cost Planes for 4 Subsets of Spectacles

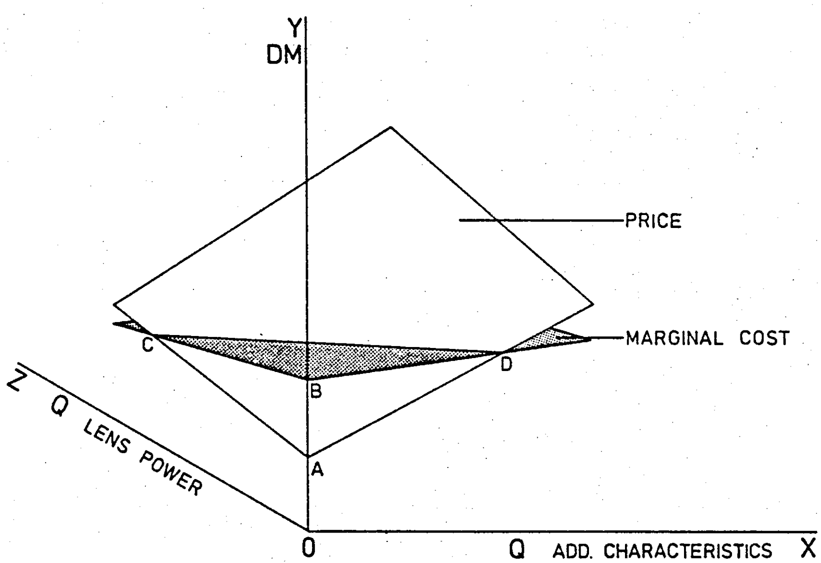


7.4 PRICE AND COST PLANES WITH BASIC PRODUCTS PROVIDED BELOW COST.

Under the German National Health scheme the basic varieties of spectacles are in the main provided below cost. This fact has considerable bearing on the relative positions of the price and cost planes. The effect is shown in Fig. 14, which shows price and cost planes for the subset comprising spectacles of singlefocal prescription including new frames.

Fig. 14

Price and Cost Planes: Basic Varieties Regulated.



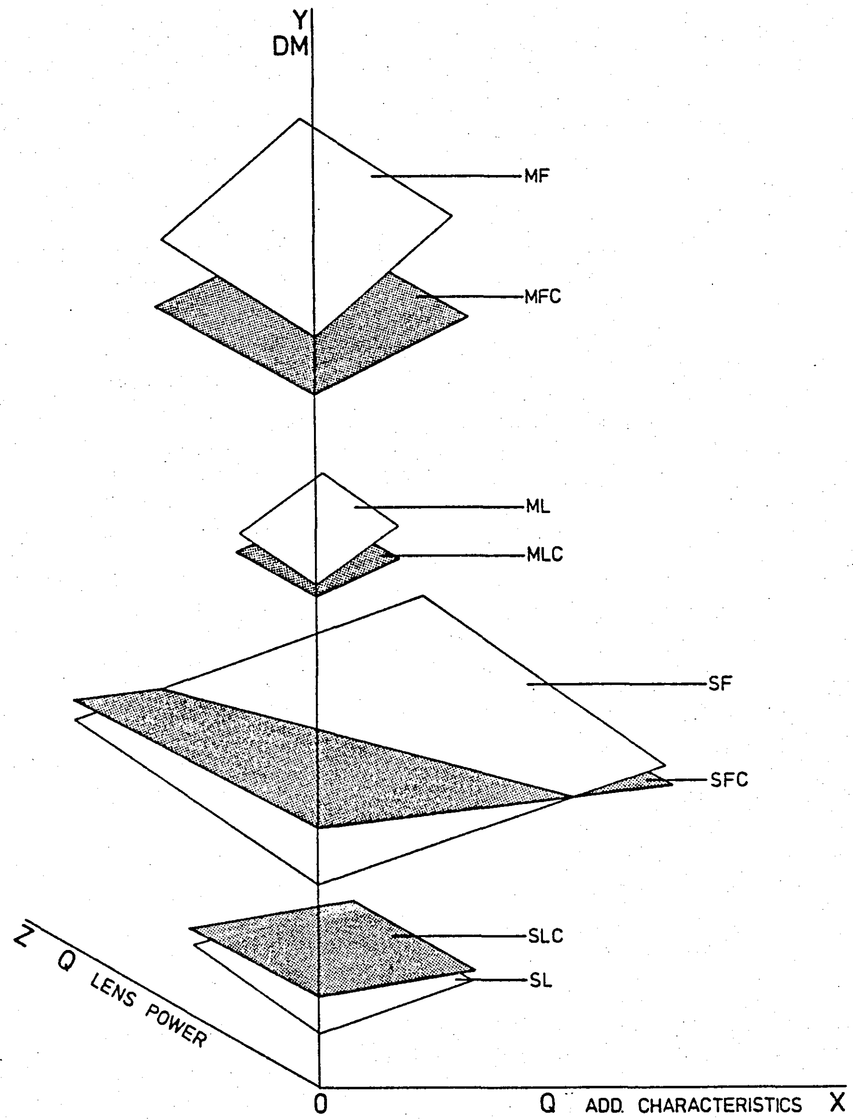
Revenue for the basic variety +-2.o is given at point A, cost at point B. As one moves outwards along the edge of the planes in the direction of the Z-axis, point C is reached at which revenue equals cost;

beyond it revenue exceeds cost. When more expensive varieties of prescriptions +- 2.o are sold this is shown diagrammatically as a movement along the X-axis until again a point of equality between revenue and cost, D, is reached, after which revenue exceeds cost. Revenue and cost planes therefore have the relative positions illustrated.

The relative positions of the revenue and price planes are different for the four subsets of spectacles, i.e. single focals with and without frames and multifocals with and without frames. Their positions follow from the explanation given for Fig. 13 in the chapter and are illustrated in Fig. 15.

Fig. 15

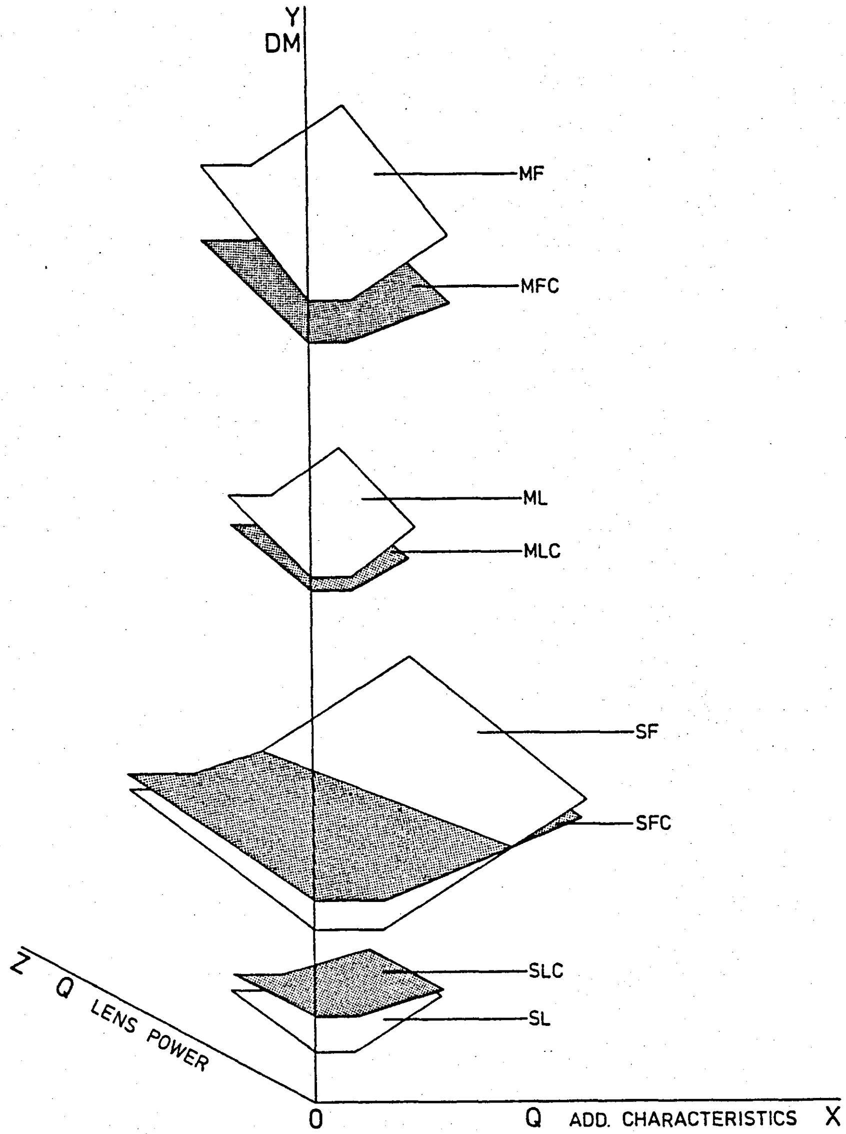
Price and Cost Planes for 4 Subsets of Spectacles: Basic Varieties Regulated.



The basic varieties of all lens powers account for about 20% of the total. As this part of sales has only one price, there is no horizontal differentiation and the price plane as well as the cost plane run parallel to the X - axis for the first 20% of their lengths. This situation is shown in Fig. 16:

Fig. 16

Price and Cost Planes: Effect of Regulation "Netted Out."



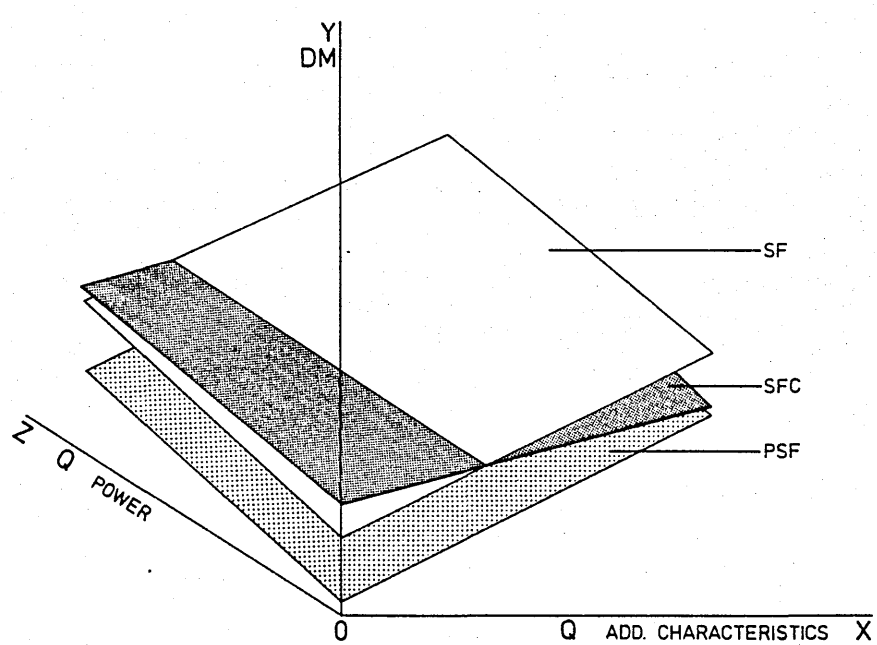
where SF = price plane single focus including. frames, SFC = cost plane single focus including. frames etc

It has been shown before, that the sickness funds which operate the German national health system provide the basic quality of spectacles free of charge. It has also been shown that approximately 80%

of consumers choose a superior quality and that the sum which the insurance fund pays for the basic variety is then deducted from the price of the superior quality. The payment by the insurance fund, then, constitutes a subsidy towards buying glasses which has the effect that the consumer only pays for the better quality, or, to put this matter into Lancastrian terminology, he pays "out of pocket" only for the additional characteristics. The price plane which the consumer faces is then the price plane of the additional characteristics. The private payment plane is shown in Fig. 17. It shows a theoretically derived set of the 3 planes for the subgroup single focus spectacles including frames.

Fig. 17

Price, Cost and Private Payment Planes.



In the same manner, private payment planes can be drawn for the subsets single focus without frames and multifocus with frames and without frames.

The graphical representation of the effect of second and third degree price discrimination occurring simultaneously in the market for a single but differentiated product has so far been derived in completely theoretical terms. It is now proposed to attempt an empirical estimation. In the section "Price Descrimination and the Hedonic Method" it has been demonstrated how a hedonic demand curve can be derived. The price plane is nothing but a hedonic demand curve derived for two "explanatory" variables and depicted in a three-dimensional graph. Thus, its estimation can easily be implemented using the traditional hedonic method.

Construction of the cost planes, however, is a less simple task. The theoretical discussion has shown that derivation of a hedonic cost curve in a monopolistic environment is methodologically unsound. It has been shown that the construction of a cost plane as envisaged in the graphical representation requires an empirical estimation of costs at a completely disaggregated level. How this can be achieved with methods borrowed from conventional cost accounting and how these cost accounting methods can be reconciled with the assumptions of economic theory will be shown in the following chapter.

Chapter 8

COSTS OF DIFFERENTIATED PRODUCTS.

8.1 MEASUREMENT OF MARGINAL COSTS: THEORETICAL CONSIDERATIONS.

In order to establish whether price discrimination exists in the case of spectacles it is necessary to measure the relevant cost of each variety, namely its marginal cost . It is worth recalling the two elements present in the concept of marginal cost. In the first sense it is incremental cost, in the second "avoidable" cost. The two expressions are often used synonymously, but there is more involved than a difference of semantics. The term avoidable cost stresses the opportunity cost aspect whereas the term incremental draws attention to the time aspect.

Incremental cost will vary according to the time horizon under consideration. It will be argued that it is long run costs which are relevant in the context of pricediscrimination. The problem then arises of estimating longrun, marginal costs in practice. The cost figures which are available are from financial accounts. These refer to prescibed time periods such as the financial year. They also depend on the volume of activity attained in that time period. They have to be standardized for the normal level of activity. The opportunity cost element, while obvious enough in theory, poses different problems for empirical work. In order to estimate the cost of a resource in its best alternative use it is necessary to have recourse to imputed or implicit costs. For example, when a business is run wholly or partially with proprietary capital, then interest has to be imputed. Then further questions arise. What is the relevant interest rate? How many percentage points above the official discount rate? Should a premium for risk be included in the interest rate?

A further complication arises from the fact that most firms in practice do not produce a single product, the standard assumption of the traditional theory of the firm, but are multi - product firms. Thus difficulties arise out of the necessity to allocate costs to different products. This is an often discussed problem. While the existence of a satisfactory solution remains in the opinion of many authors in doubt, the empirical researcher has to apply some cost estimate. Some costs can be unambiguously traced to products. These are separate costs: but their estimation is not quite as straightforward as is implied by many textbooks.

The problems involved in an estimation of marginal cost can be summarized under the following headings:

1. Defining longrun marginal cost.

2. Longrun costs and economies or diseconomies of scale.

3. Imputed costs.

4. Separate costs.

5. Common costs and their allocation.

8.1.1 Defining Longrun Cost.

Empirical estimation of longrun cost, whether average or marginal poses particular problems. The classical discussion of this issue is provided by J. Johnston[166] Caleb A. Smith,[167] and A. A. Walters[168]. Empirical cost estimation has to rely to a considerable extent on data from financial accounts. Such data are by their very nature shortrun. They are explicitly made up for a limited timeperiod, usually the accounting year. They will therefore contain costs which are invariable with output, an example being the cost of fixed capital, causing average and marginal cost to vary with the level of output actually attained in a particular period. The problem is perhaps better understood when the terminology suggested by P. G. D. Wiles is used.[169] He recommends substitution of the term partial adaptation for the usual expression 'short run' and total adaptation for the long run. Then it becomes immediately clear that under total adaptation (the long run) all factors of production can be adjusted to a firm's requirements.

Longrun costs (costs under total adaptation) are then those costs which would accrue if the entrepreneur were able to adjust all factors necessary to the present rate of production in an optimal fashion. Take, for instance, the computation of rent. Assume that 3000 pairs of spectacles are dispensed per year in a particular firm. The firm operates from premises which cost DM 30 000 per year, but would be sufficient in size to accommodate a normal production of 4200 pairs. Then the rent cost per pair of spectacles is not DM 30 000/3000 = DM 10.0, but DM 30 000/4200 = DM 7,14 per unit. This criterion has to be applied to any of the costs which are fixed under partial adaptation. As in the above example, the optician's shop contains furniture adapted to the sale of spectacles. A number of display units has to be provided at which clients can seek advice as to the frames and type of lens that would suit them best. The number necessary will depend on the number of customers per day, but there is an important proviso to be made. The number necessary should be estimated taking into account any necessary stand-by capacity to cope with fluctuations. As J. S. Bain puts it:

> "The plant or firm will have a somewhat fluctuating output, over time, and at a given scale will thus operate at a number of somewhat different output rates. Correspondingly, it will have a certain "load factor" reflecting the ratio of average actual rate of use to the capacity of best rate ofuse, and this load factor will generally be smaller than one. In that circumstance the relevant relationship of unit cost to scale ..., is thus subject to a typical "load factor" on its capacity."[170]

These problems of optimal capacity have been extensively discussed in the literature on the "queuing problem" and its mathematical solution with the help of linear programming.[171]

A mathematical solution of the capacity problem cannot be employed in this study due to the lack of data. It is proposed to substitute an "informed estimate" for the more rigorous method. Data on the optimal size of particular factors of production can be obtained from the suppliers of optical equipment. There exist in Germany specialized suppliers of shopfittings or workshops. The author has obtained from them estimates of optimal production units for a particular annual output of spectacles. These estimates will be used in the calculation of the unit costs of factors of production. Also, it shall be demonstrated in the detailed computations that the firm which will serve as the basis of a detailed cost study is more or less of optimal size in the sense that its assets can be shown to be well geared to the capacity actually required to meet production needs over a period of time.

In order to derive unit costfigures total cost over the entire life of these factors of production has to be estimated and divided by the total number of products produced. Some costs are incurred over a definite timeperiod e.g. rent. Unit rent costs are then easily calculated by dividing rent cost per time period by the number of goods produced in that period, where the number produced, of course, means not the actual volume of production, but that volume which can be achieved under normal circumstances. But if usage of a factor stretches over several accounting periods as for instance with depreciation of machinery, then further difficulties arise. When machinery is being used in the production of goods, part of the depreciation is due to wear and tear, part to technological obsolescence, part to cost of capital, and some, and often considerable part, is due to operating costs and rising maintenance costs with increased use. It is important to distinguish between costs which are a function of use and for which the term user cost has been coined,[172] and those which are not. User costs can be measured directly. Obsolescence, capital cost and various other overhead expenses are not a function of use but most costs of maintenance, wear and tear as well as operating costs are. For the others the procedure described above should be used. I.e. the total useful life and the number of units produced should be estimated. Unit cost can then be arrived at by simple arithmetic.

A further important problem is the question of historical as against replacement cost. It is the latter which will be used in this study. To give an example, sighttesting equipment is for all practical purposes not subject to any wear and tear. Thus in the writer's practice a trial case was in use until recently which had been acquired by his grandfather. The cost of using this piece of equipment would therefore seem to be infinitesimally small. Nevertheless, the replacement cost of a modern trial case is several times its historical cost. Moreover, the time-honoured way of performing sight-tests is now being superseded by computer-aided alternatives which permit a much faster and therefore more economical operation and are necessary for prestige reasons. If the useful life of the trial case is then estimated at only 3 years, a realistic economic life, its unit cost will obviously increase considerably.

8.1.2 Long Run Costs and Returns to Scale.

In the paragraphs dealing with the optimal pricing structure under price discrimination the cost curves used were based on the assumption of constant returns to scale. This assumption, although very convenient in that it simplifies the exposition considerably, is not a necessary condition.

If, however, constant returns to scale are assumed, then marginal and average costs coincide reducing the problems of cost measurement by a whole dimension. A. A. Walters gives an overview of empirical evidence on LRAC curves.[173] This evidence, although not completely conclusive, suggests that the theoretical concept of a U-shaped cost curve is not supported. Rather, LRAC curves decrease more or less steeply in the beginning, until a "threshold" efficient scale has been reached. Thereafter they only decrease very gently or not at all, indicating, for all practical purposes, constant returns to scale over a wide range of output. This has come to be adapted as the modern theory of costs.[174]

Whether in the case of spectacles dispensed by opticians constant returns to scale are present is, then, a matter of empirical observation. For this purpose it is necessary to obtain data for the industry as a whole, or at least a representative cross-section of it, from which a longrun average cost curve can be constructed. An alternative method of testing for constant returns to scale would be the construction of a production function. If the production function is specified in the form of a Cobb-Douglas function with two explanatory variables of the form $P = AL^a . K^b$, then, if the exponents add up to a value which equals or is close to unity, this may be taken as an indication of constant returns.

8.1.3 Opportunity Costs.

It has already been pointed out that cost accounting figures have to be converted into opportunity costs. Often these costs, which are a very substantial part of costs, do not show up in financial accounts at all. They then have to be "imputed". Thus, opticians` firms are usually run by the owner. If the firm, as is usually the case, is not run in the form of a limited company, the owners' salary does not show up in the accounts and has to be estimated. Similarly rent is not shown if the optician operates from his own premises. Nor is interest on the owner's capital shown. These costs have to be imputed. Computational difficulties may be encountered here. Once again this straightforward principle becomes less simple when the computation of imputed costs is attempted in practice.

8.1.4 Separate Costs.

The concept of separate cost plays a central role in this study. A separate cost is one which can be identified with a unit of operation, e.g. a product, a department, or a process.[175] In this study the main interest is in the separate costs of products, an aspect which does not receive wide-spread attention in microeconomic theory where separate costs are only casually mentioned in connection with the costs of joint products, for instance in the classic treatment of the subject provided by Marshall.[176] In accountancy, however, separate costs play an important role. They are known as "direct" or "prime" costs[177] and distinguished from indirect or common cost on the basis of traceability to different products. It is the accountant's definition which is useful in the estimation of the costs of differentiated products which is so important in this study. The estimation of separate cost does not present any great problems conceptually as they can be clearly traced to products and measured. These aspects are particularly well treated in German textbooks of cost accounting, for instance, Haberstock.[178] A test of separability would be to ask whether an activity could in principle be contracted out. An estimate of the price at which a service used in the production of a good could be supplied from outside would then seem a valid estimate of its (separate) opportunity cost. Some separate costs are fairly obviously defined. For instance, the rawmaterial used in the production of a good can easily be measured and quantified. Thus the lenses and frames used in the production of a pair of glasses constitute a separate cost. More difficult is the measurement of auxiliary material used, e.g. oil used for hinges. Here it may become necessary to have recourse to averaging over the output covered. Similar problems occur when the user cost of machinery, premises etc. have to be assessed. It will be shown in the paragraph dealing with the estimation ofalong-run cost curve how depreciation charges can be estimated on a per unit basis. In order to trace such costs to individual products, however, such averages are not sufficient. To give an example: in the optician's workshop lenses are edged on an automatic edging machine which contains diamond-studded wheels. The wear and tear on these wheels is a considerable cost factor. A lens of -2o dpts. wears much more out of the diamonds than one of +1 dpt. If the cost of 1 minute's use of the edging machine is calculated, then, according to the different time used up in the edging of lenses of different power, cost can be traced to the different lenses, i.e. products. Even interest is traceable to products. From the value of raw-materials and their average "turnover" measured in weeks capital cost can be estimated when the interest rate on capital is known. The most important separate cost in the "production" of a pair of glasses is direct labour cost. It would seem that this can easily be measured unambiguously. Practical measurement is not at all easy, however, as a multitude of different operations, often performed by different people go into the production of a pair of glasses.

8.1.5 Cost Allocation.

No matter how careful one is in estimating separate costs, many of the costs incurred, such as management expenses, advertising outlay, some part of rent for premises etc. cannot be traced to individual varieties of products. As mentioned before this type of cost is commonly known as "overheads" and gives rise to the problem of cost allocation. In single-product firms un-separable costs such as depreciation charges raise certain problems, i.e. those arising when costs are incurred in one period but have to be properly attributed to several accounting periods. These problems are, however, relatively minor ones. In multiple-product firms, however, the problem of allocating unseparable or common costs among the different products is generally considered to be more or less insoluble except in an ex-post manner, as there is no logical way in which costs incurred in the joint production of goods can be divided up between them, although there is no lack of attempts to do so, especially by accountancy methods. Nevertheless, as P.G.D. Wiles put it:

> "All these methods are arbitrary."[179]

In accountancy separate costs serve as a base which is used in order to allocate common costs to different products, activities or "cost centres".[180]

Economists denounce all such attempts at cost allocation as arbitrary. Particulary outspoken in this respect was P.G.D. Wiles[181] But accountants also voiced doubt about such procedures; i.e. W.J. Vatter,[182] A.L. Thomas,[183] M.C. Wells,[184] and D. Briggs.[185] In the case of spectacles at first glance it might appear that these problems of cost allocation might have to be faced. However, spectacles constitute a "product line" which is essentially made up of the same commodity, albeit differentiated, and can therefore legitimately be treated as if they were produced by a single-product firm. The unseparable or common costs of each individual product are then found by simply dividing total common cost per time period by the number of units produced. To this cost figure, which may be called average common cost must be added those additional costs which are unambiguously traceable to each individual differentiated product. These may be called separate costs.

It is important to note that the distinction between separate cost and average common cost must not be confused with that between variable and fixed cost. This point was discussed for instance by Joel Dean.[186] Separate costs as well as common costs in the short run may be fixed as well as variable. The problem can perhaps better be understood when put into Lancastrian terminology. It is assumed that spectacles are bundles of characteristics made up of a basic characteristic which they all have in common, namely correction of faulty vision and additional characteristics such as more standing, comfort etc.

which characterise each differentiated variety. When only one variety is produced average cost is found by simply dividing the total cost per time period by the number of units produced. When separate costs are present, each commodity has its individual separate cost and its share of common cost. This share is found by the formula:

$$ACC = \frac{TC - \sum SCi}{Q}$$

and, as separate costs of varieties A, B, C ....., N can be estimated, the cost of any variety i, is:

$$ACi = \frac{TC - \sum SCi}{Q} + SCi$$

where: ACC = average common cost, ACi = average cost of the ith product, TC = total cost, Q = quantity, SCi = separate cost of the ith product.

8.2 EMPIRIKAL ESTIMATION OF PRICES AND COSTS.

The empirical estimation of the costs and prices of the differentiated products called correction of faulty vision will involve the following steps:

1. It has to be shown that marginal costs exhibit constant returns to scale.

2. Marginal costs under total adaptation have to be identified.

3. Separate costs have to be identified and traced to different varieties of the product.

4. Prices of different varieties of spectacles have to be identified from the recommended retail pricelists for lenses and from the "calculators" for frames.

It will then be possible to compare the prices of the differentiated varieties of spectacles with their costs and to test whether prices and costs behave in the way predicted by theory.

8.2.1 Estimation of an LRAC-Curve and a Cobb-Douglas Production Function.

8.2.1.1 The available data.

Before the technical details of the empirical estimation can be addressed it is necessary to describe in some detail the actual data available. Two data sets are available:

1. Cross-sectional data on turnover and costs of approximately 160 optical firms covering the years 1964-68[187] and 1972-83.[188] The data which is very detailed covers a period of 16 years. Unfortunately, this dataset is not published and has been treated as confidential by the Federal Association of Opticians. In spite of this the author has been able to obtain part of it.

2. An analysis of costs conducted in the writer's

own optical practice in Spring 1984 with a view to measuring the common marginal costs and the separate costs of the individual varieties of spectacles.

Cross sectional data.

Although the cross-sectional dataset covers the years 1964-83 only the data set for 1977 will be used in this study. This set contains data on the number of spectacles produced per firm per year, a question which was not covered by the data procured for the following years. This information, it will be readily understood, is crucial for the construction of a Cobb-Douglas production function. It is also the basis on which an estimate can be made of the long-run average cost curve which is more accurate than can be obtained from figures on turnover. The data was collected by one of the most renowned firms of chartered accountants in Germany, the Treuarbeit AG in Frankfurt/Main, at the request of the Federal Association of Ophthalmic Opticians. The Federal Association advertised the project in the trade-journals and received answers from 751 optician who expressed readiness to complete a questionnaire prepared by the chartered accountants in cooperation with the Federal Association of Opticians. Only 165 firms, however, responded. Of these 10 returns were so incomplete that they could not be used.

Thus 155 firms make up the sample for the year of 1977, 134 of which had already taken part in the surveys conducted in the preceding years. The size of the sample is sufficiently large to be statistically significant. The size distribution of firms is shown in the following table:

TABLE 1.

Size Distribution of Firms Participating in the Survey.

TURNOVER UP TO DM (000S):	250	500	1 MIO	<1 MIO
NUMBER OF EMPLOYEES	2.2	3.5	6.1	13.3
TURNOVER DM (000S)	203	377	707	1490
NUMBER OF FIRMS	13	67	51	25

In the survey for the year 1977 the following data were collected:

1. Revenue, divided into the following subgroups:

   - turnover from the dispensing and repair of spectacles divided into "private" payments and those made by the sickness funds.

   - turnover from "related items", i.e., contactlenses, hearing aids and others, for instance binoculars, magnifying glasses, microscopes etc. Turnover is "net", i.e. rebates, discounts rendered to customers etc. have already been deducted. "Other revenues" such as revenues from rent, sale of assets and non - operative profits are not contained in the revenue figures.

2. Costs:

- labour costs.
- rawmaterial cost.
- advertising cost.
- local taxes.
- other costs.

One of the main criticisms usually levelled against cost studies of this nature is that the cost figures are "outlay costs" as shown in the profit and loss account. They, therefore, have to be converted in to what the economist means by longrun marginal cost. This requirement is rarely met by cost studies. In this particular case, however, this has been done by the firm of chartered accountants carrying out the study.

The following adjustments were made:

Labour costs include all salaries and wages including all indirect costs, statutory and voluntary. In those cases where labourcost did not include a wage for the owner - entrepreneur or his relatives, such costs have been imputed according to the following schema:

Number of Employees	Salary per owner
up to 2.5:	DM 60000
5.0	DM 65000
>5.0	DM 75000

For family members working full time in the firm half these amounts were reckoned.

Working space costs include the power costs, costs of cleaning, heating and repair costs of premises.

Advertising costs include the cost of window dressing, the cost of business entertainment, as well as travelling costs to trade shows etc.

Local taxes are mainly, the "Gewerbesteuer", a tax comparable to rates in Great Britain.

Other costs mainly consist of the cost of company cars, consultation fees, postage and administrative costs.

Under the heading 'other costs' there is also an estinate of the imputed interest on working capital and, where appropriate, imputed rent.

In order to calculate the imputed interest on working capital the asset side of the balance sheet [excluding premises] was added up and shortterm liabilities including reserves were deducted. On this working capital 7% interest was imputed.

In cases where the optician works from his own premises rent was imputed. For this purpose the opportunity cost of rent was estimated by asking respondents to give figures of rents which could be obtained in alternative use. Depreciation and interest on loans for buildings was then deducted from cost.

Tables 2 and 3 show further interesting data which were collected: In table 2 the sample is subdivided according to the number of outlets per firm.

TABLE 2.

Number of Outlets per Firm.

NUMBER OF OUTLETS	NUMBER OF FIRMS	%
1	124	79.5
2	21	13.5
3	10	6.4
4	-	-
5	1	.6
	156	100.0

In Table 3 the sample is broken up according to location, i.e. whether in small, medium-sized or large cities, and if in large cities, whether in the city-centre or suburb:

TABLE 3.

Location of Firms.

LOCATION (INHABITANTS)	NUMBER OF FIRMS	%
< 30000	78	20.5
> 30000 > 250000	78	50.1
> 250000 CITYCENTER	18	11.5
> " SUBURB	28	17.9
	156	100.0

The data set described will be used to estimate:

1. A long run average cost curve.

2. A production function.

From these estimates, in turn, inferences can be made as to the nature of longrun costs, i.e. whether they are increasing, decreasing or constant.

8.2.1.2 Decision as to the appropriate type of cost study.

Before embarking on the process of estimation, it is necessary to decide which type of cost study is most suitable to the available data set, and to determine how well the quality of the data stands up to the criticisms which are normally and legitimately levelled against empirical cost studies of this nature.

There are four types of cost studies:

- statistical cost studies,
- studies based on questionnaires to firms,
- engineering cost studies and
- studies based on the "survivor technique."

The first question to ask, then, is which of these methods should be selected in this study. The answer is more or less predetermined by the nature of the data set. The data do not lend themselves to the "survivor technique". This method assumes a time series covering, if possible, the whole of an industry, and a very long time-span, perhaps 40 years or more. Obviously this condition is not fulfilled here as only approximately 160 out of a total population of 5000 firms are contained in the sample. Moreover, the mix of firms varies from year to year, and the time-span covers only the relatively short period of 20 years.

Studies based on questionnaires require different questions from those asked in the present cost study.

An engineering cost study would also require quite different data. It would have to be based on estimates of the optimal costs for different sizes of firms and not, as is available here, merely the actual cost figures.

There remains, then, the statistical approach. This consists in the application of regression analyses to time series or cross-sectional data. For long - run statistical cost estimation it is cross-sectional data which are the most useful. Exercises based on time series analysis require that technology should remain constant over the period. Technology usually changes considerably. On the other hand, "state of the art" may be presumed to be given within an industry thereby removing this problem for cross - sectional studies. It has been argued that even within a cross-section of an industry technology will vary between firms. Large firms may be presumed to employ more modern production techniques than smaller firms. This argument is probably valid for many industries, but there are good grounds for believing that it does not apply to opticians. It is not easy to substantiate this claim rigorously. But it is borne out in the experience of the author of this study who has very intimate knowledge of the industry based on lengthy experience. He runs 5 different outlets ranging considerably in size. All of them use very similar technology. It has to be admitted that the data from the industry-wide cost study show astonishingly wide variations in average cost between individual firms at all firmsizes. Such variationes must, therefore, be attributable to factors other than size. But different technologies do not supply the explanation. In fact, it will be shown that the cost differences are mainly due to differences in the price of labour and differences in the efficiency of the labour employed. When these price- and efficiency differences are accounted for by introducing them as explanatory variables they account for nearly 80% of the cost differences.

A major criticism levelled against statistical cost studies, states that accounting data do not include the opportunity cost elements ideally required for an estimation of marginal cost. In the present data set, however, it has been noted that the most important opportunity cost elements which are missing from the accounting data have in fact been imputed.

A further criticism of statistical cost studies concerns depreciation expenses. Accounting figures should ideally be converted to user cost. In their conventional form they include full depreciation figures which cover the cost of the obsolescence of equipment which is invariable with use. In the case of this data set the argument has to be recognized as valid. However, depreciation costs only account for a minimal part of costs. Depreciation charges taken from the accounting figures do not therefore distort the result significantly. Furthermore, as the equipment used is more or less uniform over the industry, any errors attributable to different methods of depreciation employed by different firms tend to cancel each other out.

The present data set covers not only spectacles but also contactlenses, hearing aids and merchandise which is related to spectacles. There is a problem of cost allocation here. The authors of the data set deal with this problem by dividing costs between the output of spectacles and these other outputs in proportion to the number of employees engaged in the respective fields of production. It must be admitted that this procedure is arbitrary and open to all the criticism which has been levelled by economists against any method of cost allocation. However, the error introduced in this case is relatively small, as only a small percentage (approx. 16%) of turnover consists of outputs other than spectacles.

Furthermore, the greater proportion of output other than spectacles consists of the fitting of contactlenses and hearing aids, a type of service which is akin to the production of spectacles and very similar in its cost structure. Therefore, any error introduced is probably extremely small and will not distort the results of the cost study significantly.

To summarise the discussion it can be said that the data set at hand is particularly well suited to an estimation of an LRAC curve and a production function by regression methods. Of those criticisms usually levelled against empirical cost studies of this nature the most important, i.e. the lack of imputed costs and the different state of technology for different firms do not apply. Remaining possible errors have been shown to be of minor magnitude which can safely be neglected.

8.2.2 Estimation of a Long Run Cost Curve by Multiple Regression.

The empirical estimation comprised the following steps:

The data on output (in physical volume) and costs (in money terms) from the data set collected at the behest of the optical association were fed into the computer, using an appropriate statistical program or "package", in this case microstat, developed by ECOSOFT Corporation of the U.S. and implemented on an I.B.M. personal computer. The measure of output were the number of spectacles dispensed per year per firm. It is also possible to take the revenue per year per firm in monetary terms as a measure of output. This second measure was also fed into the computer and has been used as a check on the physical output measure.

Next, the cost figures had to be fed into the computer. The cost figures available in the original data are rather broken down in considerable detail. They consist of data on raw material cost, labour cost, working space cost, advertising cost, local taxes and other cost. These individual cost figures were fed into the computer. The costs of each firm have to be added and divided by number of spectacles produced in order to arrive at a measure of this LRAC of each firm. More insight into the nature of the LRAC curve can, however, be attained if rawmaterial cost is left out of the estimation. It has been shown that raw-material cost is the main separate cost and it may vary with the mix of varieties produced by individual firms thus giving rise to bias against larger firms if they sell, as is likely, a higher proportion of spectacles with a higher raw-material cost. Raw-material cost was therefore left out of the calculation of average cost per firm. A linear function was now fitted to the average cost-output observations thus defined yielding a curve of the form:

$$AC = a + b_1 Q + u$$

where AC = total labour and other cost Q = output mesured in pairs of spectacles a = intercept u = random variable.

If the coefficient b_1 is positive, this indicates increasing costs the larger the firm and therefore decreasing returns; if $b_1 = 1$ there are constant returns to scale and if b_1 is negative this is a sign of increasing returns. If the coefficient of determination, R^2, is low this may indicate that a linear curve does not fit the data very well. It is then possible to try and fit curves of a higher order. For instance a quadratic curve of the form:

$$AC = a + b_1 Q + b_2 Q^2 + u.$$

A cubic of the form:

$$AC = a + b_1 Q - b_2 Q^2 + b_3 Q^3 + u$$

might result in a higher R^2 indicating a U-shaped cost curve. The result of the various estimations of these curves can be summarized:

- The linear equation exhibited a T-ratio of 2.35 for the coefficient of the explanatary variable supporting a 95 % level of confidence, i.e. the result is statistically significant.

- The R^2, the coefficient of determination, however, was only .035, indicating that only 3.5 % of the variation could be traced to the influence of size.

- Fitting a quadratic and a cubic function did not improve matters, R^2 remained low.

Another method used to attain a better fit of the regression line would be transformation of the variables, i.e. converting them to logarithms etc. before estimation of the line of best fit by OLS. Several transformations were tried. The best result was obtained with a log/log specification. In that case R^2 increased to .10 and the t-value of the regression coefficient was - 4.16. These small improvements cannot be regarded as satisfactory. It must be concluded from these equations that there are other causes responsible for differences in cost level between firms apart from size. In such a case it is still possible to arrive at a logical measure of the influence of size on average cost. If the other influences can be traced and estimated by introducing them as further independent variables, then, if there is truly a correlation between them and the dependant variable, i.e. average cost, then their introduction will increase R^2 significantly, when the coefficients of the explanatory variables are being estimated by multiple regression.

Instead of estimating functions of the form:

$$AC = a + b_1Q + u$$

and related functions of a higher order containing only the one explanatory variable Q, it is now proposed to introduce a function with several explanatory variables. If these additional variables are justifiably included in the model, then this should show in an increase of R^2 while at the same time the T-ratios of the coefficients of the explanatory variables should remain at confidence levels above 95%.

Additional explanatory variables are not difficult to find from the data set:

- The average cost of a firm will obviously be influenced by the biggest block of costs in its cost structure. This is the average wage paid.

- The productivity of labour employed.

- The average price of a pair of spectacles should be included as the sale of higher-priced items may be presumed to entail a greater cost in selling effort, promotional expenses etc.

- Location should be included as another factor as a location in the center of a large city tends to imply higher rents, higher wages etc.

Measures have to be assigned to these concepts. For average price it is of course the average price charged. Location can be incorporated as a dummy variable, with 1 for location in city centre and O for other locations. A measure of the productivity of the workforce would be the number of pairs of spectacles produced per year per employee. For wages average wage per employee is taken because in the case of spectacles there is a great likelihood that wages per employee may vary considerably between individual firms as it is possible to employ a high proportion of apprentices. After a year's diligent training an apprentice is able to be substituted for a qualified worker, at only a fraction of his cost.

Taking the measure of output, i.e. pairs of spectacles produced per year per firm as the independent variable and the other influences as constituting the explanatory variables, on the data a stepwise multiple regression was performed. In a stepwise regression only those variables are included which result in a coefficient that is statistically significant, the level of confidence being chosen by the researcher. In this case a level of 95% was considered adequate and consequently two variables do not enter into the equation. These are location and revenue per sale. The following multiple regression equation was estimated:

$$AC = .117 - \underset{(1.973)}{.00000218\ SPECS/Y} + \underset{(12.526)}{.002WAGE/EMP} - \underset{(22.955)}{.000142\ SPEC/EMP}$$

where, SPECS/Y = pairs of spectacles produced per firm per year. WAGE/EMP = average wage per firm and SPEC/EMP = number of spectacles per employee produced by a firm per year. T-values are given in brackets.

The results allow a tentative interpretation: The coefficient of determination, R^2 has now increased to .785 This can be interpreted as indication that 78.5% of all variations in average cost are distributed amongst the explanatory variables of the equation. SPECS/Y is statistically significant at the 95% level, whereas WAGE/EMP and SPEC/EMP are significant at the 99% LEVEL. SPECS/Y is significant and has a minus sign, indicating increasing returns to scale. However, the coefficient of .00000218 indicates that for every 1000 pairs of capacity average cost increases by DM .28. This effect is almost negligible. The result of the statistical analysis may then be interpretated as indicating that, when the effect of the "suppressor" variables WAGE/EMP and SPEC/EMP are taken into account constant returns to scale are a fair assumption.

8.2.3 Estimation of a C-D Production Function.

In the preceding section it was shown that the estimation of the LRAC curve suggests the existence of constant returns to scale. An alternative method of testing for returns to scale is the estimation of a production function. A production function expresses the technical relationship between the physical quantities of inputs to the physical quantity of outputs produced. The simplest and most widely used form of a production function is the "Cobb-Douglas" function named after two American scientists who invented it in the 1920s.[189] Its form is multiplicative:

$$Q = AL^a \, . \, K^b$$

where, Q = output L = labour K = capital.

This can be generalised to:

$$Q = AF^1, \ F^2, \ .....F^n$$

for n inputs F1, F2, ... Fn.

The Cobb-Douglas function cannot be estimated by regression techniques as it stands because the multiplicative form is not linear. But if logs are taken one gets:

$$\log Q = \log A + a\log L + b\log K.$$

If a stochastic element is added such an equation can be estimated from the multiple regression:

$$\log Q = \log A + a\log L + b\log K + u$$

where, u = error term.

The Cobb-Douglas function can be used to test for returns to scale. If the coefficients add up to 1, then output has increased in the same proportion as inputs and there are constant returns to scale. If the sum of the coefficients has a value >1, then output is increased by more than the inputs have increased indicating increasing returns to scale. If the sum of the coefficients <1, then there are decreasing returns.

Many criticisms have been levelled against empirically estimated production functions. Ideally, a production function can only be estimated at a micro-economic level, for a single firm or a single homgeneous product, requiring a few homogeneous inputs.

In real-life situations, therefore, attempts to estimate production functions usually run into difficulties. The measure of output refers to heterogeneous products; labour input is of varied quality; capital input does not measure flow of capital services, i.e. user cost, but is, instead, usually a static measure of capital actually employed per time period, i.e. either actual stock of capital employed or interest and depreciation calculated according to accountancy principles.

There are various methods of circumventing these difficulties to some extent. The most obvious one is to use weights for inputs and outputs which would convert heterogeneous units of measurements into homogeneous ones. For instance, outputs can be given their market value or their cost of production, labour units can be weighted according to wage levels, corrected for different efficiency levels of high- or low wage labour cost units etc.

All these objections are more or less the same as those which have already been discussed earlier, where it was shown that the data used in this study are relatively free of these weaknesses. A meaningful estimation of a production function can therefore be made using the same data as before.

The production function estimated will be of the form:

$$\log Q = \log A + a\log L + b\log K + u.$$

where, Q = number of spectacles produced per firm per year, L = number of man-hours worked per firm per year, K = all other costs except wages and cost of rawmaterial.

The following equation was estimated:

$$\log Q = 1.2984 + \underset{(2.33)}{.1697\ L} + \underset{(10.54)}{.8216\ K}$$

with T-ratios given in brackets. R^2 = 85.8, adjusted for degrees of freedom.

The T-ratios are significant at the 95% and 99% level of significance, respectively, and the R^2 is high. The coefficients of logL and logK add up to 0.99. The deviation of the sum of a and b from unity is very slight. The hypothesis was therefore tested that the sum of the coefficients is not significantly different from unity. This hypothesis is supported by the test which tested the null hypotheses that the sum is not unity at a level of confidence well above 99%. The result of this estimation of a CD production function is then that the assumption of constant returns to scale is not rejected. This result therefore reinforces the tentative conclusion reached in the preceding paragraph which stated that constant returns are a fair assumption.

When there are constant returns to scale LRMC =

LRAC. This reduces considerably the problems of marginal cost estimation, the task which will be adressed next.

8.2.4 Estimation of Marginal Costs of Different Varieties of Spectacles.

The object of this section is an empirical estimation of the separate and marginal costs of different varieties of spectacles.

Estimates of separate costs are not available on an industry-wide basis. A cost study was therefore undertaken in the writer's own optical practice.

The theoretical considerations underlying this empirical study have already been discussed. It is now proposed to turn to their practical application.

8.2.4.1 Estimation of separate costs.

It has already been pointed out that estimation of separate costs does not pose particular problems conceptually. It is probably for this reason that separate costs play only a minor role in microeconomic theory. In practice, however, the estimation of separate costs is not always easy and procedures for estimating separate costs are widely debated in the field of cost accounting. In cost accounting it is acknowledged that tracing all separate cost - in this context called "prime" or "direct" cost may involve problems, particularly in a multiple-product firm. Horngren[190] cites as an example the distinction between order job costing and process costing. In the first case the direct costs attributable to a non-recurrent activity are measured, in process costing an attempt is made at determining a meaningful average of separate costs of recurrent jobs. Also, direct costs may not be traceable down to individual products; but still the term is applicable if costs can be traced to a branch of an enterprice, to a division etc. Separate costs are defined as those costs which are traceable to a particular activity be it division, cost centre, product or, indeed, variety of product.[191] The science of workstudy has developed methods of separate cost measurement. Although work-study ultimately aims at increasing the efficiency of opereations it can be used for purposes of this study.[192] As far as the estimation of separate costs is concerned definite procedures of identifying separate, in accounting parlance "prime" or "direct", costs have been established and are described in textbooks of production management.

There is a variety of costs which are separate, i.e. can be traced to differentiated products. In the case of spectacles they are:

1) Raw-material cost
2) Direct labour cost.
3) Other direct costs:
    a) ancillary material
    b) postage and traceable telephone costs
    c) user cost of specialized machinery or furniture

d) interest for material kept in stock

e) processing cost of bills

f) miscellaneous separate costs.

In order to arrive at a satisfactory method of estimating separate cost advice was sought from the chief cost accountant of the Volkswagen factory at Kassel, Germany.[193] The Volkswagen factory deploys, of course, the most advanced methods of cost accounting[194] which lay the utmost importance on using the correct principles to use in the estimation of "prime", i.e. separate cost. It therefore possesses a wealth of experience in their practical application.

The cost accountant made a most valuable contribution to the practical problem of measuring direct cost. He suggested the problem should be solved by employing the principles of work measuremant by "REFA" methods.

The expression "REFA" is short for Reichsausschuss fuer Arbeitszeitermittlung which translates into English as The National Committee of Work Measurement. "REFA" is the equivalent of methods of workmeasurement which ultimately go back to the time and motion studies originated by the Americans W.F. Taylor (1856-1915) and Charles Bedeaux (1888-1944). Over the last 80 years REFA has developed into a body of knowledge which goes far beyond the original time and motion studies and is widely used in German industry. The compendium on REFA methods extends to 5 volumes.[195]

Usually separate costs are divided into direct labour cost and direct material costs.

In order to measure direct labour cost the following principles are suggested by REFA:

- describe an operation, such as the production of a pair of spectacles, logically from start to finish, by suitable means, e.g. a flow-chart,

- divide the operation up into small elements which can easily be measured,

- time each element several times in order to ensure accurancy,

- calculate averages.

The object of the REFA studies is the estimation of standardardized rates. In this case, however, the measurement of traceable costs of each individual element of the operation is all that is needed so that only the first two of the steps mentioned have to be employed.

A more difficult task is that of estimating direct materials cost. The REFA methods also suggest an important principle which can be stated in a single sentence:

> "everything that can be traced, quantified and measured is a separate cost and can be calculated."[196]

The meaning of this principle becomes more obvious if it is illustrated by an example: If only "national health" frames and lenses were provided by opticians then the space required for dispensing would be minimal. Dispensing and workshop could be in the same room and only a negligible portion of the cost of premises and furniture would be incurred at the sales point. If, however, as is the case in any traditional optician's premises specialized display units for better quality frames and lenses have to be provided, then this constitutes an extra cost which is traceable to better frames. This cost can be quantified by estimating the cost over its entire life. By estimating the total time in use in appropriate units, i.e. minutes, and dividing total cost by total time, cost per time-unit can be quantified. The number of minutes which every individual variety of product makes use of the specialized furniture can then be measured and its separate cost can be calculated by multiplying individual minutes of use by cost per minute.

It is now proposed to follow the procedure suggested by the cost accountant:

1. construct a flow-chart of the production precess of spectacles and note for each stage of production the type of separate cost incurred.

2. Decide how separate costs can be measured.

3. Perform the actual calculations and measurements.

8.2.4.2 Constructing a flow chart and identifying separate costs.

Fig. 1

Flow Chart: Production of Spectacles.

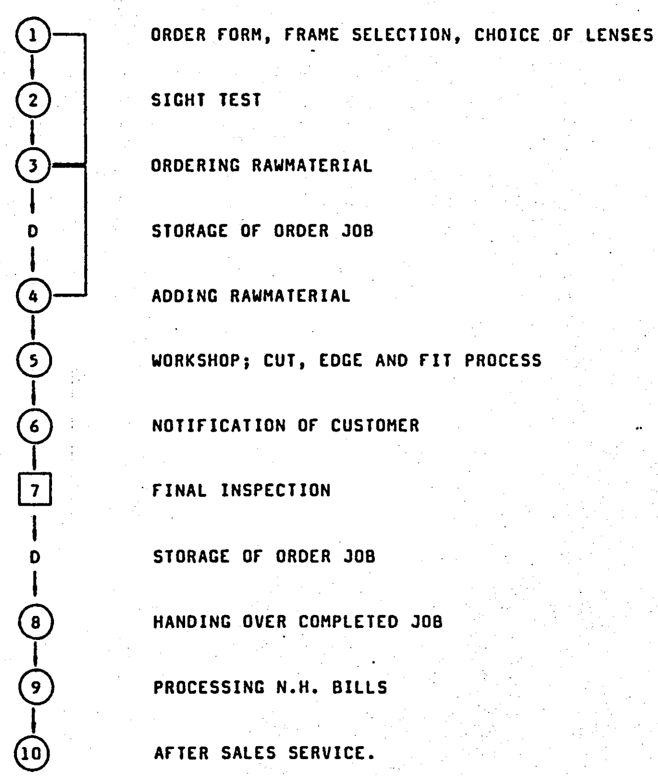


Fig. 1. shows a flow-chart outlining the ten stages of production of a pair of spectacles.

Stage 1:

The production of a pair of spectacles begins when a client enters an optician's practice with a view to ordering a pair of glasses. Stage 1 consits in fact of 3 activities which cannot be separated:

1. Filling in an order form, which accompanies the spectacles during the entire production.

2. Selecting a frame suitable for the customer.

3. Choosing the quality characteristics of the lenses to be supplied.

The optician spends a definite period of time on this activity and this time can be measured and constitutes obviously a separate cost of a pair of spectacles. The time measured should include the minutes spent on this particular activity, including time spent on tidying up frames after the customer has left and time spent in carrying the job to the workshop. The separate cost will then be calculated by determining the cost per minute of the individual optician performing the task and multiplying this figure by the minutes measured. The labour cost per minute is calculated by dividing yearly wages by yearly minutes actually spent on the job. In this way holidays, premiums, absence for breaks, but also sickness etc. are accounted for. The yearly wage includes all direct wages, taxes and contributions ect. paid by the firm. What further costs can be traced to the differentiated variety at this stage? This questions poses some rather difficult problems. It was mentioned before that specialized furniture and equipment such as display units for frames, equipment for the measuring of pupillary distance and the height of the reading segments in multi focus lenses are being used at this stage. Display units are only necessary when better quality frames are sold, but not when the client chooses to have his new lenses dispensed into his old frame or makes do with the "national health" type of frames. This equipment can therefore be traced to individual jobs and consitutes a separate cost. How to calculate this type of direct materials cost per pair of glasses was discussed in the preceding paragraph. It consists of estimating total life and total cost of the item and dividing total cost by total life, expressed in this case in minutes in order to arrive at cost/min. Multiplying actual time used by this cost figure gives separate cost for the individual pair of glasses. A more difficult question is posed by the fact that quite a determinate space is required for frame display. Should rent, maintenance, heating etc. for this space not also be calculated per minute of use and charged separately to different varieties of product? At first glance it may seen that this question has to be answered in the affirmative. However, the sales-room is also used for other stages of production, such as stages 8, adjusting frames, making payment and stage 10, after sales service. It then becomes illogical to assign cost/min. to these activities as they are produced jointly. Therefore work-space costs are not traceable to individual product varieties. They are traceable, however, when space is specially used for one stage of production only as is the case with the workshop and the sight-testing room.

Stage 2:

When the client comes to see his optician he may already be in possession of a prescription, usually made out by an ophthalmic doctor. If this is the case production goes right on to stage 3 as indicated in the flow chart. If not, the optician performs a sight-test indicated as stage 2 in the flow-chart. Sight-testing entails a separate labour-cost, and will be measured the way already described. But sight-tests usually have to be performed in a self-contained room with specialized equipment. The costs of this room are made up of the cost of original decoration, furniture and equipment, their maintenance, heating, cleaning, electricity and rent. User cost per minute can be estimated for rent by dividing total cost of rent by the yearly minutes the sight-testing room is in use per year. The cost of fitting out the room has to be estimated together with maintenance cost over the whole life of the room and cost per minute can then be calculated. It is also possible to measure the separate costs of cleaning, heating and use of electricity. But part of these costs are provided jointly for the whole firm.

Stage 3:

This involves the estimation of the separate costs of ordering raw material. Here direct labour time is expended which can be measured; along with definite separate materials cost. The cost of postage and telephone charges incurred in the process. The use of equipment and space can be ignored as they are infinitesimally small.

Stage 4:

Apart from the direct labour cost which is dealt with in the now familiar fashion, at this stage the costs of the raw material have to be established. As the retail prices are known from the record these costs can be read off from the "calculators" and recommended retail price lists which contain all retail prices and the corresponding raw material prices. Any discounts or special rebates conceded by manufacturers have to be deducted. Again, there are no difficulties as these can easily be derived from the normal accounts. A further cost is the interest incurred for rawmaterial kept in stock. Ideally, time that each item is kept in stock should be recorded individually and interest calculated. As this procedure would entail enormous cost, it is proposed to substitute another method of cost estimation for it: average turnover of frames and lenses can more easily be calculated. A good approximation to the desired figure would then be the average interest cost chargeable to each individual item of raw material. To give an example: frames are turned over n times per year. Interest per year is 7%. Average interest on frames is then (n/7)%. Separate cost due to interest of frames is then (n/7)% of the raw material value of the frame.

Stage 5:

Stage 5 is the cut, edge and fit process. Here, again, direct labour time can be measured in the usual way. Further separate costs are room-costs, i.e.

rent, but also the costs of specialized furniture, fitting up the room and maintenance costs. These costs are estimated in the now familiar manner, with just one variation. One of the major costs is use of the edging-machine and here separate costs can be traced even more finely. Its diamond-studded wheels are worn out in direct proportion to the time the machine is used to grind a pair of lenses. This cost can be assessed separately if the time of use is recorded separately. Furthermore, for some frames a "former" has to be made up specially and if so, its cost of DM .40 has to be added. Sometimes a lens or frame is spoilt in the process of production, in this case its cost should also be recorded at this stage.

Stage 6:

Notification of the customer, although seemingly a minor item, may entail relatively important separate costs. If notification is done by the phone, this, in addition to the charge for the call, often entails several minutes of direct labour cost, if the client does not answer and one has to try several times. Also, phone calls made by impatient customers asking about the time of completion of their spectacles cost considerable time and should logically be included at this stage. If notification is made by mail this includes the cost of postage and the postcard.

Stage 7:

At stage 7, final inspection, traceable cost is that of direct labour time and this is the only item that can be recorded as a separate cost at this stage.

Stage 8:

Handing over of completed spectacles, adjusting frame, making payment, again entails considerable direct labour cost. Room costs cannot be measured separately as the space is the sales-room used jointly with other stages of production. However, often cases for glasses are given away free of charge and if so they should be noted as a separate cost.

Stage 9:

Processing of "national health" bills, is a rather curious cost. The many "sickness funds" require a separate bill for every pair of glasses supplied to one of their members. This work is contracted out at a cost of 1% of the value of bills and constitutes a traceable separate cost. Furthermore, the bills are paid on average 14 days later than private bills which are normally paid right away. Interest of approximately .3% of the value of bills is therefore a separate cost to be noted at this stage.

Stage 10:

After sales service is the final stage of production. It involves refitting a client's frames free of charge as long as his glasses last. If the client has second thoughts on the type of frame, it is not unusual to exchange them free of charge for another pair. If he is not satisfied with his visual acuity, another sight test will be administered, even if the original test had been done by an ophthalmic doctor. Sometimes new lenses have then to be given free of charge. All these activities will give rise to separate labour and/or material-costs which also constitute separate costs.

8.2.5 Measuring and Calculating Separate Cost in Practice.

The flow-chart exhibited in Fig. 1 has to be modified a little to ease the actual task of measurement. This task was greatly facilitated by the fact that for every pair of glasses produced by an optician a record is made up in any case. The record in actual use only had to be expanded in order to serve adequately the purpose of the cost study and to collect on to it all the data which are required in order to serve the ultimate purpose of the exercise, namely to construct the price and cost planes mentioned in chapter 7.

An example of the expanded record is exhibited in Fig. 2.

Fig. 2

Work Sheet: Job Costing.

		NAME WORKER	MINS	DM/ MINS	COST	MINS	DM/ MINS	COST
1	NAME OF CLIENT	Müller						
2	PRESCRIPTION	4						
3	LENS VARIETY	2						
4	RETAIL PRICE RIGHT LENS	89.-						
5	RETAIL PRICE LEFT LENS	89.-						
6	RETAIL PRICE FRAME	56.-						
7	SICKNESS FUND PAYMENT	68.-						
8	SALES ROOM	Lorenz	21	.61				
	" COSTS					15		
9	SIGHT TEST	Seitz	17	.52				
	" EQUIPM.					17	.335	
10	ORDERING RAW MATERIAL	Baudt	3	.45				
	TELEPHONE ETC.							3.40
11	ADDING RAW MATERIAL		2	.45				
	RAW MATERIAL R LENS							32.-
	RAW MATERIAL L LENS							32.-
	RAW MATERIAL FRAME							12.-
12	WORKSHOP	Seitz	18	.17				
	" COSTS					18	.172	
13	USE EDGING MACHINE					4	.04	
	FORMER							.40
	WASTE							–
	OTHER MATERIAL							–
14	NOTIFICATION CUSTOMER	Lorenz	6	.61				
	" " POSTCARD							1.20
	" " TELEPHONE							–
15	FINAL INSPECTION	Lorenz	3	.61				
16	SALES COMPLETION	Seitz	11	.52				
	GIVE AWAYS							4.-
17	AFTER SALES SERVICE	Baudt	21	.45				
	MATERIAL USED							32.-

Some of the data in Fig. 2 have already been explained in the preceding section. In assigning values to the different separate costs additional explanation is given when necessary.

Row 2:

Prescription: a short-hand notation is given to indicate the strength of the lenses. Thus, all lenses of spherical power zero up to +- 2.0 dpts. are denoted by 2, all those of spherical power up to +-2 with an additional cylindrical component of up to +2 by 2/2 etc.

Row 3:

Lens variety: This is the second type of vertical discrimination, described in paragraph 5.1.3.2. The information is shown following the notation of the dummy.

1 = Single focus lenses supplied without frames,

2 = Single focus lenses supplied including frames,

3 = Multi focus lenses supplied without frames,

4 = Multi focus lenses supplied including frames.

Row 7:

Sickness fund payment: This is the sum paid by the sickness fund of which the client is a member.

Row 8:

Sales point. Separate costs incurred here are direct labour costs only. The method of measurement has been explained before. But an example of the actual calculation is shown: The optician Lorenz received a total yearly salary of DM 66319.2 in 1984. He works 40 hours per week or 6.66... = 6.7 hours per day. He gets a holiday of 30 working days. There are 9 statutory holidays in 1984. His average absence for sickness over the last 5 years was 6 days. He worked 32 hours overtime. Converting these figures to hours per year:

Gross total	= 52(weeks)	x 40	= 2080
- holidays	= 5(weeks)	x 40	= -200
- statutory holidays	= 10(days)	x 6,7	= -67
- sickness	= 1(week)	x 40	= -40
			= 1773
+ overtime			= 32
			= 1805

Total hours worked adds up then to 1805; multiplied by 60 to give minutes/year = 108300. Thus cost per minute is 66319.2 divided by 108300 = DM 0.61 per minute.

Row 9:

Sight test: Here, again, the direct cost is measured. The sight-test was performed by another employee by the name of Seitz. Direct labour cost per minute was calculated in the same manner as before to be DM .52 per minute. Since the sight-testing room is a self-contained unit user cost per minute can be calculated. The sight-testing room measures 8 square-meters. The furniture, fittings and equipment of a sight-testing room are not subject to any appreciable amount of obsolescence. Their normal span of life can therefore be estimated at 18 years.

Maintenance cost per year is approximately DM 2400.0. On average 20% of all clients have their eyes tested by opticians. 1 sight testing room per 4500 clients per year is the optimal capacity and estimating the average length of a sight-test to be 17 minutes,[197] total user-minutes per year will be 900 x 17 = 15300 and over the entire life of the equipment they will be 900 x 17 x 18 = 275400 mins. Fittings and furniture of a sight-testing room were estimated by the firm of Zeiss[198] to be DM 49500 at current prices, i.e. replacement cost. Total cost is DM 28000. Total minutes used = 275400. The cost per minute is therefore DM 49500/275400 = DM .18. To this figure has to be added the annual rental cost calculated at 8 x DM 360 = DM 2880 per year, divided by the yearly minutes of use = 2880/15300 = DM .183. The maintenance cost of DM 2400/15300 = DM .160 per minute. Thus the user cost of the sight-testing-room per minute = DM .18 + DM .183 + DM .160 = DM .52.

Row 10:

Ordering raw-material: The direct labour-cost of the third employee, was calculated to be DM .45 per minute. He incurred a telephone charge of 9 units at DM .26 = DM 2.34.

Row 11:

Adding raw-material. In additon to direct labour cost the raw-material price of the frame was DM 12.0 and the rawmaterial price of the lenses was DM 64.0. These prices were derived from the calculator[199] as far as the frames are concerned, and from the recommended retail price list of the manufacturer Rodenstock for the lenses. From the raw-material price of the lenses a 25% rebate granted by Rodenstock was deducted. For the frame there was no special rebate.

Row 12:

Workshop. In addition to the direct labour cost, space costs and the costs of specialized furniture and machinery can be traced. Cost figures were calculated for the practice and checked against figures estimated by one of the world's leading suppliers of equipment for optical workshops, the firm of Wernicke, Duesseldorf[200] A workshop with a capacity of 3000 pairs of spectacles per year occupies 15 square-meters, which, assuming an opportunity cost of DM 360 per square-meter per year gives a cost of DM 5400 per year. Fitting it out with the necessary furniture and equipment costs DM 35000, excluding the edging machine. The life span of these assets is estimated at 15 years. [201] Maintenance costs are DM 2500 per year.[202]. The minutes of use per year are equal to the average minutes per pair of glasses[203] multiplied by the number of spectacles produced[204] = 19min. x 3150 = 59850 min. This figure has to be multiplied by 15 (years) resulting in a total of 897750 minutes. Thus one arives at a cost per minute of DM 37500/897750 = DM .041 per minute. To this must be added rent of DM 5400/59850 = DM .09 per minute and yearly maintenance cost of DM 2500/59850 = DM .042 per minute. The cost per minute it then DM .041 + DM .09 + DM .042 = DM .173 per minute.

Row 13:

Edging machine. The lifespan of an edging machine is approx. 20000 hours. In these 20000 hours maintenance costs of DM 24000 will be incurred, mainly because every thousand hours the diamond wheels costing DM 1200 a set have to be replaced. 20000 hours = 1200000 min. Total cost of the edging machine over its entire life = DM 26000 + 24000 = DM 50000. The cost per minute is then: DM 50000/1200000 = DM .04 per minute.

Row 15:

Final inspection. At this stage only direct labour costs can be traced.

Row 16:

Sales completion. In additon to direct labour cost, costs were incurred for a case given free of charge.

Row 17:

After sales service. Separate costs are mainly direct labour costs, but in some cases new lenses or frames are supplied free of charge and their raw material cost then constitudes a separate cost.

As already mentioned the actual measurement of separate costs was performed in the Hann. Muenden branch of the author's firm in April and May 1984. The cost measurements were taken by the employees under the supervision of the author. They yielded 450 job forms representing 450 pairs of spectacles into which the minutes used for each operation and the other traceable separate costs were minutely entered. As every form contains 19 entries approximately 8500 separate data have thus been collected. To safeguard against possible "sloppiness" the workers filled in additional daily reports in which their daily routine was recorded by the minute. Thus a reliable estimate of the separate prices and costs of the 450 pairs of spectacles produced in that time period was attained. To these data average costs have to be added in order to arrive at a measure of marginal cost of each individual pair of spectacles.

8.2.6 Estimation of Average Cost.

It has already been shown that returns to scale are constant in the production of spectacles. It follows, that marginal cost equals average cost. This facilitates the estimation of average cost considerably, as average cost can be found by simply dividing total cost by number of units produced. At the same time separate costs have, of course, to be deducted before average cost is calculated; recall that it was shown that average cost is found by the formula:

$$AC = \frac{TC - \sum SCi}{Q}$$

where, Q would be the "normal output" per year, i.e. the optimal output under total adaptation. The sum of separate cost, SCi can be derived from the REFA estimates by projection of the sum of separate cost of 450 pairs to the "normal" 3150 pairs produced per year. It is then necessary to calculate total cost.

Total cost has to be estimated for the long run. Accountancy figures should therefore be converted into those relevant to the economist's definition of long run cost and furthermore include all relevant imputed costs.

The underlying principles have been discussed already [205]. It was shown that longrun costs are those costs which would accrue if the entrepreneur were able to adjust all factors of production to the current rate of output optimally.

The task is greatly facilitated by the fact that the practice under observation can be said to be reasonably well adapted to its current rate of production in any case.

TABLE 4.

Number of Specs Produced per Year by Firm.

YEAR	NUMBER
1972	3083
1973	3343
1974	3107
1975	3142
1976	3175
1977	3101
1978	3219
1979	3092
1980	3380
1981	3295
1982	2829
1983	2989

Table 4 shows number of spectacles produced per year over the last 12 years. Output was on average 3146 pairs of glasses per year with a low of 2829 and a high of 3343. With the exception of the firm's premises during those years more or less all assets have been replaced at some time or another. There was therefore a good chance to adjust any factor of production which was too large or too small, and there is no reason to believe that this has not been done. Therefore, it can be concluded that after some adjustments called for and to be discussed presently, figures from the financial accounts can be taken to represent costs under total adaptation reasonably well. Particularly, the average yearly output of approximately 3150 spectacles can be taken as the "normal" capacity. Also, the size of the firm and its cost structure are very nearly identical with the average of the industry structure as shown by the ZVA study which has been used to estimate the LRAC curve and the Cobb-Douglas production function. This similarity is born out by Table 5.

TABLE 5.

Costs of Firm under Observation and 155-Firm Average Observed in ZVA Study.

	Firm	ZVA
1) Turnover	656348	648497
2) Raw-material	218667	209224
3) Interest received	57	
4) Discounts received	5545	4463
5) Non-operative profit	25	-
6) Wages and salaries	223120	216637
7) Depreciation	23609	20477
8) Interest paid	4829	9699
9) Taxes, rates	15348	22356
10) Maintenance costs premises	17931	10341
11) Advertising	19062	17332
12) Rent	22320	23750
13) Miscellaneous	45032	30970

An alternative to using cost data of the firm would be to use these industry averages. This is not possible because the industry-wide data set does not contain estimates of separate costs. However, as the firm under observation can very nearly be regarded as "representative" in its costs structure, the firm data will provide an adequate measure of total cost. Another point in favour of this approach is the possibility to scrutinize every block of costs and make the necessary adjustments for a valid estimate of costs under total adaptation.

The obvious point to start from when determining the individual items of total cost is the balance-sheet and the profit and loss account for the current year, i.e. 1984 of the practice under observation. The profit and loss account has already been shown in Table 5. Table 6 shows the balance sheet.[206]

TABLE 6.

Balance Sheet, Firm of Diplom Optiker Hess Hann.-Muenden Branch

Assets		Liabilities	
Tangible Assets	93244	Value adjustments	6795
Circulating Capital		Bank liabilities	6023
Commodities-in-stock	87541	Other liabilities	145
Dept due	51344		
Cash-on-hand	150	Capital	10013
Bank balances	7940		
Money-in-transit	130		
Transitory items	2546		
	242897		24289

The task now is to go through the items of the profit and loss account and the balance sheet in order to decide whether the figures given can be used in an estimation of LRMC as they stand or whether and how some of the figures should be changed.

Considering the various items:

- Turnover of DM 656 348 is very much near the average turnover of the sample of firms on which data were collected at the behest of the optical association. The size of the firm under observation is therefore very near the average of the industry.

- raw-material cost: this is also near the industry average.

- interest received is of no importance.

- discounts received: This sum is approximately. 2 % of value of raw-material. These 2% have to be deducted from the value of raw material when separate costs of raw-material are determined in the calculation of separate costs.

- non-operative profits: again the sum is of no consequence.

- wages and salaries: As mentioned before these contain all direct wages, including social security payments, provision for pensions etc. but no other costs are "apportioned" to this item. Particularly, it does not contain any wages for the owner-entrepreneur for the firm under observation[207] whereas the ZVA-data contain imputed wages of owner-entrepreneurs where appropriate. It can be concluded that wages are at their longrun level.

- depreciation: This, of course, is a difficult problem. Depreciation as shown in the profit and loss account is calculated according to the principles of financial accounting which are governed in large part by legal principles and requirements of the tax authorities. One of the most important requirements imposed by the tax authorities is calculation of depreciation from historical cost figures. Legal rules stress the principle of caution, i.e. assets are depreciated more rapidly than warranted by the actual life of assets. Another possible factor distorting depreciation rates is accelerated depreciation.

In the literature, less in practice, it is often demanded that compound interest should be taken into account. The idea being that liquidity yearly received in the form of depreciation, if invested again, would increase through interest being received. Therefore yearly depreciation rates should be valued at their discounted present value.[208] However, depreciation charges calculated at their discounted present value become increasingly smaller every year and depreciation charges would therefore vary for every year. Should the compound interest method be employed in this study?: Lest there should be confusion it should be noted that interest paid on assets which are depreciated over several years is, of course, a cost. This interest charge is covered by the interest imputed on necessary working capital.

Loeffelholz[209] discusses the point at some length and comes to the following conclusion: disregarding the cumbersome method of calculation, it only seemingly is more exact than straight line depreciation. It is only valid under the assumption that money received in the form of depreciation will indeed earn interest. As amounts received will normally be reinvested in the firm this is not necessarily the case, and if interest is indeed earned, it is difficult to decide on the appropriate interest rate. A falsely estimated interest rate would in effect by far outweigh any increase in accuracy through the method in question. He therefore proposes to follow the method used in practice and disregard compound interest.

It is now possible to summarize the discussion above: When depreciation rates serve the purpose of determining cost under total adaptation they should be calculated from replacement costs, life of assets should be assessed realistically and depreciation should be linear, i.e. in equal yearly amounts.

TABLE 7.

Asset Sheet, Firm of Diplom-Optiker Hess,
Hann. Muenden Branch. (DM)

SETS		BOOK VALUE	HISTORIC COST	REPLACEMENT COST	ACCOUNTING DEPRECIATION Life in years	ACCOUNTING DEPRECIATION amount	in years	ECONOMIC DEPRECIATION	AVERAGE PRESENT VALUE
ND AND BUILDING	(1968)	56833	71780	280000		1660		-	280000
CONSTRUCTION EMISES	(1978)	15792	65531	80000		9473	10	8000	40000
CHINERY ND EDGER	(1964)	1	420	2500	8	52.5	30	83	1250
LDERING MACHINE	(1977)	1	2156	800	8	269.5	10	80	400
ND EDGER	(1979)	1	2849	3200	8	356	30	106	1600
OOVER	(1980)	173	868	1200	8	108	12	100	6000
CO EDGING MACHINE	(1981)	14215	22745	28000	8	2843	7	4000	14000
UIPMENT AND RNITURE									
IT LAMP	(1964)	1	3102	14000	8	388	30	466	7000
LATEST	(1964)	1	2099	40000	8	262	12	3333	20000
IAL CASE	(1964)	1	900	3600	8	112	30	120	1800
LEPHONE EQUIPMENT	(1971)	1	900	700	8	112	5	62,5	350
BINET	(1973)	1	3378	5500	8	422	30	183	2750
SH REGISTER	(1975)	330	5000	3000	10	500	15	300	1500
RNITURE SALES ROOM	(1978)	17146	43601	55000	8	5450	10	5500	27500
RKSHOP CABINETS	(1978)	368	1664	2000	8	208	15	44	1000
U-CHAIR	(1978)	1	1762	2200	8	220	20	110	1100
LAROID PORTAIT AMERA	(1979)	200	2003	1200	9	250	10	120	600
CABINET WITH RAWERS	(1981)	952	1362	1500	8	170	10	150	750
JTDOOR SIGN	(1982)	4653	7755	7500	8	969	20	375	3750
HYSIMETER	(1983)	4230	4702	5400	8	588	20	270	2700
OTAL DEPRECIATION						21664		23402,5	
OTAL DEPR. EXCL. LAND ND BUILDING						12191		23402,5	
OTAL AVERAGE RESENT VALUE									126880

Table 7 shows the asset sheet of the branch which in its conventional form would only display date of purchase, book value, historical cost and annual depreciation rate of assets. It has been amended by estimates of the replacement cost and economic depreciation charges.

The theoretical discussion of the preceding section is supported extremely well by the figures:

The first item, value of business premises and site is not relevant to the cost estimation as a normal rent is imputed. However, it shows strikingly how book value and economic value may diverge.[210]

The situation is different with the next item, reconstruction of premises. Every 10 years the sales room has to be reconstructed because it has become obsolete - mainly because it is no longer in fashion - but also because of the usual wear and tear. It is therefore legitimate to calculate the economic depreciation charge on the new basis, for 10 years, and, of course, on the basis of replacement cost whereas financial depreciation is often degressive and always calculated from historical cost. The result, however, is only a relatively minor discrepancy between the two depreciation charges.

As far as depreciation of machinery is concerned, the fact that some machines are still in use which have been bought in 1964 again underscores the necessity to use realistic estimates of the life of assets instead of the rigid 5-8 years stipulated by taxation rules. Comparison of historical and replacement costs also reveals huge differences. Replacement cost, however, may be lower than historical cost because of technical innovation. This is borne out by the items soldering machine and cash register. The calculations are more or less self-explanatory and shall not be discussed in detail therefore. Just one item needs special mention: The

"Polatest". It is required for sight-testing. Although it has already served 30 years, and could technically probably put in another ten years of service, it has become obsolete as new, electronically assisted methods of sight-testing are being substituted for traditional methods. It will therefore be necessary, in order to keep up with competitors, to instal modern sight-testing equipment estimated at a cost of DM 49500 and a life-span of 12 years. These figures have therefore been introduced and depreciation rate calculated accordingly.[211] When all adjustments have been made total depreciation excluding property is DM 23402. 5 instead of the DM 12191 shown by the financial accounts.

We now turn to the estimation of interest on necessary working capital. The profit and less account shows only interest actually paid on debts outstanding. However, interest on equity capital is an opportunity cost which must be imputed. In the Optical Association's cross-sectional date set this was found by taking the value of the asset side of the balance sheet, deducting from it all short-term liablilities as shown on the left-hand side and imputing interest at the rate of 7% to this necessary working capital. This method was the best that could be done with the data at the disposal of the ZVA. It must be admitted, however, that the estimate of the necessary working capital is open to some reservations and can be improved upon in the present case.

Return to Table 6, which shows the balance sheet of the firm under observation: The item tangible assets which comprises land, building, machinery and equipment shows a book-value of DM 93244. From this sum has to be deducted book-value of land and building, as a rent is being imputed. This operation would have been performed in the ZVA study. But also, the items reconstruction premises, machinery, equipment and furniture can be assessed more realistically. Even if assets are assessed at replacement cost, their present, i.e. corrected "book-value" will depend on the date of purchase, which determines how much is written off. There is no guarantee that old and new items will exactly balance. To arrive at an exact average it is necessary to evaluate each item at 50% of its replacement cost. This is done in the last row of Table 7, in this chapter. The average value of assets adds up to DM 126850.

Stock-in-trade, can be taken at book value, as there is no reason to suspect any loss due to obsolescence etc.

This also applies to the items cash-on-hand, sums-due- from- banks and cash- in transit. There is no reason to suspect that these are not the normal amounts corresponding to what is necessary on average.

Necessary working capital can now be calculated as shown in Table 8:

TABLE 8.

Necessary Working Capital, Firm.

Premises, Machinery, Equipment	126.850
Stock-in-trade	85.541
Cash-on-hand	150
Sums-due-from-banks	7.940
Deferred expenses	2.546
Cash-in-transit	130
	223.157
- Short-term liabilities	14.567
	208.590

Taking an interest rate of 7% imputed interest amounts to DM 14601.0 In table 5, the next cost category is taxes and rates. This item is made up of local taxes and rates, which are partly fixed sums and partly depend on income. They are taxes for which the firm is liable and are deducted before personal income tax. These taxes therefore from an economist's point of view are costs and are justifiably included.

The next items are advertising expenses, postage, telephone, maintenance costs and other expenses, which can all be taken at their book-values.

The profit and loss account can now be changed in such manner that it complies as well as practically possible with the economist's notion of total cost under total adaptation. This is shown in table 9.

TABLE 9.

Profit and Loss Account Under Total Adaptation.

	DM
Turnover	656 348
Rawmaterial	57
Discounts received	5545
non-operative Profits	25
Wages and Salaries	223 120
Depreciation	23 402
Interest Paid	14 601
Taxes, Rates	15 348
Advertising	19 062
Rent	22 320
Maintenance, Repairs	17 931
Miscellaneous	35 032
Total Cost	595 110

The estimation of average cost has now become a matter of simple calculation: normal capacity of the firm, or rather, plant, was shown to be 3.150 pairs of spectacles per year. Total cost per year under total adaptation = DM 595 110. From total cost total separate costs have to be deducted. These have to be imputed from the cost study. 450 pairs of glasses had a total of separate costs of DM 62 041.5. Separate cost per pair therefore = DM 137.81. 3.150 pairs then have separate costs of 3.150 x 137.81 = DM 434 101.5. Then,

$$AC = \frac{595\ 110 - 434\ 101.5}{3150}$$

$$= 51.11$$

If no distinction is made between common cost and profit, then the residual of AC and profit, "e" in the article by Zerby and Conlon would be determined by subtracting separate cost from turnover and dividing by Q.

$$e = 656348 - 434101.5 = 222246.5$$

$$\text{Average of } e = 70.55$$

It is important to note that the way in which average cost is estimated in no way invalidates conclusions about the presence of price-discrimination in the market for spectacles. Price discrimination is defined as the sale by the same seller of the same commodity at different prices or as the sale of different varieties of a commodity at prices which are not equal to marginal cost. AC is therefore a constant which only "shifts" the cost plane. Its inclination to the price plane will not be affected. As it will be shown that prices and costs diverge considerably, the contention that the empirical findings in the market for spectacles support Posner's theory of taxation by regulation is not invalidated by using this approach.

8.2.7 Estimation of Economic Profit.

Nevertheless, it would be interesting to see whether opticians have succeeded in exploiting the monopoly situation conferred upon them in order to reap monopolistically inflated profits in the economist's sense.

As such an estimate is made the logical consequence is a quantitative estimate of economic profit. However, economists are usually extremely cautious if asked to put a definite figure on economic profits, be it for an industry or a single enterprise and the concept has been subject to considerable debate when the necessity arose, for instance in debates about the multitude of managerial goals[212] or in discussions of the price and profit consequences of market structure[213] Problems of empirical estimation of profits were directly addressed by Almarin Philipps[214] and Dalton and Pen.[215] The subject is further explored in discussions of efficiency implications of monopoly for instance in the famous article by Harberger.[216] The general picture one receives from these discussions is the need of extreme caution in any assessment of economic profits, which in turn implies equal cautiousness in empirical estimation of long-run costs as the one implies the other. It was probably the awareness of this controversy which led Zerby and Conlon in their study to refrain from disentangling profits and common costs. It was shown, however, that their method of allocating common cost and profit is rather doubtful.

In textbooks of management accounting[217] and especially in textbooks on managerial Economics[218] less reservations about the feasibility of a meaningful estimation of economic profit are held.

From the figures an economic profit can be calculated:

TABLE 10.

Calculation of Economic Profit

Turnover	656348
+ discounts	5157
	651191
- total cost	595110
	56081

Which amounts to 8.4 % of turnover. The definition of an acceptable rate of economic profit is a much debated topic in the economic profession, an intensive discussion of which would lead too far afield. The following estimates are made in accordance with suggestions by Joel Dean:[219]

It can be said, that there is probably agreement as to the fact, that a premium for risk should be deducted before profit. If this is set, admittedly rather arbitrarily, at 5 % of necessary working capital, then 5 % of DM 208590 = DM 10429 have to be deducted from profit which leaves a profit estimate of DM 56081 - DM 10429 = DM 45652 = 6.9 % of turnover.

Calculated as rate of return on capital of DM 208.590, DM 45652 are 21.9 %, which is 3.1 percentage points below the rate of return General Motors aims for and which is often considered adequate. We can therefore conclude that some monopoly profits may be suspected but it can be ruled out that they are excessive by any standards. Some interesting implications of these profit estimates will be discussed in the concluding chapter.

8.3 EMPIRICAL ESTIMATION OF PRICE, COST AND PRIVATE PAYMENT PLANES.

It is now possible to construct empirically the price, cost and private payment planes. Individual prices, separate costs and the sums paid by sickness funds which make up the sample of 450 pairs of spectacles contained in the cost study were fed into the computer. The price of each individual pair of spectacles was then derived by adding the price of the frame, the price of the right lens and the price of the left lens. Private payment is the difference between the price thus calculated and the payment made by the sickness fund. The cost of each individual pair of spectacles is the sum of the separate cost of each pair to which is added the average cost of DM 51.11. Next, the data set was divided up into 4 subsets:

1. Single focus without frames.

2. Single focus including frames.

3. Multi focus without frames.

4. Multi focus including frames.

It has been mentioned that approximately 20% of sales consist of the basic variety paid for by the funds. Here only lens power differences are involved. These varieties do not contain additional characteristics. If the planes for the 4 subsets were estimated including these basic varieties the resulting estimates of the price. cost and private payment planes would consequently be distorted.[220] Therefore each subset was divided into 2 further subsets; a subset comprising those spectacles for which a private payment was made and one for which such payment was not made. There are therefore 8 subsets:

1. Single focus without frames: no private payment. (1 TOTNOP).

2. Single focus without frames with private payment. (1 TOTPRIV).

3. Single focus incl. frames: no private payment. (2 TOTNOP)

4. Single focus incl. frames with private payment.(2 TOTPRIV).

5. Multi focus without frames: noprivate payment. (3 TOTNOP).

6. Multi focus without frames with private payment. (3 TOTPRIV).

7. Multi focus including frames: noprivate payment. (4 TOTNOP).

8. Multi focus incl. frames with private payment. (4 TOTPRIV).

The names for each subset are given in brackets.

The individual varieties contained in each subset are defined by

1. The power of the lens.

2. The quality content of the pair of spectacles represented by the raw material cost.

The power of the lens was represented by assigning digits starting with 1 in ascending order to each power bracket. Thus, the power bracket +-2 is represented by the digit 1, +-4 by 2, +-2/2 by 3 etc.[221] The proxy for quality is the value of the additional characteristics contained in each individual variety. Consequently, it is not the actual raw material cost of each pair of spectacles that is relevant, but the raw material cost of the additioϕnal characteristics. This value was found by subtracting in each case the raw-material cost of the basic variety from the observed raw material cost. The proxies for quality, raw material cost of additional characteristics, were then sorted in ascending order of magnitude and represented by the digits 1, 2, 3, ...n for the n varieties of each subset. The name QADDCH was assigned to the ordering, which represents the "quantities" of each variety. For each subset 3 multiple regressions were performed, taking as dependent variables:

1. Price.

2. Marginal Cost.

3. Private payment.

and as "explanatory" variables the variables QADDCH and QPOWER of each subset. The regressions yielded the following result:

1 TOTNOP					
17 Cases	RETPR	24.77	-	1.47 (4.06)	.52
	MC	75.92	-	1.45 (2.84)	.35
1 TOTPRIV					
89 Cases	RETPR	12.49	1.85 (18.24)	.39 (3.87)	.80
	MC	79.21	1.20 (17.96)	.21 (3.08)	.80
	PRIVPAYM	-3.10	1.76 (17.94)	.11 (1.08)	.79
2 TOTNOP					
62 Cases	RETPR	61.86	-	1.68 (24.68)	.91
	MC	94.27	-	1.54 (2.01)	.18
2 TOTPRIV					
191 Cases	RETPR	45.28	2.17 (39.67)	.22 (4.08)	.89
	MC	89.60	1.44 (34.72)	.10 (2.36)	.87
	PRIVPAYM	-10.3	2.14 (43.51)	.06 (1.28)	.91
3 TOTNOP					
1 Case	no regression possible				
3 TOTPRIV					
23 Cases	RETPR	106.76	16.67 (12.07)	5.68 (4.31)	.88
	MC	110.11	12.44 (10.16)	4.53 (3.88)	.84
	PRIVPAYM	6.64	14.47 (20.80)	.95 (1.42)	.96
4 TOTNOP					
5 Cases	RETPR	179.24	-	6.45 (16.59)	.98
	MC	182.05	-	6.56 (3.93)	.84

4 TOTPRIV					
62 Cases	RETPR	201.90	9.12 (41.31)	1.70 (7.7)	.97
	MC	196.87	5.79 (22.58)	1.00 (3.93)	.89
	PRIVPAYM	26.27	9.1 (43.90)	.12 (.61)	.96

RETPRICE = price of each variety, MC = marginal cost, PRIVPAYM = "OUT OF POCKET" payment for each variety. T - values are given in brackets, names for the subsets have been explained on page 262.

The regressions "predict" the value of the retail price, marginal cost and private payment for each variety in each subset in the following way: multiply the value of QADDCH by the appropriate coefficient, multiply value of QPOWER by its coefficient, add the results to the constant. For instance, the retail price of the variety single focus spectacle without frame QADDCH 89, Power 1 is found by the following calculation:

$$
\begin{aligned}
89 \cdot 1.85 &= 164.65 \\
+ 1 \cdot 0.39 &= 0.39 \\
+ \text{constant} &= 12.49 \\
\hline
\text{Predicted value} &= 177.53
\end{aligned}
$$

It is possible to construct from the results of the regressions price, cost and private payment planes for each subset. For instance, in order to construct the planes for the subset 2 TOTPRIV the endpoints for each plane have first to be calculated. These calculations are done in Table 12.:

TABLE 12.

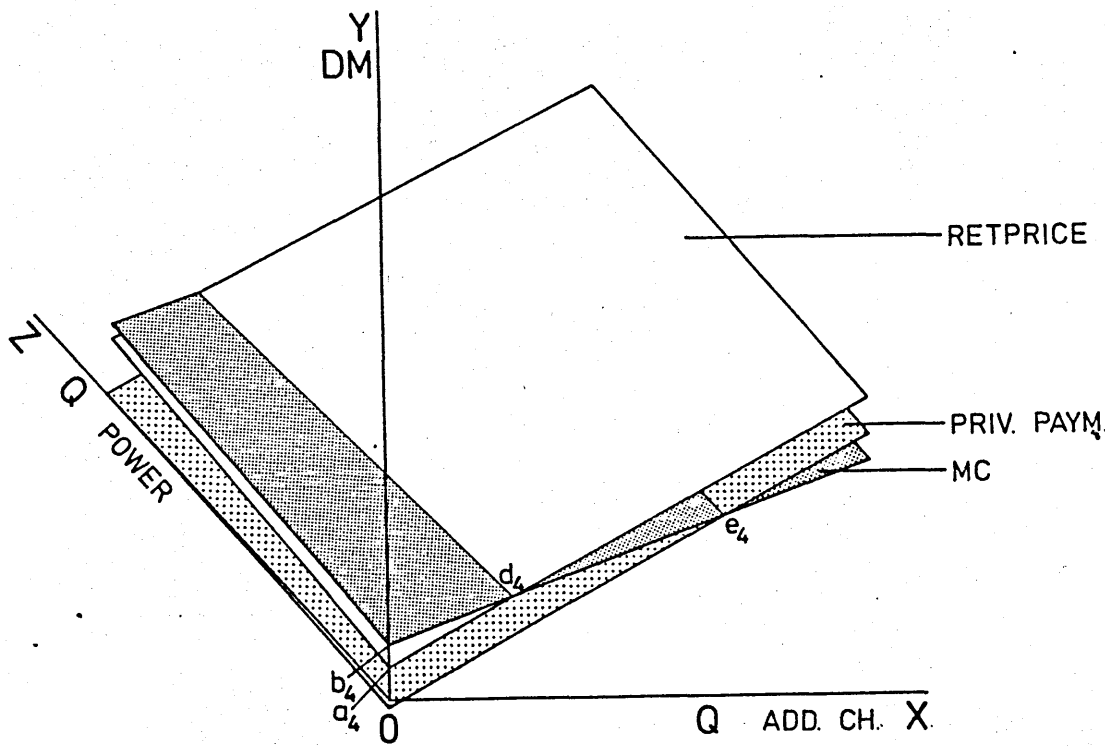
Calculation of Endpoints for Price, Cost and Private Payment Planes.

		PRICE PLANE	COST PLANE	PRIVATE PAYMENT PLANE
Observed Xi value:				
1 QADDCH	= 0			
2 QPOWER	= 0			
calculated Y value	=	45.29	89.60	-10.30
observed Xi value:				
1 QADDCH	= 0			
2 QPOWER	= 191			
calculated Y value	=	87.21	108.37	1.68
observed Xi value:				
1 QADDCH	= 191			
2 QPOWER	= 0			
calculated Y value	=	459.27	356.80	397.80
observed Xi value:				
1 QADDCH	= 191			
2 QPOWER	= 191			
calculated Y value	=	501.20	384.65	409.78

The calculated Y - values give the four endpoints of each plane and these planes are then represented in a 3-dimensional graph in Fig. 3.

Fig. 3

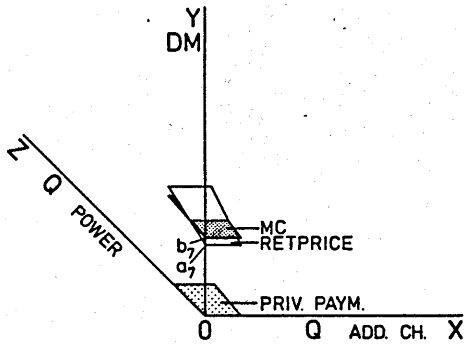
Empirically Estimated Price, Cost and Private Payment Planes: 1 Subset of Spectacles.



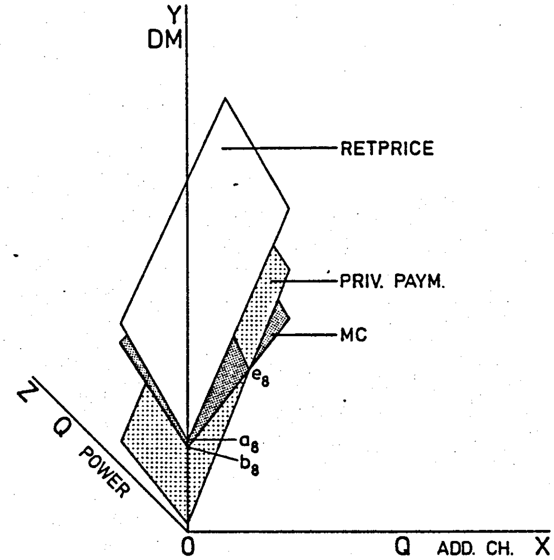
4. 2 TOTPRIV

In like manner, the planes for each of the 8 subsets were constructed. In the theoretical discussion of the planes in chapter 7 it was proposed to depict all price and cost planes in one graph. However, the result would be extremely confusing in the present case as most of the planes would not become visible. Therefore the graphs have been drawn for each subgroup separately, but have been assembled on one single page in Fig. 4. The numbers of each graph correspond to those of the 8 subsets described on page 262.

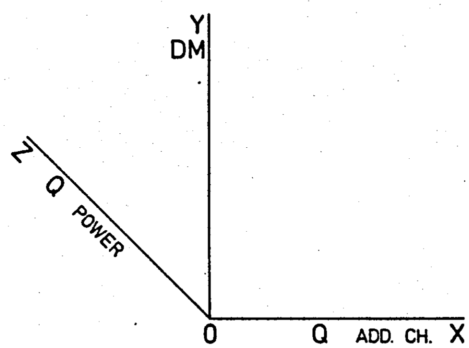
Payment Planes: 8 Subsets of Spectacles.



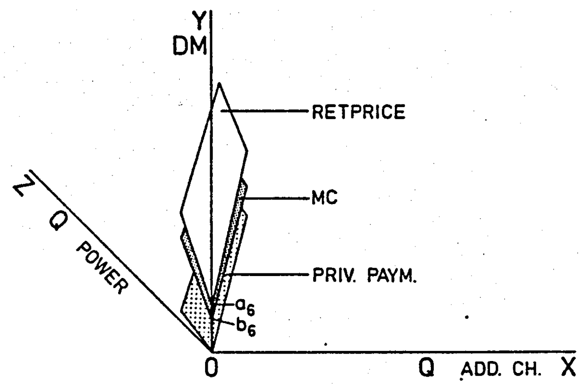
7. 4 TOTNOP



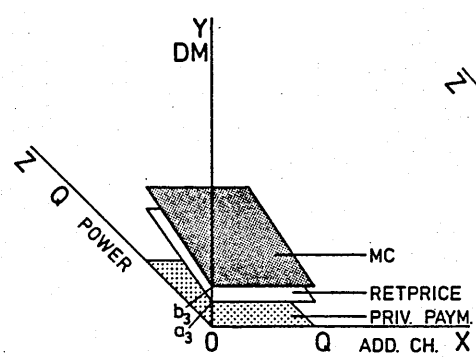
8. 4 TOTPRIV



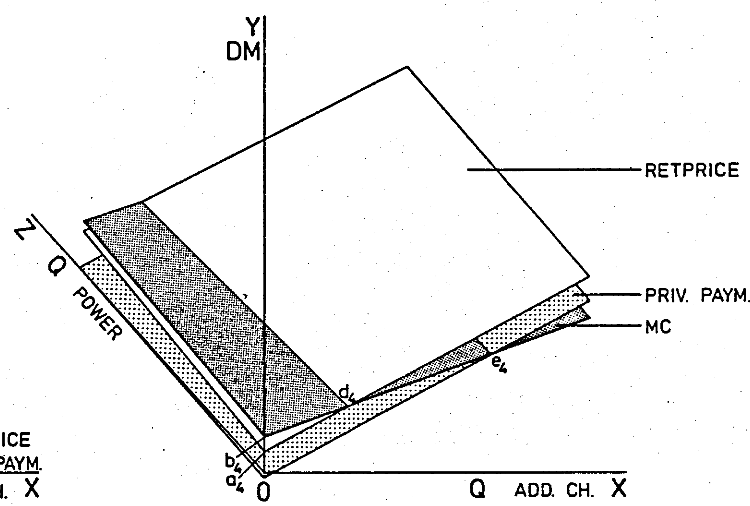
5. 3 TOTNOP



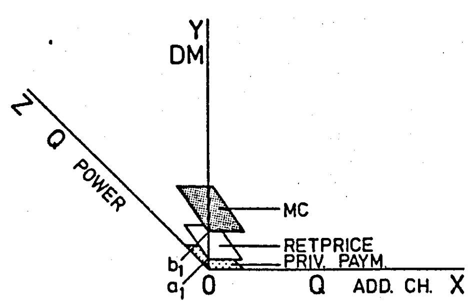
6. 3 TOTPRIV



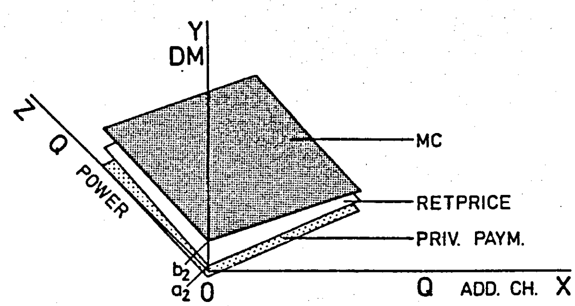
3. 2 TOTNOP



4. 2 TOTPRIV



1. 1 TOTNOP



2. 1 TOTPRIV

The question has now to be asked, whether the empirically derived planes correspond with the predictions about their relative positions which follow from the theoretical considerations derived in chapter 7; and whether the predictions of Posner's theory of taxation by regulation are verified, i.e., whether those varieties which are sold at regulated prices are subsidized by revenues from varieties sold at unregulated prices. In chapter 7 the follwing predictions about the relative positions of the price, cost and private payment planes were made:

1. Prices increase more rapidly than costs when additional characteristics are added. In the graph this would result in: slope retprice > slope MC.

2. Prices increase more rapidly than marginal cost with increasing lens power. Hence: slope QPOWER > slope MC.

As one moves from the lowest priced varieties to the highest priced varieties the excess of marginal cost over price decreases until MC equals RETPRICE. Thereafter, the difference to RETPRICE which is now greater than MC, increases. In Fig. 4 the difference between MC and RETPRICE decreases as one moves upwards from the lowest priced varieties, e.g. 1 TOTPRIV to 2TOTPRIV. At 3 TOTPRIV the difference tends to zero, i.e. there is no difference between MC and RETPRICE. From 3TOTPRIV to 4TOTPRIV, i.e. as one moves to the higher priced varieties the excess of RETPRICE over MC increases.

For those varieties which entail additional characteristics the private payment planes should be parallel to the price planes. This arises from the fact that the subsidy payment is a fixed sum. For those varieties which do not entail additional characteristics the private payment planes lie on the horizontal X - Z surface. From Fig. 4 it can be seen that the empirically estimated price, cost and private payment planes correspond extremely well with the theoretically derived curves in chapter 7. But the predictions of Posner's theory of taxation by regulation are exactly verified only for the subsets 1TOTNOP AND 2TOTNOP but not for 4TOTNOP; an exception which will be explained later. Consider figure 4: For 1TOTNOP point a_1 indicates the price of the lowest priced basic variety and point b_1 indicates marginal cost of that variety; a = DM 24.77 and b = DM 75.92. The difference between price and marginal cost is therefore DM 51.2. Hence, price covers no more than approximately 33% of cost. As one moves outward from a in the direction of the Z-axis prices increase continuously indicating that price increases with increasing lens power. As one moves outward in the direction of the X-axis one moves, for all practical purposes, parallel to the X-axis, an indication that additional characterstics are absent. The private payment plane lies on the surface formed by the X- and Z-axes; just as predicted.

Now consider 1 TOTPRIV: the difference between a_2 and b_2 is DM 79.21 - DM 12.49 = DM 66.72; price covers no more than approximately 16% of cost. As one moves in the direction of the Z-axis prices increase as expected and marginal cost increases also, but less steeply; i.e. the predicted outcome. The same holds true of the increase in price and MC as one moves outwards along the X-axis, i.e. with an increase in additional characteristics costs increase less rapidly than prices; again the predicted outcome. The private payment plane increases only very slightly with QPOWER, but increases in step with additional characteristics; again the outcome which is predicted. For 2 TOTNOP again the relative positions of the planes are as predicted; a_3 = 61.86 and b_3 = 94.27. The difference between cost and price is therefore DM 94.27 - DM 61.86 = DM 32.41. The price of the lowest priced variety therefore covers approximately 66% of cost, while for 1 TOTNOP it covers only 33%.

For 2 TOTPRIV, with increasing lens power and with the addition of characteristics, prices and marginal cost increase as expected and again the slope of MC is less steep than that of RETPRICE. It is interesting to note that, as one moves along the MC-plane in the direction of the X-axis, point d_2 is reached, where price equals marginal cost. Thereafter price exceeds marginal cost and beyond point e_2 even the private payments are greater than MC. The private payment plane slopes upwards parallel to the price plane for additional characteristics, just as predicted.

For multi focus, however, shown as 5, 6, 7 and 8, only for the subsets TOTPRIV are the relative positions of the planes as expected. Thus, MC rises less steeply than RETPRICE. For the lowest priced item, in 3 TOTPRIV, MC still exceeds MC, but only by DM 3.35, whereas for 4 TOTPRIV price exceeds cost by DM 5.03 indicating that the vertical product differentiation between the two sets results in an increased gap between prices and cost. Turning now to the subsets 3 TOTNOP and 4 TOTNOP it has to be admitted that here the predictions of the theory are not confirmed; for 3 TOTNOP a regression could not be performed, as, out of 24 varieties contained in the set only 1 variety had been sold without a private payment being made. For the important corrections in vision requiring lenses it is the case that additional characteristics are more frequently sold. As regards 4 TOTNOP, only 6 out of 67 multifocus spectacles including frames had been sold without a private payment. The regression shows that price is higher than marginal cost for approximately 70 percent of the cases contained in the subset.

Before this observation which seemingly contradicts Posner's theory of taxation by regulation is discussed, the results derived so far are assembled and shown in table 13:

TABLE 13.

	SLOPE MC < SLOPE	SLOPE MC < SLOPE	PRIVATE PAYMENT	PRIVATE PAYM.	DISTANCE A -B >	COS > P ICE
	RETPRICE	QPOWER	PLANE PARALLEL	PLANE PARALLEL	THAN IN PREVIOUS	

(heading continued on p. 271)

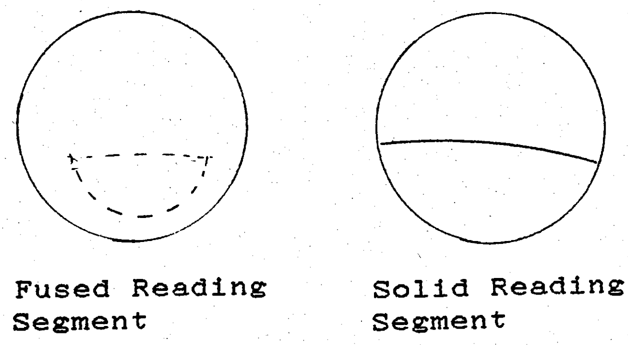
			X - AXIS	PRICE PLANE	SUBSET	
1 TOTNOP	YES	YES	YES	n.a.	YES	YES
1 TOTPRIV	YES	YES	n.a.	YES	YES	PAR
2 TOTNOP	YES	YES	YES	n.a.	YES	YES
2 TOTPRIV	YES	YES	n.a.	YES	YES	PAR
3 TOTNOP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a
3 TOTPRIV	YES	YES	n.a.	YES	YES	NO
4 TOTNOP	YES	YES	YES	YES	YES	PAR
4 TOTPRIV	YES	YES	n.a.	YES	YES	NO

From Table 13 it can be seen that the prices of spectacles behave exactly as predicted with only one exception. Approximately 70% of the prices paid by the sickness funds for multifocus spectacles i. e. 4TOTNOP are not set below cost as one would expect from Posner`s theory of taxation by regulation.

This exception can be explained. In the early days of the funds they provided payment for rather unsightly bifocal lenses for their members, the socalled "solid" bifocals at prices below cost. The opticians offered as an alternative "fused" bifocals which were aesthetically much more pleasing and charged prices which were set considerably above cost. Figure 5 shows the two kinds of bifocals.

Fig. 5

Bifocal Lenses.



In 1974, the "Ersatzkassen" (substitute funds) which compete with the "RVO - Kassen" (state insurance funds) for members, struck a deal with the "Zentralverband der Augenoptiker" (Association of Ophthalmic Opticians) in which they agreed that their members could receive the better quality fused bifocals and that the substitute funds would pay the higher prices. The motives behind the deal are very interesting:

In the early days of state insurance and up to the second world war the substitute funds provided superior services. This advantage was gradually eroded. The substitute funds saw in the provision of the better quality lenses an easy means of demonstrating to their members the superiority of their services. The state insurance funds at first refused to take up the challenge; but, approximately 2 years later they also provided fused bifocals and agreed to pay the higher prices. Although there are many interesting aspects to the outcome of this duopsony situtation between the two types of funds a discussion of them would lead too far afield. In the present context it is sufficient to note that the price of the better variety was set only 5% below the prices in the recommended retail price lists of the firms of Rodenstock and Zeiss and that when the state insurance- funds later joined the agreement they accepted prices as high as those paid by the substitute funds.

The inconsistency posed by the prices for multi focus is therefore explained in a satisfactory manner.

Chapter 9

CONCLUSIONS.

The empirical estimation of the price- cost and private payment planes yields results which give strong support to Posner's theory of taxation by regulation; basic varieties of spectacles sold at regulated prices, with the exception of multi focus spectacles, do not cover cost and are subsidized by those varieties which are sold at unregulated prices. The exception posed by the multi focus spectacles can be accounted satisfactorily for by a harmony of interests; in this particular instance, between the sickness funds, a duopsony of buyers, and the opticians, essentially organised as monopolistic sellers. The outcome was the concession of profitable prices for these particular varieties.

It is shown that in order to achieve the desired taxation by regulation an extremely complex pricing structure has been erected and maintained in the market for spectacles. This structure can only be fully understood by employing the model of price discrimination with horizontal and vertical product differentiation at a cost which is developed in this thesis. This new hybrid model was built upon two simpler models. The first of these was developed by the German economists H. and M. Jacob who showed that contrary to a widely held opinion, horizontal product differentiation at a cost in conjunction with second degree price discrimination is a rational strategy for sellers exerting some monopoly power. Jacob and Jacob described the set of profit-maximising prices, costs and output pertaining to that situation. A second model, based on work done by Eli Clemens shows that vertical product differentiation combined with third degree price discrimination also leads to a rationally determined set of prices, cost and output. Incorporation of the two types of price discrimination into a single model is achieved by a three-dimensional representation in Lancastrian characteristics space. Prices and costs are measured on the Y - axis, quantities of the differentiated commodities on the X - and Z - axes. In this way not only the existence of price discrimination in the market is demonstrated; the model also permits the precise identification of those varieties of a differentiated commodity which are sold below cost, those which cover cost and those which are sold above cost.

Further applications of the model suggest themselves. Pilati has shown that motorcars are differentiated vertically as well as horizontally. In Pilati's model however, only a rough measure of vertical differentiation is employed. He distinguishes between different models of cars, i. e. between a Renault 4 and a Renault 5. Phlips, however, argues that vertical product differentiation also occurs when a particular model is, for instance, transformed into a hatchback, offered in a "GTI" version, etc. All these vertically differentiated varieties are in turn offered with a multitude of "options", i.e metallic paint, power steering etc. By determining the price and cost planes in the way shown in this thesis a configuration of costs and prices similar to that demonstrated for the market of spectacles may well become apparent. It may well be that basic varieties are in fact sold at prices which do not afford a profit or may incur a small loss which is compensated for by increased profits from varieties with more additional characteristics. The dangers of such a strategy become at once apparent; a competitor may bundle a considerable amount of options with his product and place it below the prevailing price line. If he does not offer a basic variety at or below cost he may well be able to offer his product at a lower price and still make a profit. It would seem that such a strategy has often successfully been employed by Japanese car manufacturers.

Further applications of the model suggest themselves in the health care sector in Germany. It is very likely that the pricing structure for instance for dental care is similar to that for spectacles. Here basic varieties of dental prostheses made of stainless steel are provided at regulated prices and it may well be that they are cross - subisdized by varieties made from gold and sold at unregulated prices producing revenues in excess of cost.

The model also provides the possibility of demonstrating the effect of subsidy payments. In the market for spectacles in Germany the subsidy payment takes the form of a lump sum payment. It is shown how this results in a shift of the revenue curve to the right resulting in an increase in quantity demanded and sold.

Both the cross - subsidisation effect and the increasing divergence between cost and prices as more and more additional characteristics are introduced pose a welfare issue. It has not been the purpose of this thesis to discuss the complex welfare issues arising when both vertical and horizontal price discrimination at a cost are present. Its objective is rather to provide a means of describing more adequately than has hitherto been possible the complex situations which cause such issues to arise.

The need for precise description may be suggested by an example. It has been shown that the prices paid by the sickness funds for single focus spectacles fail to cover cost by a considerable margin whereas the prices paid by the funds for multifocus spectacles afford a profit. If it is felt that it is difficult to justify a situation where consumers with greater needs, i.e. those requiring multifocus spectacles are subsidizing those with less needs, then a change in this pattern of cross subsidisation would be a natural policy recommendation. The extent of the undesirable cross - subsidisation could be decreased if the prices paid for multifocal spectacles were lowered and the prices of single focus spectacles were increased. The respective increases and decreases could be calculated in such manner that the total sum paid by the sickness funds remained unchanged. In this way the price planes for single focus spectacles would be shifted upwards, those for multifocus spectacles downwards and the distortion in the pricing structure would be alleviated at no cost. Care must be taken, however. This measure will have an effect on the private payments. As the payments made by the sickness funds are increased for single focus spectacles the private payment planes for these varieties are lowered. By symmetrical reasoning the private payment planes for multifocal spectacles will be shifted upwards. The opticians could then increase the unregulated prices of the single focus varieties while leaving the prices for multifocus spectacles unchanged. Depending on the respective elasticities of demand, i.e. if demand elasticity for multi focus spectacles is less elastic than for single focus spectacles, then total revenue would be increased whereas total cost remains unchanged resulting in an increase in the optician's profits. Only if the opticians either refrained from increasing the prices of single focus spectacles or lowered the prices of multi focus spectacles appropriately could the changes in the regulated prices be advocated without reservations. The argument highlights the usefulness of the model developed in this thesis. Without it it would be extremely difficult to make valid judgements about the overall effects of policy changes.

In summary the research presented here finds several interesting features in the market for spectacles. Posner's theory of taxation by regulation which stipulates that often commodities sold at regulated prices are subsidized by commodities sold at unregulated prices is supported extremely well. This cross - subsidisation results in an extremely complex pricing structure. In order to describe this pricing structure a model of price discrimination has been developed in this thesis which exhibits several novel features.

1. Cross - subsidisation is achieved by price discrimination.

2. Price discrimination is implemented with the help of product differentiation other than spatial differentiation.

3. The terms vertical and horizontal product differentiation are introduced and shown to have considerable explanatory power.

4. A 3 - dimensional representation of price- and cost- planes in Lancastrian characteristics space makes it possible to demonstrate visually the details of price discrimination within a market.

A type of cost study has been employed which introduces methods of work - measurement in order to arrive at a measure of costs of differentiated products which is compatible with the economist's notion of marginal cost.

Finally, applications of the model have been suggested for other fields where, it is hoped, the model can usefully be deployed.

Notes

[1]Handwerksordnung vom 17. Sept. 1953, Fassung vom 28. Dez. 1965, BgBl.1966 I S.2

[2]ibid.

[3]From personal experience. It is common knowledge in the profession that the local guilds do no longer hold master craftsman examinations. Such examinations are only held in the cities in which the four colleges reside for college graduates. An inquiry asking for the next date for an examination was answered negatively by the Handwerkskammer at Kassel.

[4]See for instance: 1) Gebuehrenordnung fuer Aerzte (GOA), fuer Rechtsanwaelte (GOR) fuer Architekten (GOAe) which translates into scale of fees for doctors, lawyers, architects.

[5]See, for instance, lists by the leading manufacturers Zeiss of Aalen and Rodenstock of Munich, but also of the Japanese manufacturers Hoya, Hamburg.

[6]This is common knowledge in the profession. But, additionally, an enquiry was undertaken by systematic questioning of travelling salesmen of the lens suppliers who visit the writer's practice. They did not report a single case in which RRP lists were not strictly adhered to.

[7]Samples of calculators were collected from various parts of Germany.

[8]From personal recollection of the author's father who was guildmaster at Kassel from 1935-1943.

[9]See: Loeffelholz, J. Repetitorium der Betriebswirtschaftslehre (Wiesbaden, Carl Gabler, 1965).

[10]Rasch H., Wettbewerbsbeschraenkungen: Kartell- und Monopolrecht (3. Aufl., 1966)

[11]From statistics provided by the marketing department of the firm of Rodenstock, Munich.

[12]Treuarbeit A.G., Frankfurt am Main, Betriebsvergleich im Augenoptikerhandwerk (Mimeographed, 1977)

[13]Statistisches Bundesamt (ed.)Statistisches Jahrbuch 1985 fuer die Bundesrepublik Deutschland (W. Kohlhammer, Wiesbaden, 1985)

[14]there are 644 communities of 10000 - 20000 inhabitants in West Germany. (From: Statistisches Jahrbuch 1985, op. cit.)

[15]Dohm, H.J. Der selbstaendige Augenoptiker. (Optische Fachveroeffentlichungen, Heidelberg, 1979 (The self-employed ophthalmic optician)

[16]see, for instance, Kessel, R.A. Price Discrimination in Medicine (Journal of Law and Economics, 1. 1958)

[17]See: Dohm, H.J., op.cit.

[18]There are colleges at Berlin, Cologne, Munich and Aalen, Wuerttemberg.

[19]ZVA report, Duesseldorf, 1983. (Official brieflet, sent at irregular intervals to the members of the Association of Opticians.)

[20]Statistisches Jahrbuch 1985, op. cit. p.78

[21]ZVA report, 1984.

[22]Henning, J., Preisbildung, Produktivitaet und Wettbewerb auf dem Markt fuer Sehhilfen (WIDO, 1981)

[23]Translation by the author

[24]Leichter, H.M. A Comparative Approach to Policy Analysis of Health Care Policy in Four Nations (Cambridge, Cambridge University Press, 1979)

[25]On May 31, 1883 the Reichstag approveed the Bill with a majority of 216 to 99, from: Leichter, op.cit.

[26] ibid..

[27]Leichter, op.cit.

[28]Whereas originally the funds insured mainly "blue collar" workers along occupational and regional

lines, later "white collar" workers founded their own funds which were given the name of Ersatzkassen (substitute funds). These different types of sickness funds have organized themselves in two associations: the "Verband der Ortskrankenkassen" (association of compulsory health insurance funds) and "Verband der Angestelltenkrankenkassen" (association of substitute funds).

[29]see: supply agreement between federal association of opticians and association of substitute funds, paragraph 2. Compulsory funds form agreements on Laender-basis; as an example see: Supply agreement of Optical Association of Westfalen-Lippe and association of compulsory funds Nordrhein-Westfalen.

[30]Chadwick, E. Results of Different Principles of Legislation and Administration in Europe: of Competition for the Field as Compared to Competition within the Field of Service (Journal of the Royal Statistical Society, 1859) Hadley, A.T. Railroad Transportation. (New York and London, Putnam's Sons. 1886) Bentley, A.F. The process of Government (Chicago, University of Chicago Press. 1908.)

[31]Herring, E.P. Public Administration and the Public Interest. (New York, McGraw-Hill. 1938.) Hotelling, H. The General Welfare in Relation to Problems of Taxation and Railway and Utility Rates. Econometrica, 6. 1938.)

[32]Bernstein, M. Regulating Business by Independent Commission. (Chicago, Chicago University Press. 1955) Holen, A.S. Effects of Interstate Licensing Arrangements on Interstate Mobility and Resource Allocation (Journal of Political Economy, 1951) March, J. and S.H. Organisations (New York, Wiley. 1959) Bonbright, J.C. Principles of Public Utility Rates. (New York, Columbia University Press. 1961) Caves, R. Air Transport and its Regulators: An Industry Study. (Cambridge, Mass., Harvard University Press. 1962) Kahn, A.E. The Economics of Regulation. (New York, Wiley. 1970) Bailey, E. Economic Theory of Regulatory Constraint. (Lexington, Mass. Lexington Books) Peltzman, S. Towards a More General Theory of Regulation.

[33]Posner, R.A. Theories of Economic Regulation (The Bell Journal of Economics and Management Science, Spring 1971)

[34] Paul 1. Joskow and Roger C. Noll, Regulation in theory and practice: An overview (In Fromm, G., editor, Studies in Public Regulation (Cambridge, Mass., MIT Press, 1981)

[35]Stigler, G.J. The Theory of Economic Regulation. (The Bell Journal of Economics and Political Science, Spring 1971)

[36]Stigler, G. op. cit.

[37]Jordon, W.A. Airline Regulation in America: Effects and Imperfections. (Baltimore, John Hopkin's Press. 1970)

[38]Kolko, G. Railroads and Regulation., 1877-1916.

[39]Peltzman, S. An Evaluation of Consumer Protection Legislation: The 1962 Drug Amendments (Journal of Political Economy, 1966)

[40] Posner, R., Theories of Regulation op. cit.

[41]Posner, R., ibid.

[42]Stigler, G. op. cit.

[43]For a general discussion see: Cullins, J.G., and West, P.A. The Economics of Health (Oxford, Martin Robertson. 1979) Arrow, K.J. Uncertainty and the Welfare Economics of Health (American Economic Review, 53. 1963.) Less,D.S. Economics and Non-economics of Health Services. (Three Banks Review, 110. 1976)

[44]Titmuss, R.M. Commitment to Welfare (London, George Allen and Unwin. 1968)

[45]Fringe treatments of lenses is an expression used in the optical profession to describe the innumerable ways in which a lens can be enhanced, for instance by tinting it, covering it with an anti-reflex coating, using plastic instead of mineral glass, etc. These possibilities will be described in detail in chapter 5.

[46]Machlup, F. Characteristics and Types of Price discrimination. in the N.B.E.R. conference report, Business Concentration and Price Policy (Princeton, Princeton University Press, 1955)

[47]Kessel, R.A. op. cit.

[48]See: p. 9.

[49]See: Chaper 1, Table 1.

[50]Posner, R.A., Taxation by Regulation (Bell Journal of Economics and Management Science, Spring 1971)

[51]op. cit.

[52]ibid.

[53]Steiner, O., Peak Loads and Efficient Pricing (Quarterly Journal of Economics 71, 1957)

[54]Standard Oil company of New Jersey v. U.S., 221 U.S. 1, 47, 76, (1911)

[55]For instance: McGee, J. The Standard Oil ,New Jersey, Case (Journal of Law and Economics, 1958)

[56]Scherer, F.M. Industrial Market Structure and Economic Performance, (Chicago, Rand McNally, sec. ed. 1979)

[57]Scherer, F.M., op.cit.

[58]Kahn, A.E., op.cit

[59]Pigou, A.C. The Economics of Welfare (London, MacMillan, 1920)

[60]See: Kahn, A.E. op.cit.

[61]Douglas, G.W. and Miller, J.C, Economic Regulation of Domestic Air Transport (Washington, D.C. Brookings Institution, 1974.)

[62]See: Bailey, E., D.R Graham and Kaplan, D.P. Deregulating the Airlines (Cambridge, Mass., MIT Press, 1985), see also: Meyer, J.R. and C.V. Oster Deregulation and the New Airline Entrepreneurs (Cambridge, Mass., MIT Press, 1984)

[63]Posner, R.A. The Economics of Regulation, op.cit.

[64]op.cit.

[65]Robinson, J. The Economics of Imperfect Competition (London, Macmillan. 1934.)

[66]Samuelson, P.A. Foundations of Economic Analysis (Cambridge, Mass. Harvard University Press. 1983)

[67]Machlup, F. Characteristics and Types of Price Discrimination in: the National Bureau of Economic Research Conference Report: Business Concentration and Price Policy (Princeton University Press, 1955)

[68]Phlips, L. ,op.cit.

[69]Telser, L.G. Abusive Trade Practices: An

Economic Analysis. (Law and Contemporary Problems, 3o. 1965)

[70]op. cit.

[71]Phlips, L. op. cit.

[72]op. cit.

[73]Pigou stresses the importance of public opinion as a curb to price discrimination. This emphasis is quite understandable if one considers the sometimes bitter debate about railway rates of his times.

[74]Joan Robinson, op. cit.

[75]ibid.

[76]Schmalensee, R. Output and Welfare Implications of Third-Degree Price Discrimination (American Economic Review, 71, 1981)

[77]Pigou, A.C., op. cit.

[78]op. cit.

[79]ibid.

[80]ibid.

[81]Phlips, L. op. cit.

[82]Joan Robinson. p. 179.

[83]ibid.

[84]op. cit.

[85]Ekelund, R.B. and Hulett, J.R. Joint supply, the Taussig-Pigou Controversy and the Competitive Provision of Public Goods. (Journal of Law and Economics 16, 1973)

[86]Demsetz, H. Joint Supply and Price Discrimination. (Journal of Law and Economics 16, 1973.)

[87]op. cit.

[88]op. cit.

[89]op. cit.

[90]op. cit., p.16

[91]op. cit.,ch.14)

[92]Dean, J. Managerial Economics (Englewood Cliffs, Prentice Hall, 1951)

[93]Lange, M. Preisbildung bei neuen Produkten (Berlin, 1972) and Sabel, H. Zur Preisbildung bei neuen Produkten (Wiesbaden 1973.) as well as Scheuing, E.E. Das Marketing neuer Produkte (Wiesbaden, 1972)

[94]Bass, F.M. A New Product Growth Model for consumer Durables. (Management Science, 15, 1969)

[95]Stackelberg, H.v. Preisdiskriminierung bei willkuerlicher Teilung des Marktes. (Archiv fuer Wirtschafts- und Sozialforschung, Vol.5, 1939)

[96]Jacob, H. and M. Jacob Preisdifferenzierung bei willkuerlicher Teilung des Marktes und ihre Verwirklichung mit Hilfe der Produktdifferenzierung (Jahrbuch fuer Nationaloekonomik und Statistik, Vol.174, 1962), (Price discrimination of the second degree and its implementation with the help of product differentiation) also, Jacob, H. Preispolitik (Wiesbaden, 1971)

[97]It is possible to prove that constancy of marginal costs is not a necessary conditions. This proof is not necessary to the argument, though. See: Jacob, op.cit.

[98]selling a quantity which is also 33% higher.

[99]It is here assumed that marginal costs are constant. If this assumption is dropped, the cost term in the equation becomes: $-V[g(P_2) + v_1(P_1, P_2, s_1, s_2, P`2) + v_2(P_1, P_2, s_1, s_2, P'_2)] - F$, (29) where, F=fixed cost, V=variable cost.

[100]Pappas, J.L., E.F. Brigham and Shipley, B. Managerial Economics (New York, Holt Rinehart and Winston, 1983). A more systematic approach has been tried by Oxenfeldt, A.R.: A decision - making Structure for Pricing Decisions (Journal of Marketing, Jan. 1973)

[101]Urban, G.L. A Mathematical Modelling Approach to Product line Decisions. (Journal of Marketing Research - Febr. 69)

[102]Schumpeter, Capitalism, Socialism and Democracy 5th edition, (London, Allen and Unwin. 1977)

[103]Lipsey, R.G. An Introduction to Positive Economics. (6th edition, London, Weidenfels and Nicholson, 1983)

[104]Hay. D.A. and Morris, D.J.Industrial Economics : Theory and Evidence (Oxford, Oxford University Press, 1979)

[105]Chamberlin, E.H. The Theory of Monopolistic Competition (Cambridge, Mass., Harvard University Press, 1933)

[106]Lancaster, K. A New Approach to Consumer Theory. (Journal of Political Economy, 74, 1966) and Variety, Equity and Efficiency (New York, Columbia University Press, 1979)

[107]Griliches, Z. Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change. In: (The Price Statistics of the Federal Government, 1961) Also, Griliches, Z. (Editor,) Price Indexes and Quality Change (Cambridge, Harvard University Press, 1971)

[108]Spence, Product Selection, Fixed Costs, and Monopolistic Competition (Review of Economic Studies43, 1976) and Monopoly, Quality and Regulation (Bell Journal of Economics and Management Science 6, 1975)

[109]Schmalensee, R. Entry Deterrence in the Ready-To-Eat Breakfast Cereal Industry (Bell Journal of Economics 9, 1978.)

[110]Pilati. P. Prolifération des marques: Barriére a l'entrée (Ph.D. Thesis, Louvain-la -neuve, Université Catholique de Lôuvain, 1979)

[111]op.cit.

[112]King, The Demand for Housing: Integrating the Roles of Journey-to-work, Neighborhood-Qualities and Prices in: N.Tercckyi, editor, Household Production and Consumption, New York, N.B.E.R., 1975

[113]op. cit., p. 205

[114]op. cit. p. 206

[115]Each lens power is available not only in the simple quality the price of which is shown here, but also in "enhanced" versions as described previously. Their prices would then appear as columns to the right of the price column of the basic version. In this manner recommended retail price lists supplied by manufacturers are constructed.

[116]Griliches, Z. Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change

(Cambridge: Harvard University Press. 1961)

[117]Cowling, Keith and Cubbin, John. Price, Quality and Advertising Competition: An Econometric Investigation of the United Kingdom Car Market. (Economica 30, 1971) ______ "Hedonic Price Indexes for United Kingdom Cars." (Economic Journal, 82. 1971)

[118]Ohta, M. : Hedonic Price Index for Boiler and Turbo Generator: A Cost Function Approach (Technical Report No. 40, Project for the Evaluation and Optimization of Economic Growth, University of California (Berkeley). 1971)

[119]Ohta, M. and Griliches, Z.: Automobile Prices Revisited: Extensions of the Hedonic Hypothesis. In Terleckyj, editor, "Household Production and Consumption". Vol.4o, Studies in Income and Wealth, (NBER Columbia University Press. N.Y. 1971)

[120]King, A.J. The Demand for Housing in Terleckyj N. editor, op.cit.

[121]Straszheim, M., An Econometric Analysis of the Urban housing Market (National Bureau of Economic Research, New York, 1975)

[122]McLennan, D. Housing Economics (Longman, New York. 1982)

[123] Rosen, S. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition (Journal of Political Economy. 1974)

[124]Triplett, J.E. Consumer Demand and Characteristics of Consumption. in N. Terleckyi, editor, op.cit.

[125] Bryan, I. A. The Effect of Ocean Transport Costs of the Demand for some Canadian Exports (Weltwirtschaftliches Archiv, 110. 1974)

[126]Shneorson, D. The Rationality of Conference Pricing and Output Policy (Maritime Studies and Management 3. 1976)

[127]Heaver, T.D. Trans-Pacific Trade, Liner Shipping and Conference Rates (Transportation and Logistics Review, 8, 1972). ________ The Structure of Liner Conference Rates (Journal of Industrial Economics, 20, 1973)

[128]Spady, R.H., and Friedlaender, A.F. Hedonic Cost Functions for the Regulated Trucking Industry (Bell Journal of Economics, 9, 1978)

[129]Ferguson, D.C.: Joint Products and Road Transport Rates in Transport Models (Journal of Transport Economics and Policy, 8, 1974). and, Friedlaender, A.F., Ferguson, W.L. and Sloss J. The Rate Structure of Unit Coal Trains in the 1970's (Journal of Industrial Economics, 28, 1980)

[130]Deakin, B.M. Shipping Conferences: A study of Their Origins, Development and Economic Practices (Cambridge, Cambridge University Press, 1973)

[131]Marshall, A.: Principles of Economics (London, McMillan, 1920)

[132]Deakin, B.M. op. cit.

[133]Zerby, J.A. and Conlon, R.M.: Joint Costs and Intra-Tariff Cross-Subsidies: The Case of Liner Shipping (Journal of Industrial Economics, 31. 1983).

[134]Zerby, J.A. and Conlon, R.M. Capacity Utilisation in Liner Shipping (Journal of Transport Economics and Policy, 12. 1980)

[135]ibid.

[136]to clarify the matter the actual rawmaterial cost is shown in brackets in a line of its own.

[137]op. cit.

[138]op. cit.

[139]op. cit.

[140]It is a 45-degree line as it can be imagined as the "regression line" of actual price against actual price.

[141]Hay, D.A., and D.J. Morris, Industrial Economics, Theory and Evidence, (Oxford, Oxford University Press, 1979.)

[142]op. cit.

[143]op. cit., p. 385, Zerby and Conlon here refer to the method of common cost allocation.

[144]op. cit., pp.6.

[145]Taussig, F.W., A Contribution to the theory of Railway Rates, (Quarterly Journal of Economics, 1891)

[146]op. cit. see also, Ekelund and Hulett, op. cit.

[147]Haberstock, op. cit.

[148]See: Division 5.1.4.

[149]Phlips, L., op. cit. see also, Jacob, M. and H. Jacob, op. cit.

[150]p.(9)

[151]op. cit., p.385

[152]op. cit.

[153]Palda, K.S., The Marketing Mix and Brand Quality in:Modelling for Government and Business (Editor van Bochove et al., Leiden, H.E.S. Kroese B.V., 1977)

[154]op.cit. p. 386

[155]Spady, R.H. and Friedlaender, A.F. , op.cit., also, McAvoy, P.W., Regulation of Entry and Pricing in Public Transportation (A.E.I. Studies in Government Regulation, 1977)

[156]op. cit.

[157]Barzel, Y. and Ohta and Griliches, op. cit.

[158] See: Horngren, C.T.,Cost Accounting: A Managerial Emphasis (Englewood Cliffs, Prentice Hall, 1962.)

[159]See figure 2, p 94

[160]op. cit.

[161]op. cit.

[162]op.cit.

[163]op.cit.

[164]Shown as shaded areas

[165]This is the form in which all computer programs order magnitudes. It would be very inconvenient to draw diagrams in the reverse order from that exhibited by computer output which will be used extensively in the empirical part of this study. When appropriate, therefore, demand functions will be plotted starting with the lowest value at the Y-axis.

[166]Johnston, J. "Statistical Cost Analysis" (New York, McGraw-hill, 1960)

[167]Smith, C.A., Survey on the Empirical Evidence on Economies of ScaleinBusiness Concentration and Price Policy (Princeton, Princeton University Press, 1955)

[168]Walters, A.A.,Production and Cost Functions: An Econometric Survey (Econometrica 31, 1963)

[169]Wiles, P.G.D.,op. cit.

[170]Bain, J.S. Barriers to New Competition (Harvard University Press, Cambridge Mass.,1956) p. 63

[171]See: Dorfman, R. "Mathematical or Linear Programming (American Economic Review, 1953) also, Dreze, J:H:Demand Fluctuations, Capacity Utilisation and Costs in: Essays on Economic Decisions under Uncertainty, (Cambridge, Cambridge University Press, forthcoming)

[172]See. Kahn, A.E., op. cit. p. 71-72.

[173]op.cit.

[174]Koutsoyannis, A. Modern Microeconomics, 2nd edition.(London, MacMillan, 1979)

[175]See: Horngren, C.T., op. cit.

[176]Marshall, A.E. op. cit.

[177]Horngren, C.T., op. cit.

[178]Haberstock, L., op. cit and Riebel.[222] Einzelkosten-und Deckungsbeitragsrechnung (Wiesbaden. 1972)

[179]Wiles, P.G.D., op. cit. also, Riebel, P. , op. cit.

[180]Dickey, R.A., (ed.) Accountant's Cost Handbook (New York, The Ronald Press Co., 1960)

[181]op. cit.

[182]Vatter A.L., Limitations of Overhead Allocation (The Accounting Review, 1945)

[183]Thomas, A.L. The Allocation Problem in Finacial Accounting Theory (Studies in Accounting Research 3, American Accounting Association. 1969)

[184]Wells, M.C. Is the Allocation of Overheads Necessary? (The Australian Accountant. 1970)

[185]Briggs, D. Is Cost Allocation Necessary?

(Mimeographed, Glasgow, Scottish Business School, 1983)

[186]Dean, J., op. cit.

[187]Laub, K. Betriebsvergleich im Augenoptikerhandwerk (Institut fuer Handwerkswissenschaft, Muenchen. 1971)

[188]Treuarbeit A.G., op. cit.

[189]See: Nerlove, M. Estimation and Identification of Cobb-Douglas Production Functions (Chicago, Rand McNally, 1965) and, Konijn, H.S. Estimation of an Average Production Function from Surveys. (Ecconomic Record, 1959)

[190] op. cit.

[191]Horngren, C.A.,op. cit. see also; Joel Dean, op.cit.

[192]For instance, Currie, R.M., Work study (Sir Isaac Pitman and Sons, 1972) and: Piercy B. and Jandrell R., Coordinated Work Measurement (Edward Arnold, 1975)

[193]Diplom-Kaufmann Reinhard Pogrzybilla, Goethestrasse 51, Kassel, West-Germany.

[194]For instance, in the course of a conversation the cost accountant showed a volume of approximately 400 pages concerning the Volkswagen costing system which had been prepared for the Volkswagen factory by Professor Mellerowicz, perhaps the leading German theorist on cost accounting at present.

[195]Das REFA-Buch.

[196]As cited by the cost accountant, Mr. Progzibylla.

[197]Average calculated from the data collected in the cost study.

[198]The estimate was provided by the Ophthalmic Instruments Division, Carl Zeiss, Oberkochen, West Germany, Ref. ME-AT/HSP/WEIN

[199]Calculator is a term used in the optical profession to describe a recommended retail price list provided by the guild. The calculator was explained in section 1.2.

[200]An estimate of the cost of a workshop was supplied by the firm of Wernicke and Co., Duesseldorf,

West Germany, Jaegerstr. 58.

[201]This is the average life span of all the workshops in the 5 optical practices of the author.

[202]Average of the author's 5 optical practices.

[203]Average calculated from the data in the cost study.

[204]Average from the practice under observation.

[205]paragraph 8.1.1.

[206]Balance sheet of the branch of firm of Diplomoptiker Hess, Hann.-Muenden, Lange Strasse 6, West Germany; from the ZVA-data set a balance sheet could not be constructed.

[207]The owner did not put in any appreciable amount of work from 1975 onwards.

[208]Loeffelholz, op. cit.

[209]ibid.

[210]Historic value and book value are DM 71780 and DM 56833 respectively, while replacement cost is a staggering DM 280000 estimated conservatively at 12 times rental value. (Normally business property is offered for sale at 15- 18-times yearly rent, see: Property pages in Frankfurter Allgemeine Zeitung, Friday, March 1985). Depreciation rate for tax purposes is DM 1660 per year, whereas one can in no way speak of an economic depreciation when the property has in fact appreciated over the last 24 years by approximately DM 210000.

[211]see: Kahn, A.E., op. cit

[212]See: Simon, H. Theories of Decision Making in Economics and Behavioural Science (American Economic Review, 1959), Machlup, F. Marginal Analysis and Empirical Research (American Economic Review, 1946), Marris, R., A Model of the "Managerial" Enterprise (Quarterly Journal of Economics, 1963), Williamson, O.E., The Economics of Discretionary Behaviour (Englewood Cliffs, N.J., Prentice Hall, 1964), Cyert, R.M. and J.R. Cliffs, A Behavioural Theory of the Firm (Englewood Cliffs, N.J., Prentice Hall, 1963.)

[213]For an overview of the immense literature see: Weiss, L. The Concentration-Profits relationship and Antitrust in: (Goldschmid, J. et al., eds., Industrial Concentration: The New Learning. (Boston, Little, Brown, 1974), the original study on

the subject was by Bain J.S, Relation of Profit Rate to Industry Concentration: American Manufacturing 1936 - 1940 (Quarterly Journal of Economics, 1951)

[214] Philipps, A., A Critique of Empirical Studies of Relations Between Market Structure and Profitability (Journal of Industrial Economics, 1976)

[215] Dalton J.A. and Penn, D.W., The Quality of Data as a Factor in Analyses of Structure-Performance Relationships. (Federal Trade Commission Staff Report) (Washington, D.C., Government Printing Office, 1971)

[216] Harberger, A.C., Monopoly and Resource Allocation (American Economic Review, 1954)

[217] Horngren, C. T., op. cit.

[218] Dean, op. cit. and Pappas et al., op. cit.

[219] op. cit.

[220] The problem was discussed in section 7.4.

[221] see paragraph 5.1.3.

[222] Riebel, P., Einzelkosten- und Deckungsbeitragsrechnung (Wiesbaden, Th. Gabler, 1972,)

[223] Thomas, A.L. The Allocation Problem in Financial Accounting Theory Studies in Accounting Research 3, American Accounting Association. 1969)

BIBLIOGRAPHY

Arrow, K.J., Uncertainty and the Welfare Economics of Health (American Economic Review, 53, 1963)

Bailey, E., Graham, D.R. and Kaplan, D.P., Deregulating the Airlines. (Cambridge, Mass., MIT Press, 1985)

Bain, J.S., Barriers to New Competition. (Harvard University Press, Cambridge, Mass., 1956)

Bain, J.S., Relation of Profit Rate to Industry Concentration: American Manufacturing 1936 - 1940. (Quarterly Journal of Economics, 1951)

Bass, F.M., A New Product Growth Model for Consumer Durables. (Management Science, 15, 1969)

Bentley, A.F., The Process of Goverment. (Chicago, University of Chicago Press, 1980)

Bernstein, M., Regulating Business by Independent Commission. (Chicago, Chicago University Press, 1955)

Bonbright, J.C., Principles of Public Utility Rates. (New York, Columbia University Press, 1961)

Briggs, D., Is Cost Allocation Necessary? (Mimeographed, Glasgow, Scottish Business School, 1983)

Bryan, I.A., The Effect of Ocean Transport Costs of the Demand for some Canadian Exports. (Weltwirtschaftliches Archiv, 110, 1974)

Caves, R., Air Transport and its Regulators: An Industry Study. (Cambridge, Mass., Harvard University Press, 1962)

Chadwick, E., Results of Different Principles of Legislation and Administration in Europe; of Competition for the Field as Compared to Competition within the Field of Service. (Journal o the Royal Statistical Socienty, 1859)

Chamberlin, E.H., The Theory of Monopolistic Competition. (Cambridge, Mass., Harvard University Press, 1933)

Cowling, Keith and Cubbin, John, Price, Qualtiy and Advertising Competition: An Econometric Investigation of the United Kingdom Car Market. (Economica 30, 1971)
Hedonic Price Indexes for United Kingdom Cars. (Economic Journal, 82, 1971)

Cullins, J.G. and West, P.A., The Economics of Health. (Oxford, Martin Robertson, 1979)

Currie, R.M., Work study. (Sir Isaac Pitman and Sons, 1972)

Cyert, R.M. and March, J.G., A Behavioural Theory of the Firm. (Englewood Cliffs, N.J., Prentice Hall, 1963)

Dalton, J.A. and Penn, D.W., The Quality of Data as a Factor in Analyses of Structure-Performance Relationships. (Federal Trade Commission Staff Report, Washington, D.C., Goverment Printing Office, 1971)

Deakin, B.M., Shipping Conferences: A Study of Their Origins, Development and Economic Practices. (Cambridge, Cambridge University Press, 1973)

Dean, J., Managerial Economics. (Englewood Cliffs, Prentice Hall, 1951)

Demsetz, H., Joint Supply and Price Discrimination. (Journal of Law and Economics, 16, 1973)

Dickey, R.A., Accountant's Cost Handbook. (New York, The Ronald Press Co., 1960)

Dohm, H.J., Der selbstaendige Augenoptiker. (Optische Fachveroeffentlichungen, Heidelberg 1979)

Dorfman, R., Mathematical or Linear Programming. (American Economic Review, 1953)

Dreze, J.H., Demand Fluctuations, Capacity Utilisation and Costs, in: Essays on Economic Decisions under Uncertainty. (Cambridge, Cambridge University Press, forthcoming)

Douglas, G.W. and Miller, J.C., Economic Regulation of Domestic Air Transport. (Washington, D.C. Brookings Institution 1974)

Ekelund, R.B. and Hulett, J.R., Joint supply, the Taussig-Pigou Controversy and the Competitive Provision of Public Goods. (Journal of Law and Economics, 16, 1973)

Ferguson, D.C., Joint Products and Road Transport Rates in Transport Models. (Journal of Transport Economics and Policy, 1974)

Friedlaender, A.F., Ferguson, W.L. and Sloss, J., The Rate Structure of Unit Coal Trains in the 1970's. (Journal of Industrial Economics, 28, 1980)

Griliches, Z., Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change. in: (The Price Statistics of the Federal Goverment, 1961)

Griliches, Z., Price Indexes and Quality Change. (Cambridge, Harvard University Press, 1971)

Goldschmid, J., Industrial Concentration: The New Learning. (Boston, Little Brown, 1974)

Hadley, A.T., Railroad Transportation. (New York and London, Putnam's Sons, 1886)

Harberger, A.C., Monopoly and Resource Allocation. (American Economic Review, 1954)

Hay, D.A. and Morris, D.J., Industrial Economics, Theory and Evidence. (Oxford, Oxford University Press, 1979)

Heaver, T.D., Trans-Pacific Trade, Liner Shipping and Conference Rates. (Transportation and Logistics Review, 8, 1972)
______________ The Structure of Liner Conference Rates. (Journal of Industrial Economics, 20, 1973)

Henning, J., Preisbildung, Produktivitaet und Wettbewerb auf dem Markt fuer Sehhilfen. (WIDO, 1981)

Herring, E.P., Public Administration and the Public Interest. (New York, McGraw-Hill., 1938)

Holen, A.S., Effects of Interstate Licensing Arrangements on Interstate Mobility and Resource Allocation. (Journal of Political Economy, 1951)

Horngren, C.T., Cost Accounting: A Managerial Emphasis. (Englewood Cliffs, Prentice Hall, 1962)

Hotelling, H., The General Welfare in Relation to Problems of Taxation and Railway and Utility Rates. (Econometrica, 6, 1938)

Jacob, H., Preispolitik. (Wiesbaden, 1971)

Jacob, H. and Jacob, M., Preisdifferenzierung bei willkuerlicher Teilung des Marktes und ihre Verwirklichung mit Hilfe der Produktdifferenzierung. (Jahrbuch fuer Nationaloekonomik und Statistik, Vol. 174, 1962)

Johnston, J., Statistical Cost Analysis. (New York, McGraw-Hill, 1960)

Jordon, W.A., Airline Regulation in America: Effects and Imperfections. (Baltimore, John Hopkin's Press, 1970)

Kahn, A.E., The Economics of Regulation. (New York, Wiley, 1970)

Kessel, R.A., Price Discrimination in Medicine. (Journal of Law and Economics, 1, 1958)

King, A.J., The Demand for Housing: Integrating the Roles of Journey-to-work, Neighborhood-Qualities and Prices. in: Terleckyi, N., Household Production and Consumption. (New York, N.B.E.R., 1975)

Koutsoyannis, A., Modern Microeconomics. 2nd edition. (London, MacMillan, 1979)

Kolko, G., Railroads and Regulation 1877 - 1916. (Princeton, Princeton University Press, 1965)

Konijn, H.S., Estimation of an Average Production Function from Surveys. (Economic Record, 1959)

Lancaster, K., A New Approach to Consumer Theory. (Journal of Political Economy, 74, 1966)

Lancaster, K., Variety, Equity and Efficiency. (New York, Columbia University Press, 1979)

Lange, M., Preisbildung bei neuen Produkten. (Berlin, 1972)

Laub, K., Betriebsvergleich im Augenoptikerhandwerk. (Institut fuer Handwerkswissenschaft, Muenchen, 1971)

Leichter, H.M., A Comparative Approach to Policy Analysis of Health Care Policy in Four Nations. (Cambridge, Cambridge University Press, 1979)

Less, D.S., Economics and Non-economics of Health Services. (Three Banks Review, 110, 1976)

Lipsey, R.G., An Introduction to Positive Economics. (6th Edition, London, Weidenfeld and Nicholson, 1983)

Loeffelholz, J., Repetitorium der Betriebswirtschaftslehre. (Wiesbaden, Carl Gabler, 1965)

Machlup, F., Marginal Analysis and Empirical Research. (American Economic Review, 1946)

Machlup, F., Characteristics and Types of Price Discrimination. in: The National Bureau of Economic Research Conference Report: Business Concentration and Price Policy (Princeton University Press, 1955)

McAvoy, P.W., Regulation of Entry and Pricing in Public Transportation. (A.E.I. Studies in Government Regulation, 1977)

McGee, J., The Standard Oil, New Jersey, Case. (Journal of Law and Economics, 1958)

McLennan, D., Housing Economics. (Longman, New York, 1982)

Marris, R., A Model of the "Managerial" Enterprise. (Quarterly Journal of Economics, 1963)

Marshall, A., Principles of Economics. (London, McMillan, 1920)

Meyer, J.R. and Oster, C.V., Deregulation and the New Airline Entrepreneurs. (Cambridge, Mass., MIT Press, 1984)

Nerlove, M., Estimation and Identification of Cobb-Douglas Production Functions. (Chicago, Rand McNally, 1965)

Otha, M., Hedonic Price Index for Boiler and Turbo Generator:

A Cost Function Approach. (Technical Report No. 40, Project for the Evaluation and Optimization of Economic Growth, University of California, Berkeley, 1971)

Otha, M. and Griliches, Z., Automobile Prices Revisited: Extension of the Hedonic Hypothesis. in: (Terleckyi, Editor, "Household Production and Consumption", Vol. 40, Studies in Income and Wealth, NBER: Columbia University Press, New York, 1971)

Oxenfeldt, A.R., A Decision - Making Structure for Pricing Decisions. (Journal of Marketing, 1, 1973)

Palda, K.S., The Marketing Mix and Brand Quality. in: Modelling for Government and Business. (Editor van Bochove et.al., Leiden, H.E.S. Kroese, B.V., 1977)

Pappas, J.L., Brigham, E.F. and Shipley, B., Managerial Economics. (New York, Holt Rinehart and Winston, 1983)

Paul, L. Joskow and Noll, Roger, C., Regulation in Theory and Practice: An Overview. in: (Fromm, G., editor, Studies in Public Regulation (Cambridge, Mass., MIT Press, 1981)

Peltzman, S., An Evaluation of Consumer Protection Legislation: The 1962 Drug Amendments. (Journal of Political Economy, 1966)

Peltzman, S., Towards a More General Theory of Regulation. (Journal of Law and Economics, 1976)

Phlips, L., The Economics of Price Discrimination. (Cambridge, Cambridge University Press, 1983)

Philipps, A., A Critique of Empirical Studies of Relations Between Market Structure and Profitability. (Journal of Industrial Economics, 1976)

Piercy, B. and Jandrell, R., Coordinated Work Measurement. (Edward Arnold, 1975)

Pigou, A.C., The Economics of Welfare. (London, MacMillan, 1920

Pilati, P., Proliferation des marques: Barriere a l'entree. (Ph.D. Thesis, Louvain-la-neuve, Universite Catholique de Louvain, 1979)

Posner, R.A., Taxation by Regulation. (Bell Journal of Economics and Management Science, Spring 1971)

Posner, R.A., Theories of Economic Regulation. (The Bell Journal of Economics and Management Science, Spring 1971)

Rasch, H., Wettbewerbsbeschraenkungen: Kartell- und Monopolrecht. (3. Aufl., 1966)

Riebel, P., Einzelkosten- und Deckungsbeitragsrechnung. (Wiesbaden, Th. Gabler, 1972)

Robinson, J., The Economics of Imperfect Cempetition. (London, MacMillan, 1934)

Rosen, S., Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. (Journal of Political Economy, 1974)

Sabel, H., Zur Preisbildung bei neuen Produkten. (Wiesbaden, 1973)

Samuelson, P.A., Foundations of Economic Analysis. (Cambridge, Mass., Harvard University Press, 1983)

Shneorson, D., The Rationality of Conference Pricing and Output Policy. (Maritime Studies and Management, 3, 1976)

Simon, H., Theories of Decision Making in Economics and Behavioural Science. (American Economic Review, 1959)

Smith, C.A., Survey on the Empirical Evidence on Economies of Scale. in: Business Concentration and Price Policy. (Princeton, Princeton University Press, 1955)

Spady, R.H. and Friedlaender, A.F., Hedonic Cost Functions for the Regulated Trucking Industry. (Bell Journal of Economics 9, 1978)

Spence, M., Product Selection, Fixed Costs, and Monopolistic Competition. (Review of Economic Studies, 43, 1976)

Spence, M., Monopoly, Quality and Regulation. (Bell Journal of Economics and Management Science 6, 1975)

Scherer, F.M., Industrial Market Structure and Economic Performance. (Chicago, Rand McNally, 1979)

Schmalensee, R., Entry Deterrence in the Ready-To-Eat Breakfast Cereal Industry. (Bell Journal of Economics, 9, 1978)

Schmalensee, R., Output and Welfare Implications of Third-Degree Price Discrimination. (American Economic Review, 7: 1981)

Schumpeter, Capitalism, Socialism and Democracy. (5th edition, London, Allen and Unwin, 1977)

Stackelberg, H.V., Preisdiskriminierung bei willkuerlicher Teilung des Marktes. (Archiv fuer Wirtschafts- und Sozialforschung, Vol. 5, 1939)

Bundesamt ed., Statistisches Jahrbuch 1985 fuer die Bundesrepublik Deutschland. (W. Kohlhammer, Wiesbaden, 1985

Steiner, O., Peak Loads and Efficient Pricing. (Quarterly Journal of Economics, 71, 1957)

Stigler. G.J., The Theory of Economic Regulation. (The Bell Journal of Economics and Political Science, Spring 1971)

Straszheim, M., An Econometric Analysis of the Urban Housing Market. (National Bureau of Economic Research, New York, 1975)

Taussig, F.W., A Contribution to the Theory of Railway Rates. (Quarterly Journal of Economics, 1981)

Telser, L.G., Abusive Practices: An Economic Analysis. (Law and Contemporary Problems, 30, 1965)

Thomas, A.L., The Allocation Problem in Financial Accounting Theory. (Studies in Accounting Research 3, American Accounting Association, 1969)

Titmuss, R.M., Commitment to Welfare. (London, George Allen and Unwin, 1968)

Treuarbeit AG, Frankfurt am Main, Betriebsvergleich im Augenoptikerhandwerk. (Mimeographed, 1977)

Triplett, J.E., Consumer Demand and Characteristics of Consumption. in: Terleckyi, N. Editor, op. cit.

Urban, G.L., A Mathematical Modelling Approach to Product Line Decisions. (Journal of Marketing Research, Febr. 1969)

Vatter, A.L., Limitations of Overhead Allocation. (The Accounting Review, 1945)

Walters, A.A., Production and Cost Functions: An Econometric Survey. (Econometrica 31, 1963)

Wells, M.C., Is the Allocation of Overheads Necessary? (The Australian Accountant, 1970)

Williamson, O.E., The Economics of Discretionary Behaviour. (Englewood Cliffs, N.J., Prentice Hall, 1964)

Zerby, J.A. and Conlon, R.M., Capacity Utilisation in Liner Shipping. (Journal of Transport Economics and Policy, 12, 1980)

Zerby, J.A. and Conlon, R.M., Joint Costs and Intra-Tariff Cross-Subsidies: The Case of Liner Shipping. (Journal of Industrial Economics, 31, 1983)