A STUDY INTO THE EFFECTS OF DEREGULATION OF THE NEW ZEALAND PETROL INDUSTRY

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ABSTRACT

The overall objective of this thesis is to investigate the effects of deregulation of the New Zealand petrol industry. Various economic theories are presented in an effort to help the reader better understand the industry, and to explain its workings. The legislative background is discussed, and areas looked at cover the structure, conduct, and performance of the industry and its participants, both prior to, and after deregulation. An econometric analysis of the industry is also conducted.

ACKNOWLEDGEMENTS

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CHAPTER 1: INTRODUCTION

The New Zealand economy prior to 1984 was characterised by extensive legislation and regulation. This legislation resulted in the exchange of many goods and services at prices that were restricted by the government, rather than being set by the forces of supply and demand. This occurred both at the national level, such as the wage and price freezes of the Muldoon era, and at the individual market level. With the election of the fourth Labour government in July of that year, the process of deregulation was set in motion.

One such market was the petroleum industry, which was deregulated on the 9th of May 1988 with the enactment of the Petroleum Sector Review Act 1988. The objective of this legislation was to increase the level of competition within this industry, and thus bring benefits to consumers in the form of lower prices. Whether this industry is more competitive now that the regulations have been removed is a contentious issue. There is a common belief among many people that the petrol companies have for years, been colluding and making supernormal profits, at the expense of consumers.

This thesis analyses the industry before and after deregulation, and seeks to draw conclusions as to the 'success' of deregulation.

Chapter two sets out to review the earlier works concerning this topic, and briefly outlines various economic theories that relate to this thesis. It also describes the market structure-conduct-performance framework, on which the structure of this thesis is based.

Chapter three outlines the background conditions governing the industry, including the regulatory background.

Chapter four presents the structure of the New Zealand petrol industry, and covers such topics as oligopoly theory, vertical integration, and barriers to entry.

Chapter five analyses the conduct and performance of this industry, and includes the pricing behaviour and non-price strategies of the firms within the industry.

Chapter six is a basic econometric analysis of the New Zealand petrol industry, which provides, among other things, a comparison of the determinants of the price of petrol before and after deregulation.

Chapter seven presents the conclusions of this thesis, as well as outlining possible future research.

CHAPTER 2: LITERATURE REVIEW

2.1 INDUSTRY DEREGULATION

Ten years have passed since the deregulation of the New Zealand petroleum industry. The twelve months following this deregulation saw several papers that looked at the immediate effects of this legislation on the market. Most notable are those published by the Ministry of Energy's Market Analysis Unit (1989) and Miller (1989).

The aim of the Ministry of Energy's report was to "outline the structure of petrol distribution in New Zealand immediately prior to deregulation, and identifying key areas to monitor after the removal of controls" (p.1).

They identified seven changes that they expected to occur as a result of deregulation (p.2). These were as follows:

- Intensified competition and sporadic price wars in the major urban areas;
- Regional wholesale price differentials reflecting variations in transport costs;
- Volume concentration of retail sales through larger outlets;
- Diversified use of outlet sites with expanded accessory and grocery stores;
- Relocation of outlets from restricted inner city sites to sites with lower land value;
- Wholesaler acquisition and franchising of strategic sites, to secure market shares; and
- Continued niche markets for smaller suburban and rural outlets.

These forecasts have turned out to be very close to what we see in the industry today. Petrol costs in various areas now better reflect their respective transport

costs, while retail outlets certainly have expanded their stores. Wholesalers did indeed acquire, or contract, retailers to secure their market shares.

The main findings of this paper were as follows:

- Wholesalers had secured access to retail outlets;
- There was a reduction in the supply cost of petrol;
- Coastal cost equalisation was retained;
- Both wholesale and retail margins had increased; and
- The industry had undergone rapid structural changes.

The fact that a new entrant failed to appear in the market, made it easier for the existing wholesalers to retain cost equalisation in coastal shipping. It also reduced the pressures to lower prices. The threat of a new wholesale entrant became even bleaker when BP acquired the two largest independent chains of retail outlets; the Brierley/Fay Richwhite backed Top Group, and Solo Energy, within a year of deregulation.

Miller, in his book, identifies seven conditions that will influence the degree of price competition in the market (p.6). They are as follows:

- The number and relative size of sellers;
- The complexity and differentiation of the product in question;
- The cost structure;
- The demand elasticity;
- The social structure;
- The speed of change; and
- The characteristics of transactions.

The fewer and larger the sellers, the closer their respective products and cost structures, the more inelastic is demand, and the smaller the size of each transaction relative to the total sales, the easier it is for rival firms to understand each others pricing. The New Zealand petrol industry has been

characterised by four large wholesalers with virtually identical products and cost structures, and an inelastic demand (-0.2), resulting in a low degree of price competition.

Miller (p.56) concludes, "the very structure of the industry requires both oligopolistic interdependence in pricing and the identity of wholesale price of petrol". He also states that "among the four wholesalers there is an understanding clearly, but there is no collusion".

In 1996, the New Zealand Institute of Economic Research (NZIER) was commissioned by the Ministry of Commerce to write a report concerning petrol prices in New Zealand. They showed New Zealand's petrol price in 1995, excluding taxes, to be the fifth most expensive of the twenty-three OECD countries. New Zealand's petrol price was approximately US10c per litre more than Australia's.

With 2.7 billion litres of petrol consumed annually in New Zealand (NZIER, p.13), the oil companies make $2.7 million per annum for every cent in petrol price. At the time of writing ten months had passed since Challenge entered the market. Retail prices in areas where a Challenge station has opened are on average five cents per litre cheaper than the pre Challenge days. If we take this as a rough estimate of the level of competitive pricing failure, then the oil companies have been making supernormal profits of approximately $135 million per annum. As the four major oil companies are all foreign owned this money (less taxes) is potentially lost overseas.

The NZIER conclude, "in competitive conditions, one would expect to see margins squeezed over time, not increasing" and that "margins can only be increased above competitive levels if there are barriers to entry" (p.14).

So what is a barrier to entry, and what are the potential barriers. The definition of a barrier to entry for the purpose of this thesis is that given by Stanton and Launder (1998).

> "A barrier to entry is any factor that prevents or makes it very difficult for new firms to enter a market and compete with the existing operators" (p.11).

Potential barriers proposed by the Ministry of Commerce (1996, p2-3) include:

- Economies of scale and scope to determine the structure and size of the market required for a viable importing operation;
- The extent to which the interdependence of the four wholesalers and contractual arrangements between them with respect to port storage and coastal tankers may create barriers;
- The ability to develop new port storage facilities, availability of suitable sites, entry and exit costs including allowing for resource consent procedures;
- The access to existing retail outlets, including whether contractual arrangements of existing wholesalers with independents may constitute a barrier;
- The likely responses of existing wholesalers to the threat of entry and the extent to which this constitutes a barrier to entry;
- The ability to develop new retail outlets, availability of suitable sites, entry and exit costs including allowing for resource consent procedures;

These represented some fairly substantial barriers, with the four major wholesalers controlling the single refinery, the coastal shipping system, and their shared storage facilities. Thus when Challenge entered the market earlier this year it had to build its own storage terminal, and had to import refined petrol. Challenge is currently negotiating with New Zealand Refining Company for access to the Marsden Point Refinery and the Wiri pipeline.

The International Energy Agency (1997), in their review of New Zealand's energy policies concluded that there were:

> "grounds for suspecting oligopolistic pricing behaviour by the four oil companies that dominate the industry. There are entry barriers to the New Zealand market, resulting from the high cost of installing port terminals, bulk storage facilities and new retail outlets, such that the companies may be able to continue to make oligopoly profits without the threat of competition from independent importers and retailers."

It can be argued however, that the costs mentioned by the International Energy Agency above are simply costs of operation, which the incumbent firms have already incurred.

2.2 COMPETITION

The purpose of the Petroleum Sector Review Act (1988) was to remove all regulation governing the industry, and to increase competition in the market. Whether or not the latter has occurred is a matter for debate. At the time of writing, premium unleaded petrol was approximately 84 cents per litre in the major centres. At the time of deregulation, super, the equivalent to premium unleaded, was 77 cents per litre. However, one must be careful when using this figure, as the Minister of Energy reduced the price of petrol from 83 cents per litre to 77 cents just days before deregulation came into effect. This can cause problems when this is used as a base to compare today's petrol prices. On the 9th of May Caltex immediately increased it price by approximately 3 cents per litre, as did BP on the 11th of May. Mobil and Shell both increased their price by approximately 3.5 cents per litre on the 10th May. Thus within two days of deregulation taking effect, petrol prices were between 2.5 to 3 cents per litre cheaper than the regulated price prevalent at the beginning of May (Miller, p.44-45).

Many people believe that because the petrol prices of the different wholesalers are the same, there is no competition. They believe the oil companies collude, and operate a cartel type arrangement. Wayne Makeig, a former deputy-

managing director of Mobil believes the opposite is true. He states "that because prices are all quite close it indicates there is quite fierce competition ... we watch ourselves like hawks to ensure we don't get out of line" (Hawkes, 1989, p.35).

Thus without the ability, or willingness to compete on price, oil companies have to differentiate themselves in other areas. BP's Mike Walshe states that "the real differential will be in the area of convenience services, whereby we try to make the acquisition of motor spirits a pleasurable experience" (Hawkes, 1989, p.35). Oil companies promote and compete in the areas of convenience, friendly service, grocery items, and give-aways. The major service stations now resemble small supermarkets, with hundreds of household items in spacious, clean premises.[1] This has had negative effects on other businesses such as the corner dairy.[2] When Shell recently overtook BP to have the largest market share, primarily as a result of the Fly Buys scheme, BP began its own scheme, AA Rewards, to try to regain the number one spot. Not one of the wholesalers advertise their petrol, they all promote some other aspect that makes them 'the best'. Currently Mobil is 'the quick stop', BP's 'on the move', Caltex's 'were pumping', and 'you can be sure of Shell'.

One of the best ways to increase competition is of course a new entrant into the industry. As Challenge has been around only ten months and Gull Petroleum a matter of weeks, we must look elsewhere to study the effects of new entrants to a market. I will therefore look at the retail petrol industry of the United Kingdom in the 1950's and 1960's.

This market was a highly concentrated oligopoly in the 1950's with Shell-BP having a 50% market share, Esso 30%, Regent/Texaco 13%, and Mobil and Petrofina both having smaller shares. Incumbent firms had control over the supply of oil, as imports from the United States were restricted. Pricing behaviour in this period was characterised by the price leadership model, with Shell-BP or Esso generally leading any price changes. There were eighteen

[1] see Scott (1988), and Stuart (1988).
[2] see Agee (1991).

price changes between 1953 and 1959, with all firms matching the changes within twenty-four hours. Interestingly price increases were followed as well as price decreases. This is contrary to the kinked demand curve theory, which states that firms will follow a price reduction so as to maintain their market shares, but will not follow price rises.

This all changed when new oil supplies in the Middle East and Africa were discovered. In the early 1960's several 'cut-price' firms such as Jet and VIP entered the market with significantly lower prices.

By 1970 the market shares of Shell-BP, Esso and Regent/Texaco had fallen to 40, 22 and 9% respectively. The new entrants had between them secured almost 20% of the market.

Shaw (1975) concludes that:

> "The tight oligopoly dominated by Shell-BP and Esso which had carefully avoided price competition among established firms in the 1950s was threatened at the end of the decade by new entry. Despite this threat the leaders chose to set prices which promised abnormal profits for new entrants and minor firms and consequently the former had to accept a continuous decline in their market share. This policy was dictated by the unprofitability of adopting a full-scale limit pricing policy to deter small-scale entry. Nevertheless the established firms did try to control the rate of entry and their loss of market share partly by advertising and trying to control retail outlets and partly by a series of price cuts which reduced the incentive to entry and further expansion by minor firms. However, the losses in market share placed considerable strains on the pricing discipline of the established firms and the restraint which had characterised competition in the 1950s almost disappeared" (p77-78).

Marvel (1978) in his study of the US gasoline market concluded that "collusive prices had characterised most retail gasoline markets following the 1965 Texaco-led price 'restoration', but by 1970 prices in several of the markets had reverted to competitive levels".

2.3 COMPETITION LAW

The New Zealand petrol industry is one of many that are constantly being monitored by various agencies and consumer groups, to ensure that none of the petrol wholesalers are in breach of the Commerce Act 1986. The Long Title of this Act states that it is "an Act to promote competition in markets within New Zealand". This in turn has positive effects on consumer welfare and efficiency.

Unfortunately New Zealand's small size and geographical isolation from the rest of the world, means that a number of our markets will be small in numbers, and thus the problems associated with imperfect competition will be large.

Although there may be some evidence to suggest that oligopolistic markets are uncompetitive, anticompetitive behaviour in these markets does not appear to fall inside the boundaries of the Act, particularly sections 27, 30 and 36.

Section 27 prohibits contracts, arrangements or understandings, which substantially lessen competition. Section 30 states that price fixing by rivals with the purpose or effect of lessening competition to be per se illegal, while section 36 restricts the use of a dominant position in a market.

Tacit collusion by oligopolists may not fall under section 27 despite the fact that the outcome can be identical to that arising from explicit collusion, while section 36 prohibits the use of dominance in a market seems to apply to single firms, even though oligopolists can achieve joint dominance.

Berkahn (1997, p.58-59) concludes, "the interpretation generally given to New Zealand's market dominance and collusion provisions has failed to take

account of the unique features of oligopolies. There is evidence that some oligopolistic markets, such as that for the retail sale of petrol, are not competitive, and are thus operating at lower than optimal efficiency, resulting in significant transfers of wealth from consumers to producers as well as 'dead-weight' losses."

This interpretation is similar to those adopted in Australia and the United States. The European countries however, tend to focus more on the outcomes of possible collusive behaviour rather than the type of collusion.

Pickford (1998, p.3) however states "that pro-competition goal (of the Commerce Act) can be over-ridden through the authorisation of business acquisitions and restrictive trade practices, where it can be demonstrated that greater efficiencies and other public benefits can be expected from a less competitive outcome."

The Commerce Commission, under section 67 of the Act can authorise the creation of a dominant position in a market. To do this it must weigh up the detriments of such a dominant position against any benefits that the acquisition may give to the public. It is this 'public benefit test' that allows the Commission to grant permission for acquisitions and restrictive practices that would otherwise be illegal under the Commerce Act.

The Commission must make its decision based on what it believes would occur if it were to allow the acquisition or restrictive practice, versus what it believes will occur without this permission.

The Commissions approach "is underpinned by economic welfare analysis, as typified by Williamson's merger trade-off model" (Pickford, p23.). This model assumes that acquisitions have two consequences. Firstly, they can create or reinforce the dominant position of a firm, which is likely to result in an increase in price. Secondly, they may create a benefit to the public via efficiency gains. Thus the overall impact of an acquisition will depend on the relative strengths of the benefits versus the detriments. Williamson used the model shown in figure 2.1 below.

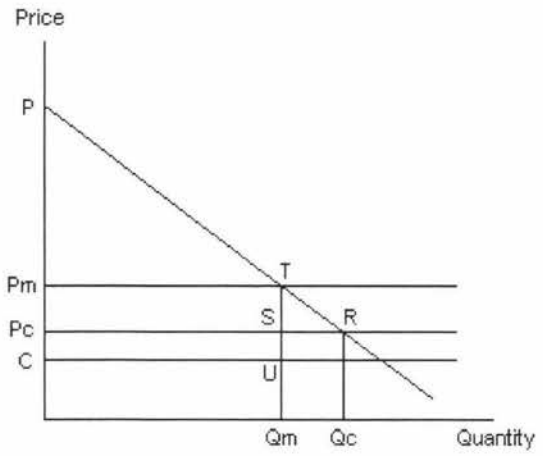

Figure 2.1: The Williamson Merger Trade-off Model.

This basic model assumes a two firm industry, with identical products and cost structures. There are also substantial barriers to entry, and the market is a competitive one before the merger. Thus we initially have a price P_C and output Q_C. Prior to the merger each firm possesses no market power, and allocative efficiency is maximised. We initially have a consumer surplus equal to the area PRP_C. This consumer surplus arises, as consumers are willing to pay more for each unit of output up to Q_C than it costs the firms to produce those units. Following the merger of the two firms there are three effects: a market power effect; an income distribution effect; and a productive efficiency effect.

The market power effect arises as the new firm (a monopoly), will increase the price and decrease the quantity of output to P_M and Q_M respectively. Consumers willing to pay a price between P_M and P_C will no longer be able to purchase the good. Resources equal to the area SRQ_MQ_C are no longer used in the production of this good. The net result is a loss of allocative efficiency, equal to the area RST. This is a dead-weight loss.

The increase in price also results in a redistribution of income from consumers to the new monopolist. This redistribution of income is equal to the area P_MTSP_C. The net result to society is nil, as the consumers loss is the monopolists gain.

The production efficiency effect arises as the new monopolist is assumed to be able to produce the product at a lower average cost, C. Thus the new firm's total cost is lowered by the area P_CSUC. These cost savings represent a gain to society, as these inputs can be used for other purposes.

Thus the overall effect depends on the relative sizes of the loss in allocative efficiency, against the gain in productive efficiency. Williamson showed that only a small fall in unit cost is required to counter the allocative efficiency loss, and thus create a net gain for society.

2.4 VERTICAL INTEGRATION

The passing of the Petroleum Sector Review Act (1988) saw the legalisation of vertical integration by wholesalers into the retail market. Vertical integration is defined by Black (1997, p.496) as "the combination in one firm of two or more stages of production normally operated by separate firms." Forward integration involves a firm moving into the following stage, while backward integration occurs when a firm moves into the previous stage. The petrol industry after deregulation is an example of forward integration, with the wholesalers now also controlling the retail end.

This was a very interesting change as vertical integration is often cited as a reason for lessened competition, and as stated above, the aim of this legislation was to increase competition. Fellner (1960), states that "so-called vertical integration ... may also strengthen an oligopolistic structure by effectively 'tying' one stage of production to another, and so extending the oligopoly to all levels of an industry".

This is also interesting as the current government reforms in the electricity industry are aimed at the separation of the generation of electricity, and the supply of electricity to consumers. The government believes that this will lead to an increase in competition, and thus result in cheaper electricity for consumers.

Thus the petrol industry has gone from a period where the wholesale and retail sectors were kept separate by government legislation, to a situation where they are very much one and the same. The electricity industry is set to go the other way, from a single entity to separate supply and generation sectors.

The reasons for vertical integration and its effects are discussed further in section 4.2.

2.5 MODELS OF OLIGOPOLIES AND GAME THEORY

Models of oligopolies are many and varied. This is because of the difficulty in predicting the interactions between firms in an oligopolistic industry.

Fisher (1898, p.126) states that "no business man assumes that his rival's output or price will remain constant", and that "his whole thought is to forecast what move the rival will make in response to his own."

Models of oligopolies can however be divided into three groups, single period models; multi-period models; and co-operative models. All models have three things in common; there are two or more firms, each firm aims to maximise its

profit, and that each firm is aware of its interdependence. The profit received by each firm depends on the number of firms, the rules of the 'game', and the length of the game (Carlton and Perloff, 1994).

In a single period game firms choose their price and quantity without the knowledge of the others actions. This is done 'simultaneously' by all firms, and thus each firm must try to predict the decisions of the other firms. The three major single period models are the Cournot, Bertrand, and Stackelberg models. These models are explained further in chapter four.

The most recent developments in game theory have been the emergence of multi-period games, that is games that are repeatedly played. In such games the strategies used by firms can be quite complex, as they depend on the strategies adopted by other firms in the previous period.

A co-operative game occurs when the firms collude rather than compete against one another. Firms in this situation will agree to set prices so as to maximise the sum of their profits. This formation of a cartel is often unstable, inefficient, uncompetitive, and illegal under the Commerce Act 1986.

Oligopolies will be covered in detail in section 4.1.

2.6 MARKET STRUCTURE-CONDUCT-PERFORMANCE FRAMEWORK

The framework of this thesis is based on the market structure-conduct-performance model first developed by Edward S. Mason at Harvard University (1939, 1949). It is widely used in many industrial organisation studies.[3] This framework is shown in Figure 2.2 below, which is an adaptation of those shown in Scherer and Ross (1990), and Pickford and Bollard (1998). A solid arrow indicates a direct effect, while 'broken' arrows represent feedback effects.

[3] see for example Schmalansee, 1987; Scherer and Ross, 1990; and Pickford and Bollard (eds), 1998.

The theory is that market performance is determined by the conduct of the market. This is determined by the market structure, which in turn is determined by various background conditions. All these areas are also influenced by public policy.

Background conditions can be divided into supply-side and demand-side conditions. Supply-side conditions include the nature of the production technology, the location and ownership of raw materials, and the cost structures of firms. Demand-side conditions include price and income elasticities, consumer tastes, the nature of the sale, and the availability of substitute goods.

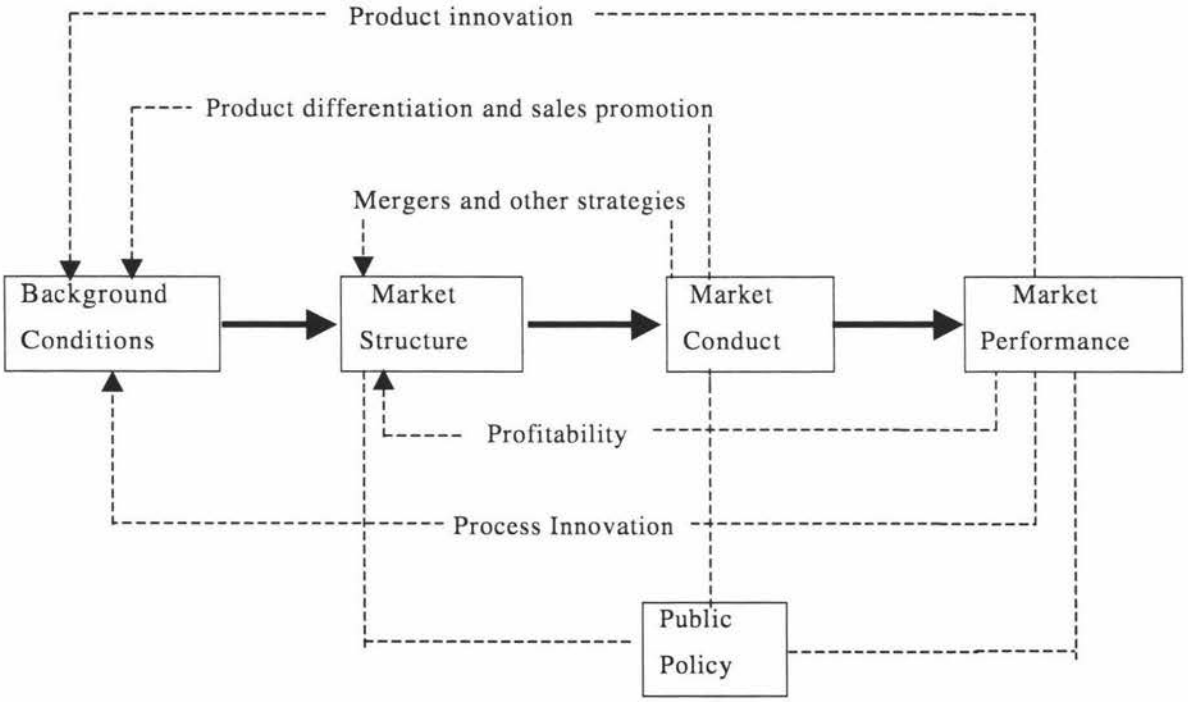

Figure 2.2: The Market Structure-Conduct-Performance Framework.

Market structure is concerned with those aspects of the market that are stable or change slowly over time. Such aspects include the number of buyers and sellers, barriers to entry, product differentiation, vertical integration, and diversification.

Market conduct is concerned with the behaviour of the firms in the market. It covers areas such as output and pricing strategies, overt and tacit collusion, advertising and other promotional strategies, investment in capital, and research and development. Collusion is an interesting topic and will be looked at in detail in chapter five.

Market performance is concerned with how well the industry performs. This is much harder to gauge than the previous sections, and to a certain extent is fairly subjective. Areas looked at include production and allocative efficiency, profitability, and income distribution.

The information required to analyse market conduct and especially market performance can often be commercially sensitive.

Some of the indirect feedbacks are also very important. For instance the profitability of the industry will affect its structure. The more profitable the industry, the more appealing it is to other companies, and thus the greater the chance of new entrants. Firms in high profit industries must accept this, and be prepared for lower future profits, as new entrants will erode these supernormal profits.

Mergers by several firms or vertical integration by one or more firms will also affect the industry structure.

Public policies, which will affect all areas of the industry, include competition laws, tax laws, environmental laws, and consumer protection laws. Such legislation in New Zealand includes the Commerce Act 1986, the Resource Management Act 1991, the Sale of Goods Act 1994, the Consumer Guarantees Act 1993, and various tax laws.

The Chicago School challenged this market structure-conduct-performance framework in the 1970s and 1980s. This school believes that unless supported by government regulation, market power is a temporary problem. Thus they regard the competitive market model as sufficient to explain market behaviour,

and believe the market structure-conduct-performance framework to be unnecessary. This framework was also criticised for its causal links and uni-directional focus. The aforementioned feedback effects were added to the model to counter these criticisms.

Chapter three now looks at the background conditions governing the New Zealand petrol industry.

CHAPTER 3: BACKGROUND CONDITIONS

3.1 REGULATORY BACKGROUND

As mentioned in chapter one, the New Zealand economy prior to the election of the fourth Labour government 1984 was characterised by extensive legislation and regulation.

The New Zealand petroleum industry became a deregulated one with the enactment of the Petroleum Sector Review Act 1988, on the 9th of May 1988. The major effects of this Act on petrol retailers were the removal of the price controls that were in place on all motor spirits, and the legalisation of vertical integration by petroleum wholesalers. The effects on the wholesalers included the removal of controls on the returns on assets, the availability of imported refined products, and the end of licensing, opening up the way for new entrants (Ministry of Energy, 1989).

Prior to this the Motor Spirits (Regulation of Prices) Act 1933, and the Motor Spirits Distribution Act 1953 governed the industry.

The Motor Spirits (Regulation of Prices) Act 1933, allowed the Minister of Energy to control the price of all motor spirits, including petrol, by setting maximum and minimum prices. This legislation was in response to the appearance on the market of Associated Motorists Petrol Company (AMP), a New Zealand owned price discounter, and was introduced to protect AMP from the price war that erupted upon their arrival in the market (Commission on Inquiry, 1976).

This regulation allowed wholesalers a return of 13% on all assets allocated to wholesale distribution, thus establishing a single wholesale price at all ports and a single price at the retail end.

The Motor Spirits Distribution Act 1953, outlawed both the ownership of retail outlets by the wholesalers and any attempts to control retailers. As stated above this distinction ended in 1988, and most petrol stations are now owned by one of the wholesalers, while a smaller number are independently owned and have supply contracts with a wholesaler (International Energy Agency, 1997). The duration of these contracts was generally between ten and fifteen years, thus many of the shorter length contracts are currently up for renewal.

This could be why we are only now seeing new entrants to the market, ten years after the Act was introduced to increase competition. It is logistically easier to takeover an existing station than it is to build a new one. The four major wholesalers have shown that they will not let their franchised stations go easily however. For example Mobil Oil is suing the owner of a Pahiatua station who switched allegiance to Challenge for $3.4 million.[4]

3.2 THE COMPETITORS

There are currently six wholesalers in the New Zealand petroleum industry. In order of appearance they are Mobil, Shell, Caltex, BP, Challenge, and Gull Petroleum.

The first to appear was Mobil in 1896, as a New Zealand branch of Vacuum Oil Pty Ltd of Melbourne. In 1952 this become Vacuum Oil Co (NZ) Ltd and then Standard-Vacuum Oil Co (NZ) Ltd (1955). When the parent company changed its name to Mobil Oil Corp New York, it became Mobil Oil New Zealand Ltd (1962).[5]

Shell products were first distributed in the 1890's and in 1912 a branch of the Australian Imperial Oil Co opened. In 1927 the Shell Company of New Zealand Ltd was established and in 1959 it became Shell New Zealand Ltd. It is a subsidiary of the Shell Petroleum Co Ltd, London.

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[4] see Saunders (1998).
[5] Atlantic Union Oil, a Mobil subsidiary was converted to the Mobil brand in 1982.

In the early 1900's Texaco products began to be distributed, and then come the formation of the Texas Company (Australasia) in both New Zealand and Australia. A subsidiary of the Caltex Petroleum Corp of Dallas, Caltex Oil (NZ) Ltd was formed in 1975.

The British Petroleum Company of New Zealand was established in 1946 and in 1957 it became BP New Zealand Ltd. In 1955, the New Zealand government sold its 51% share to British Petroleum Co Ltd, and it is now a wholly owned subsidiary of that company. BP fully acquired Europa Oil NZ Ltd[6] in 1977 and all Europa stations and products are now branded BP.

In April of 1998, the first new competitor since deregulation entered the market. Challenge, a Fletcher Challenge Energy company opened ten service stations in the North Island. Although this is only a very small percentage of the total retail the number is constantly growing.

Perth based Gull Petroleum opened its sole station in Hamilton in February this year.

Another Australian company, Melbourne based Liberty Oil has also announced its intentions to enter the New Zealand market. At the time of writing however, they had not made any firm commitments.

3.3 DEMAND CONDITIONS

Petrol is characterised by a high cross price elasticity and a low price elasticity of demand. The cross price elasticity shows us the percentage change in the quantity demanded of a good, with respect to the percentage change in price of a substitute good. A high cross price elasticity means that a small rise in the price of petrol by one company, will result in a large fall in sales as consumers

[6] Associated Motorists Petrol Co Ltd became Europa Oil NZ Ltd in 1954.

switch to other brands. Likewise a small reduction in price, will see a large increase in sales for that company.

This is a result of the homogeneity of the product. Because each firm's petrol is virtually identical, consumers will buy the cheapest. Each brand of petrol is a very close substitute to any other brand.

The price elasticity of demand, is the ratio of the percentage change in quantity demanded to the percentage change in price that brings about the change quantity demanded. A low price elasticity of demand, means that consumers will change their demand less than proportionally when faced with a change in price. Thus the loss in sales caused by an increase in the price of petrol is more than compensated for by the increased profit margin. The price elasticity of demand for petrol in New Zealand is –0.2. This is because petrol is a necessity.

The nature of the sale is that of high frequency, and low value. That is each petrol company makes thousands of sales a day, with each sale being only a small fraction of total turnover. It is therefore important for each company to make as many sales as possible. Retail outlet location thus becomes of paramount importance.

3.4 SUPPLY CONDITIONS

The major product they sell (petrol) is identical, with the exception of newcomers Challenge and Gull Petroleum, and they face very similar cost structures.

The four major wholesalers all source their petrol from the Marsden Point refinery, from which it is shipped to eleven ports around the country. The total cost of transporting petrol to all ports is distributed between the wholesalers in proportion to their output from the Marsden Point refinery. This results in a uniform average unit cost of petrol for all the wholesalers at each of the coastal

depots, regardless of the actual distance from the Marsden Point refinery. This is known as coastal cost equalisation. Inland distribution is conducted independently.

At each port the four major wholesalers have separate depots, with the exceptions of Timaru which has no Mobil or Caltex depots, and Whangarei and Bluff neither of which has a Shell depot. If one of the wholesalers exceeds their own storage capacity (or in the cases outlined above has no storage capacity), they can readily lease storage capacity from the others.

Figure 3.1 below shows the current structure of the New Zealand petrol industry.

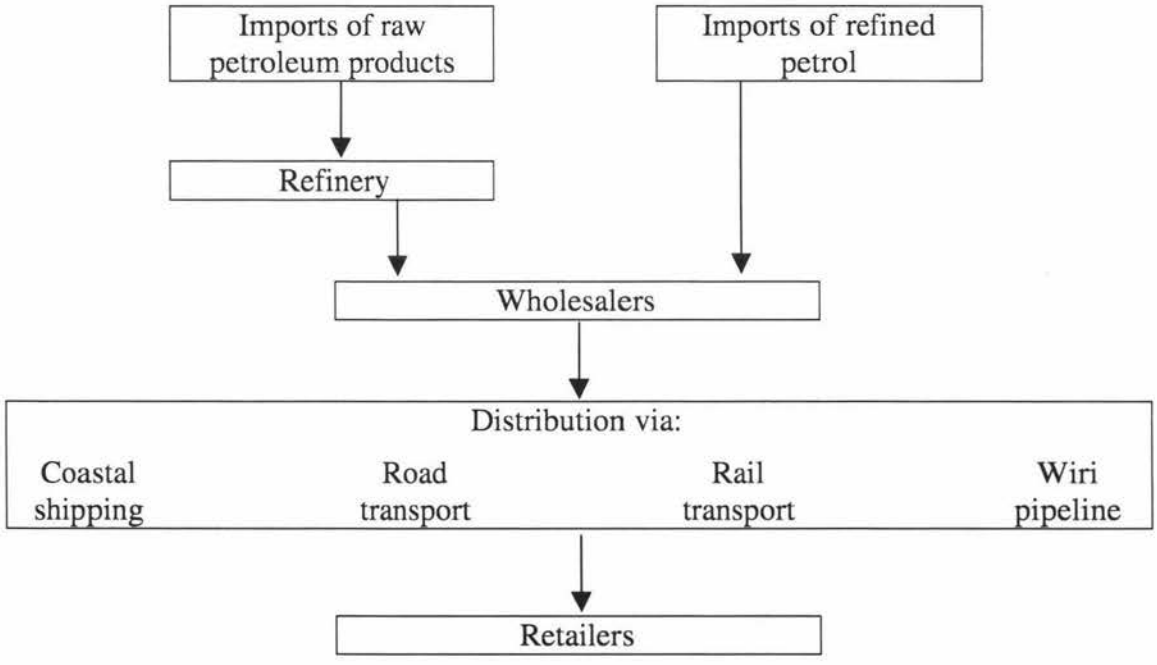


Figure 3.1 Structure of the New Zealand Petrol Industry.

Petrol has a fairly long shelf life and thus retailers can hold a long-term supply in their storage tanks. This reduces the need for frequent deliveries from the wholesalers. The durability of petrol therefore has significant cost savings.

The market is dominated by vertical integration, with the oil companies controlling the refining, wholesale, and retail of petrol.

The next chapter looks at the structure of the New Zealand petrol industry.

CHAPTER 4: MARKET STRUCTURE

4.1 OLIGOPOLY

The New Zealand petroleum industry is very much an oligopolistic one. Black (1997, p.331) defines an oligopoly as:

> "A market situation with only a few sellers, each anticipating the others reactions. Each firm has a sufficiently large share of the market to need to consider the individual reactions of others to changes in its price or output. Equilibrium thus depends on how each oligopolist forecasts the others reactions."

As mentioned in chapter 2 there are three groups of oligopoly models, single period, multi-period, and co-operative models. This section looks at the various models and their outcomes, and relates them to the New Zealand petrol industry.

4.1.1 SINGLE PERIOD MODELS

4.1.1.1 The Cournot Model

Named after the French mathematician Augustin Cournot, who developed this model in 1838, the Cournot model assumes each firm attempts to maximise its profits by choosing its output level. Firms do this simultaneously and must base their output decision on their forecasts of other firm's output. Firms base this decision on their reaction function, which gives them the highest profit level of output, taking their beliefs about firms output as given. Equilibrium in the Cournot model occurs at the intersection of the various firm's reaction functions. That is in equilibrium each firm sells that quantity which maximises its profits, given its beliefs of the other firm's output choices, and that in equilibrium these beliefs are correct. Thus in equilibrium all firm's correctly forecast the output levels of their rivals.

The Cournot equilibrium lies between the equilibrium obtained from a monopoly and that from perfect competition. Each firm has a certain degree of market power enabling the price to set above marginal cost. The size of this price-cost margin depends on both the number of firms and the elasticity of market demand. The greater the number of firms and the greater the elasticity of demand, the smaller this profit margin becomes. As the number of firm's rises the profits must be shared amongst this greater number of players. Industry output increases, price falls, and consumer welfare increases. The smaller the number of firms the closer equilibrium is to that found under a monopoly, while the larger the number of firms the closer equilibrium is to that of perfect competition.

Each firm will have the same profits if they face identical costs. If costs are not identical, then the lower the cost of a given firm, the greater its market share.

4.1.1.2 The Bertrand Model

Most firms with a degree of market power set their price rather than their output. They then let market forces determine the quantity sold. Another French mathematician, John Bertrand, formulated such a model. Firms set their prices simultaneously and believe that rival firms prices are fixed. Thus by setting a price lower than its competitors a firm can capture the entire market (assuming homogenous products and complete information on the part of consumers). Thus equilibrium in the Bertrand model must be the competitive equilibrium, that is where price equals marginal cost. A firm cannot charge more than this as it will make no sales, and it cannot charge less as it will be making negative profits. Thus the Bertrand model encourages firms to compete in non-price ways.

With heterogeneous products the Bertrand equilibrium does differ from the competitive equilibrium, and is affected by the number of firms in the industry.

4.1.1.3 The Stackelberg Model

Heinvich von Stackelberg was a German economist who in 1934 presented the first leader-follower model. In the Stackelberg model each firm sets its output.

However one firm (the leader) chooses their output first and then the other firms (the followers) select their optimal output level given the leaders output. This model is often used to describe the behaviour of industries in which there is a dominant firm.

The leader chooses that level of output that maximises its profits, subject to the knowledge that the followers will select their output levels using their response functions. In equilibrium, the leader is better off than under a Cournot equilibrium, while the followers are worse off. That is, knowing how the followers will react let's the leader profit at their expense.

4.1.1.4 Comparisons

So how do these models stack up against each other? All three models predict a monopoly outcome when there is only one firm. When there are two or more firms the Bertrand equilibrium is the same as the competitive equilibrium. The Cournot and Stackelberg equilibrium's get closer to the competitive equilibrium as the number of firms increases. The Cournot and Stackelberg models are far more intuitively appealing. That equilibrium is closer to the monopoly solution when firms are few and closer to perfect competition when the numbers of firms is large is more logical than the Bertrand solution of monopoly with one firm and prefect competition with two or more firms.

4.1.2 MULTI-PERIOD MODELS

The above single period models assume that firms make their output or pricing decision once and then live happily ever after based on the outcome of that decision. This is obviously not true, with firms constantly acting and reacting based on rival's decisions in previous periods. Multi-period games, or supergames, were developed to address this problem.

In a multi-period game firms use complex strategies in which they can change their pricing and output decisions in every period based on the outcome of the previous period's choices. In such models firms can 'signal' to each other their

intentions. For example a firm may cut its output, signalling to its rivals that it is prepared to enter a less competitive 'arrangement'. Seeing this other firms may also decrease their output, thus restricting supply and increasing the profits of the firms at the expense of consumers.

Firms also have the ability to punish rivals if they lower their price and increase their output. It is this ability to signal and punish that makes these games so interesting and complex.

A quick note must be made here. That is the difference between an ongoing game and a game that lasts a set number of periods. The above signalling and punishing only works if the game is indefinite in length or the number of periods is unknown. To illustrate this lets assume we have a two firm, T period game where T is known to both firms.

Starting with period T (the last period) both firms will choose their best strategy as though it was a single period game. Because previous prices do not affect the profits in period T, each firm must maximise its 'static profit' given its competitors price. Thus the equilibrium will be the competitive one. So what will be the equilibrium period T-1? As the pricing decision in period T does not depend what occurred in period T-1, then period T-1 effectively becomes the last period. Thus firms also select the competitive price in period T-1. Following the same logic, and working backwards, all periods result in the competitive equilibrium. Thus a T period game (where T is known) is simply a single period game repeated T times.

4.1.3 CO-OPERATIVE MODELS

Firms in an industry with few rivals may choose not to compete, and instead get together to set the market price and output, in order to maximise their collective profits. Such a situation results in the monopoly solution with firms sharing the monopoly profit. This is known as a cartel. The most commonly used example of a cartel is that is the Organisation of Petroleum Exporting Countries (OPEC).

When OPEC formed it had three quarters of the worlds oil reserves, and by limiting output they initially quadrupled the world oil price.

Cartels are often unstable, as the incentive to cheat such an agreement is strong. Just one rogue cartel member can set off a price war.
Many conditions affect the likelihood of a cartel and its chances of success. These include the elasticity of the demand curve, the extent of anti-competitive laws, the number and concentration of firms, the homogeneity of the good, and the nature of the sale. The more inelastic the demand curve, the weaker the competition laws, the fewer and larger the firms, the higher the degree of homogeneity, and the greater the frequency of sale, the more likely a cartel type arrangement will be.

As mentioned earlier the New Zealand petrol industry is characterised by an inelastic demand, a high concentration of firms, a homogenous product, and a high frequency of sale. Thus this industry is conducive to cartel type behaviour.

This is of course illegal under the Commerce Act 1986.

4.2 VERTICAL INTEGRATION

4.2.1 INTRODUCTION

The passing of the Petroleum Sector Review Act (1988) saw the legalisation of vertical integration by wholesalers into the retail market. Perry (1989, p185) gives us the following definition of vertical integration. He states that

> "A firm can be described as vertically integrated if it encompasses two single output processes in which either (1) the *entire* output of the 'upstream' process is employed as *part or all* of the quantity of one intermediate input into the 'downstream' process, or (2) the *entire* quantity of one intermediate input into the 'downstream'

process is obtained from *part or all* of the output of the 'upstream' process".

The current state of the New Zealand petrol industry fits both of the above qualifications. The *entire* output of the 'upstream' process (wholesaler) is employed as the *entire* quantity of one intermediate input of the 'downstream' process (retailer).

4.2.2 DETERMINANTS OF VERTICAL INTEGRATION

The theoretical determinants of vertical integration are many and varied. They can however be broadly grouped into three main areas: technological economies, transactional economies, and market imperfections.

Most authors generally mention technological economies only briefly as a reason for vertical integration. As it is of only limited importance to this thesis I will continue this trend. Technological economies arise when there are cost savings to be made from the technological interdependence of consecutive stages of production. The example cited in many texts is that of the steel industry. Here vertical integration can eliminate the need to cool and then reheat the steel at the various production stages. Transport costs may also be saved.

Transactional economies are similar in nature to technological economies. They are concerned with the process of exchange itself rather than the production process. One of the original proponents of transaction cost economics is Ronald Coase. In his 1937 paper he argued that to understand vertical integration we must examine vertical *exchange* relationships, not vertical production relationships. Vertical integration is after all only one way to bring about a bilateral exchange. The major alternative is a contractual exchange.

Thus transaction cost economics is concerned with the relative benefits and costs of internal exchange versus those of contractual exchange through the marketplace. Coase (1937, p341.), states that a firm will integrate up to the point where "the costs of organising an extra transaction within the firm become equal

to the costs of carrying out the same transactions by means of an exchange in the open market or the costs of organising in another firm". He believes that this is the point at which the optimal or equilibrium level of vertical integration occurs.

Williamson (1987) details the situations where transaction costs will be relatively high and thus so will the likelihood of vertical integration. Such conditions include a high degree of asset specificity, a high level of uncertainty, and a high frequency of transactions.

Asset specificity means that the investments of an upstream or downstream firm are of greatest value when the exchange of product is made between these two firms rather than with other firms. This creates a bilateral monopoly between the wholesaler and retailer. Put another way, it is in the best interests of both firms to conduct business with each other. Thus we have an economic rent that is equal to the difference between the value of the asset in its current use versus its value in its next best employment. Klein, Crawford and Alchian (1978) have labelled this as 'appropriable quasi-rents'.

The third group of reasons for vertical integration falls under the heading of market imperfections. The most common example is that of imperfect competition. The case I will examine is that of successive stages of imperfect competition. The easiest case is that of successive monopolies. We consider a wholesaler who has a national monopoly and retailers who each have local monopolies.

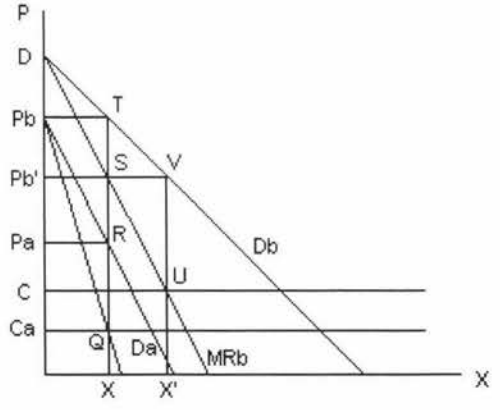
With constant marginal costs of distribution, the marginal revenue function of a retailer is also that retailers inverse demand function to the wholesaler. This causes the upstream monopolist to produce a level of output less than that which would maximise the profits of the industry. Vertical integration by the monopolists would lead to an increase in output, a reduction in price, an increase in industry profits, and an increase in consumer welfare (Perry, 1989).

As stated above this was a case of successive monopolies. So how does this relate to the situation we have in the New Zealand petrol industry, which is

characterised by successive oligopolists, not successive monopolies? The wholesalers have a national oligopoly in the importing, refining, and distribution of petroleum products, while the retailers have local oligopolies in the final sale of these goods to consumers. The answer is that the above analysis is exactly the same for successive oligopolists.

Greenhut and Ohta (1976, 1978, and 1979) show this in a series of papers. The mathematics required to prove this are quite complex, so I will not attempt to explain them here. I will simply report the results. Greenhut and Ohta (1979, p137) conclude that "vertical integration of successive oligopolists is mutually profitable, industry output increases, and product price is lowered'.

Although to difficult to show mathematically Davies (1987) explains it nicely with the use of graphs. The following analysis is based on his work (p.89-92) and is shown in figure 4.1 below. We consider a situation were we have two successive monopolists, firm A, the upstream monopolist, and firm B, the downstream monopolist.



The downstream monopolist faces the demand curve, D_B, and its corresponding marginal revenue curve, MR_B. This gives the upstream monopolist the derived demand curve D_A. This is simply firm B's marginal revenue curve less firm A's constant marginal cost, C_A. Firm A will produce at the point where their marginal cost equals their marginal revenue. This is shown as point P on the diagram.Figure 4.1: Vertical integration of successive monopolists.

The output corresponding to this point is X and price is P_A. The final product price is thus P_B (P_A plus C_B, firm B's constant marginal cost.

At this point the upstream monopolist earns profits equal to the area P_AQRC_A, while the downstream monopolist earns P_BTSP_B'. After integration the integrated monopolist faces the final demand curve D_B and incurs a constant marginal cost, C, equal to the marginal costs of the two separate firms ($C_A + C_B$). Once again equilibrium output is found where marginal cost equals marginal revenue, point U. Output has now risen to X' and equilibrium price has fallen to P_B'. The profit of this new monopolist is $CUVP_B$. This area is always greater than the sum of the two profit areas of the separate monopolists.

Once again Greenhut and Ohta have shown this case also holds for successive oligopolists.

An important qualification must be made here. In the above analysis the following critical assumption is used. The product of the upstream firm must be used in fixed proportions in the product of the downstream firm. This means that the downstream firm cannot substitute the product of the upstream firm for another product. The New Zealand petrol industry fulfils this condition as for every litre of petrol sold by a retailer it requires a litre of petrol from a wholesaler. This may be stating the obvious, however without this assumption the above conclusions do not necessarily hold.

Greenhut and Ohta (1979) also extend this analysis to include a Stackelberg type oligopoly as well as a Cournot oligopoly. In fact they show that the equilibrium market supply will be even higher in a Stackelberg oligopoly after vertical integration than it would under a Cournot oligopoly.

The underlying motive for many motives of vertical integration is the desire to reduce or eradicate uncertainty. By integrating vertically businesses can ensure there is a market for their output and/or a certain supply of inputs (Carlton 1979, Porter 1980). This is certainly the case with the New Zealand petrol industry

after deregulation. The wholesalers all vertically integrated downstream to guarantee a market for their products, and thus capture market share.

The question is then raised, can vertical integration be used as a barrier to entry. The answer is yes, but only if all of the incumbent firms are integrated. If all incumbent firms in the industry do not integrate then independent suppliers to and buyers from the industry can still exist. Deregulation saw all four incumbent wholesalers integrate into the retail sector. This made it very difficult for any new entrant wanting to enter either the wholesale or retail sector separately. A new firm could not enter the wholesale side, as it would have no one to sell its product to, while a new entrant into the retail side would be unable to source a supply.

Therefore by integrating downstream into the retail sector the incumbent wholesalers not only guaranteed themselves a certain market but also constructed another barrier to entry into the industry.

Bain (1956) argues that in situations such as what we have in the New Zealand petrol industry, where the incumbents have control over strategic assets, new entrants will be at a significant cost disadvantage. We can certainly view Challenge's inability to use the Marsden Point refinery as an example of this.

4.3 BARRIERS TO ENTRY

Like most industries with a degree of market power the New Zealand petrol industry has significant barriers to entry.

Firstly there is the strategic assets which the four incumbent firms have ownership and or control over. The largest of these assets is undoubtedly the Marsden Point Refinery north of Auckland, and the Wiri pipeline. The four incumbents use the Marsden Point Refinery to refine their product. This is why their products are identical. Without access to this facility new firms such as Challenge and Gull Petroleum are forced to import their product. Challenge imports its product from South East Asia while Gull imports from Australia.

Although this means that their products will be different from those produced at Marsden Point, New Zealand's strict controls over petrol ensure that this difference is negligible.

It would be far too expensive for a new entrant to build their own refinery, especially given the small market share they would initially capture. In fact the New Zealand government had to bail out the Marsden Point Refinery in the late 1980s.

The refining of petrol in New Zealand is likely to be a natural monopoly. A natural monopoly is one where the advantages of large scale production make it possible for a single firm to produce the entire output of the market at a lower average cost than a number of firms that each produce a smaller output.

This raises the question of whether the refinery is economically viable, and whether the incumbents would be better off importing their product from overseas, as the new entrants do.

The coastal shipping system and storage facilities that the four incumbents share, also represents a major barrier to entry. New entrants are forced to build new storage facilities and transport their product around the country on their own. Again this barrier is magnified by the small scale of new and potential entrants, and could result in new firms concentrating on the major centres.

This is true of the two current new entrants, Challenge and Gull, who both have their businesses concentrated in the large North Island cities (Gull has its sole outlet in Hamilton). This leads to an increase in competition in these centres, while South Island and rural towns could suffer as a result. There are already cries that the four incumbent firms are making up for lost profits in centres with new competition by increasing prices in unaffected areas. In fact South Island Members of Parliament have called on the Government to put pressure on the oil companies.[7] Since Challenge entered the market in April last year prices have

[7] see Wellwood (1999)

fallen 16% in the North Island and only 10% in the South Island. Prices in Nelson are approximately eight cents per litre higher than in Hamilton. That is a 10% difference that cannot be accounted for by the extra transport costs alone.

As discussed in the previous section, vertical integration by the incumbent firms has virtually ensured that any new entrants must enter both the wholesale and retail sectors. Therefore the incumbent firms network of retail outlets also presents a barrier to entry. This barrier is lessened by the fact that many of the retail outlets are independent and contracted to a wholesaler. Thus new entrants may be able to poach independents to their brand rather than have to build new retail facilities.

New Zealand's strict and often time-consuming resource consent procedures can make the building of new refining, storage and retail facilities even more difficult.

All the above barriers to entry have one thing in common. That is the barriers are greater the smaller the new entrant. Thus we have an economies of scale problem. The greater the output of a new competitor the less the per litre cost of refining, storage, and transport. The size of the New Zealand market however virtually ensures that a new entrant will be relatively small, at least initially.
The final barrier to entry, and one of the most important, is the responses of the incumbent firms to the threat and actuality of entry. Incumbent firms have two options. They can either fight new entrants aggressively, and thus try to minimise their impact, or they can accept the new entrants, and take a smaller share of the market. If potential new entrants believe the incumbents will take the former option then they will be less likely to enter the market.

Actions to deter new entrants by the four incumbent wholesalers in the ten years since deregulation took effect include the signing of independent retail outlets to long term supply contracts, and the acquisition by BP of the Top Group and Solo Energy retail chains. Both of these actions occurred very quickly after deregulation. The actions of the incumbents since then have been less 'threatening'.

4.4 MARKET CONCENTRATION

The New Zealand petrol industry is a highly concentrated one, and has been for a long time. At the time of deregulation BP/Europa had 32% of the market, Mobil 28%, Shell 24%, and Caltex 16%. These shares had been fairly stable for a number of years. The latest industry figures (before Challenge's entry) had both Shell and BP with 28% market share (although Shell was slightly ahead), Mobil 26% and Caltex 18%.

One of the most common measures of market concentration is the Herfindahl-Hirschman Index or HHI. The HHI is given by the formula:

$$HHI = \sum_{i=1}^{N} S_i$$

S_i is the market share of the ith firm. A maximum value of 1.0 is obtained when we have a monopoly, while perfect competition gives us a HHI of close to zero. The value decreases as the number of firms increases, and increases with increasing inequality amongst given firms.

Calculating the HHI for the New Zealand petrol industry at the time of deregulation gives us a value of 0.264, while the latest market share figures give a value of 0.257. As the number of firms was the same in both calculations, the fall in the HHI must be attributed to an increased equality in market shares of the firms. The 'range' of market shares falling from 16-32% in 1988 to 18-28% in 1998 shows this.

The emergence of new entrants will affect this index greatly. Although no figures are available, if the new firms can capture just 4% of the market (1% from each incumbent), the HHI will fall to 0.238. This fall is nearly three times greater than that from 1988 to 1998.

CHAPTER 5: MARKET CONDUCT AND PERFORMANCE

5.1 PRICING STRATEGIES

5.1.1 INTRODUCTION

Product pricing in an oligopolistic market presents economists with a specific set of problems. With either perfect competition or a monopoly situation there are definitive solutions to the questions of how much to produce and at what price to sell it (assuming firms wish to maximise their profits). A monopolist can set both the price and quantity sold in order to maximise their profits, while a firm operating under perfect competition, where the price it receives for its goods is given, chooses its optimal level of output.

An oligopolist however must recognise its interdependence with the other firms in the industry. The price and output decisions of a firm will impact on all other firms in the industry. When making a price or output decision a firm must try to factor in to its thinking the possible reactions of its competitors. This is the reason why oligopolistic industries are so difficult to analyse, the complex interactions between the firms. This naturally has led to a multitude of theories that attempt to explain these interactions. These theories fall under the broad heading of game theory.

5.1.2 THE PRISONERS' DILEMMA

I will start with one of the more simple examples, which illustrates nicely the problems facing oligopolistic firms. This is the well known 'prisoners' dilemma' game. The situation is as follows. There are two prisoners both charged with the same crime. They each have two choices, they can confess or they can plead innocent. Figure 5.1 below shows the possible outcomes of their decisions. The numbers in the boxes represent the number of months each prisoner will get in jail given the choices made them. The first number is the number of months prisoner A will get and the second number is prisoner B's sentence. For example

if they both confess they each get four months, while if prisoner A confesses and prisoner B does not then they will receive six and one months respectively. The prisoners are interrogated in separate rooms and neither knows what the other has said.

		Prisoner B	
Prisoner A		Confess	Don't confess
	Confess	4,4	0,6
	Don't confess	6,0	1,1

Figure 5.1: The Prisoners' Dilemma.

Looking at the pay-off matrix above the best 'total' outcome is for them both to plead innocent. This way they each get one month on a technicality (two months total). If only one confesses then they get a total of six months, while they will get eight months if they both confess. From an individual perspective however, each prisoner is 'better off' if they confess. If prisoner B confesses then prisoner A is better of to confess (four months versus six), while if prisoner B does not confess then prisoner A should still confess as they will get off free. Thus whatever decision prisoner B makes prisoner A is better off confessing. Confessing is prisoner A's dominant strategy. The same is of course is true for prisoner B. They also are better off confessing. Thus we have a Nash equilibrium of confess-confess, with each prisoner receiving a four month sentence. This is obviously not a Pareto efficient outcome.

A Nash equilibrium occurs when no firm can be better off choosing a different strategy given the strategies chosen by the other firms. That is no firm wants to change its strategy.

So how do we get to this solution when both prisoners are clearly better off if they both keep quiet? The key to the answer lies in the assumption that the prisoners do not know what the other is doing. If the two prisoners could

communicate to each other and agree to say nothing then they would both be better off. Even if such a deal was struck the incentive for each prisoner to 'break' it is strong. By breaking the deal the 'defector' will be better off, while the other will be worse off. Thus both prisoners will defect, and we find ourselves back at the Pareto inefficient Nash equilibrium. This arises because the deal cannot be enforced, and defectors cannot be punished.

So how does this relate to the New Zealand petrol industry? Well, if we change the prisoners to petrol companies and their decision to high price or low price we get the following analogy.

		Company B	
Company A		Low price	High price
	Low price	1,1	8,0
	High price	0,8	5,5

Figure 5.2: The Prisoners' Dilemma Adapted.

If both companies choose a high price strategy they each earn profits of 5, while profits of 1 will be earned if they both choose a low price. If one company sets a low price while the other sets a high price, then the low price company will make a profit of 8 and the high price company will not make a profit at all. Thus following the same logic as for the prisoners, the dominant strategy for each firm (regardless of the other firm's decision) is to set a low price. This gives us the Nash equilibrium of profits equal to 1 for both firms. Clearly both firms would be better off though if they were to set high prices (profits of 5), but this can only happen if both firms collude. This is discussed in section 5.2.

The above analysis although relating to two firms can be extended to include more firms simply by changing the 'players' to firm A and other firms.

Extending this from a single period game to a multi-period game changes the outcome dramatically. In a multi-period game (with an infinite or unknown timeline), firms will learn to co-operate by keeping the price high thus increasing their collective profits. Firms can defect from this high price strategy and thus increase their profit in the next period. Rival firms will however react to this and also decrease their price, thus punishing the defector. Multi-period games such as this can have many different and sometimes quite complex strategies.

Axelrod (1984) invited theorists to put forward strategies to a Prisoners' Dilemma game similar to that shown above. He then played each strategy off against each other. He found the best strategy to be a very simple one, tit-for-tat. That is the player simply does what their rival did in the previous period. Thus if the opponent cuts their price in one period the player punishes the defection by cutting their price in the next period. Likewise if the opponent increases their price the player rewards them by increasing their price the next period.

With a multi-period game firms must account for the possibility of a price war and long-term losses when deciding whether to lower their prices and make short-term gains.

5.1.3 PRICING IN THE NEW ZEALAND PETROL INDUSTRY

So what pricing strategies have firms in the New Zealand petrol industry adopted since they have been able to control the price.

Firstly price differences between areas have emerged. This is a result of the petrol companies allocating the transport costs. This difference has widened as a result of new competition.

Prices of the different companies within local regions have been virtually identical, with firms keeping close tabs on each other. Pricing has followed a leader-follower type model with price changes by one company matched generally within 24 hours by the other companies. Reasons given for price

changes are generally either tax changes, a change in the world price of oil, or a change in New Zealand's exchange rate.

No one firm is the dominant player within the industry. That is it is not any one firm that leads the price changes. In fact it is not necessarily even one of the four major wholesalers. Challenges entry to the market as a 'cut-price' company saw it set its price approximately five cents per litre lower than the prices of the four incumbent wholesalers. These companies immediately matched Challenges price in those centres where the new comer had emerged.

The arrival of Gull Petroleum in Hamilton saw price activity that was unprecedented in the last twenty years. Prices fell to the low seventy cents mark during a day that saw prices change half a dozen times. Rival firms had 'spies' keeping an eye on each other's prices making sure that they matched any changes.

Challenges entry to the market saw the largest fall in price since early 1986. Prices again fell significantly in Hamilton with Gull's entrance. This is in line with both the Cournot and Stackelberg models of oligopoly. That is the greater the number of firms the greater the competition, and thus the lower the equilibrium price.

The New Zealand petrol industry over the past ten years can be described as having followed a sequential game. The price of petrol has changed many times during this time, with one of the oil companies changing its price (price leader), only to be followed within days by the other companies (price followers). There is however a belief that the market has to some extent been a co-operative game, with the four major oil companies earning supernormal profits. The major price reduction since Challenge's arrival adds support to this claim.

5.2 TACIT COLLUSION

When we talk of collusion amongst firms many people envisage company bosses in dark suits, sitting round the lunch table, eating lobster, drinking champagne, and then cheerfully agreeing on an inflated price for their product. This is of course nonsense. There is however no need for firms to physically 'get together' and set the price (as is done by the OPEC nations when setting the price of oil). It is only necessary that firms recognise their interdependence for them to be able to maintain a price above its competitive level (Chamberlin, 1929). The basis of Chamberlin's paper was to show that a monopoly price can be prevalent even without formal collusion when sellers are few and products are homogeneous.

Scherer and Ross (1990, p.208) state that "firms in an industry with a small number of large rivals may well recognise the benefits from co-operative behaviour, and hence are more likely to believe that rivals will be motivated similarly."

At this point I would like to clarify the difference between overt and tacit collusion. The somewhat far-fetched example given at the beginning of this section is an example of overt collusion. Overt collusion requires some form of communication between the participants. There must be physical evidence that an arrangement has been made between the firms. Such cartel type arrangements are illegal under the Commerce Act 1986. The difficulty lies in proving that communication between firms has occurred. No one has been able to prove any overt collusion between the petrol companies, and thus no prosecution against these companies has been successful.

The Commerce Commission however does currently have a case in court against three of the major wholesalers over a free car wash promotion in Auckland. They also have successfully prosecuted twelve North Island meat companies for price fixing by having weekly meetings and telephone conferences.

Tacit collusion occurs when firms in an oligopoly co-ordinate their actions without an explicit cartel arrangement. Firms 'co-operate' by keeping their price

high or their output low with the understanding that other firms will do the same, thus increasing industry profits. Such collusion does not appear to be illegal under the Commerce Act 1986.

Chamberlin (p.48) states that "when there are two or few sellers ... no one will cut [their price], and although the sellers are entirely independent, the equilibrium result is the same as though there were a monopolist agreement between them."

Tirole (1988), shows three different approaches to develop models of dynamic price competition. In each approach a firm that undercuts its rivals will make short-term profits, and set off a price war. The motives for retaliating, however, differ in the three approaches.

In the first approach, that of the supergame, a firm will charge a lower price simply because it expects its rivals to do the same.

The second approach assumes that there are short-term price rigidities. That is it takes time, and costs money, for firms to change their prices. This creates the possibility that price cuts are simply used to regain market share that may have been lost by competitors aggressive pricing strategies in previous periods.

The third approach focuses on the 'reputation for friendly behaviour.' A firm will charge a lower price if its rivals cut their price, as it will take this as a signal that the rival firms are likely to charge low prices in the future.

Tirole also highlights factors that will facilitate or hinder collusion. Two such factors are detection lags, and asymmetries between firms.

Detection lags will hinder tacit collusion as a firm can only retaliate to a rival's price cut when they become aware of it. If prices are not easily observable, then the incentive to cheat such an arrangement is greater. The longer the period in which price changes go unobserved, the longer the period that the price cutting firm will make extra profits.

When firms have similar cost structures and identical products, the price at which they will collude would be they monopoly price. At this price industry profit is maximised. However, when there are asymmetries between firms, there is no such 'focal' price at which to collude. For example, if one firm has a lower cost structure than its rivals do, then it will want to collude at a lower price than its rivals.

Other factors such as the returns to scale, and interest rates will also effect the profitability of a price cut. Decreasing returns to scale and a lower interest rate will make price-cutting today less profitable. Likewise increasing returns to scale and a higher interest rate will make price-cutting more profitable.

5.3 NON-PRICE COMPETITION

Prior to deregulation firms in the New Zealand petrol industry were unable to compete on price. Thus they had to use other means in which to promote themselves to consumers as the 'number one' petrol company. This trend continued after deregulation. Firms still seemed reluctant to compete on price and risk a price war.

Early attempts centred on product differentiation. Firms promoted their own 'special additives' which if you were to believe the advertising made their petrol a superior product to that of their rivals. These additives had little effect on the petrol however, and this advertising strategy had limited success.

The next approach was that of diversification. Service, car washes, food, and other household products became the focus of the advertising strategies. This was necessary as consumers rightfully saw each petrol product to be the same as the next. Retail outlets today are a marked improvement from five years ago. They are generally modern in appearance, have large spacious forecourts, extensive and clean shopping areas, automatic car washes, and EFTPOS at the pump. All these factors attempt to make visiting the petrol station a more convenient and friendly experience.

This product differentiation was also necessary for retailers, as they saw the margin on petrol being squeezed, and thus needed to increase their revenue by other means. Food and household products sold in petrol stations are priced considerably higher than equivalent goods in supermarkets.

Firms are trying to establish a strong brand image through their service station layouts and advertising.

Firms also run very appealing prize promotions. Every year the petrol companies give away cars, boats, holidays, televisions, stereos, free petrol supplies for a year, cokes, cheeseburgers and so on. The list is almost endless. All this in an effort to entice the consumer to their outlets. There are also the Fly Buys and AA Rewards schemes of Shell and BP respectively, which were mentioned in chapter two.

Despite all this effort to capture market share, the most important factor for consumers other than price, is the location of the retail outlets. Consumers will generally go to the most convenient petrol station. This is especially so in smaller towns where there may only be a few companies present. Consumers will not travel large distances just to purchase their petrol from a certain company. Thus there is also strong competition between petrol companies for good service station sites.

5.4 MARKET PERFORMANCE

I will not be calculating industry profit margins myself as this has been done by the NZIER in their report to the Ministry of Commerce. The margin that they use is the difference between New Zealand's retail prices (less levies and taxes) and the notional import prices. They call this the importer margin. The values were expressed in real 1995 dollars. From 1984 to deregulation in 1988 they show no apparent trend in the importer margin. There was then a steady decrease in the importer margin following deregulation through to the start of the Gulf crisis at

the end of 1990. Since then there has been a regular upward movement in the importer margin of approximately 1.1 cents per litre per year. In late 1994 the importer margin rose above it's pre-deregulation average of 24.4 cents per litre.

Figure 5.3 below shows New Zealand's retail petrol prices for the last twenty years. These figures are nominal dollars per litre of premium grade petrol.

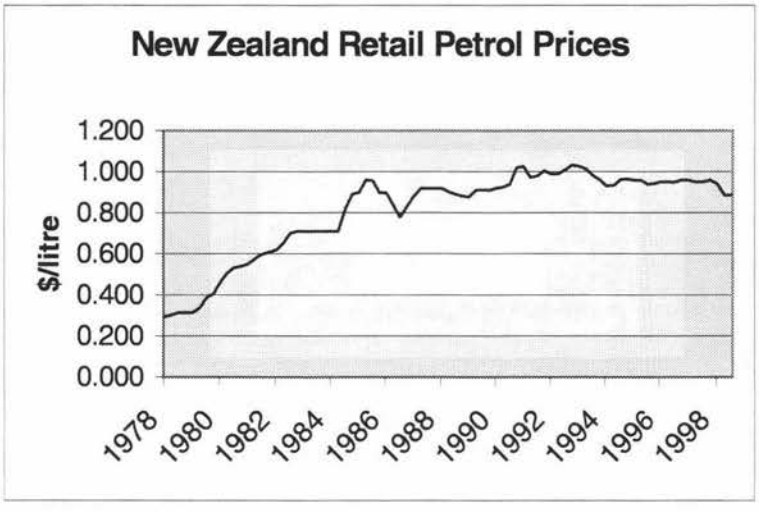


Figure 5.3: New Zealand's Retail Petrol Price.

They also compared New Zealand's the average yearly retail petrol prices (less taxes) to the other countries in the OECD. This was done from 1985 through to 1995. The higher (lower) the ranking the less (more) expensive the petrol price in New Zealand compared to the other OECD countries. Below is a graph of how New Zealand fared.

As can be seen deregulation did appear to have an initial positive effect on New Zealand's petrol prices. In the years leading to deregulation New Zealand's retail petrol prices were amongst the highest in the OECD. In 1985 we had the third highest price in the OECD. The years immediately following deregulation saw our ranking increase drastically. That is our petrol become relatively less expensive. Our ranking fell as low as 16th of the 24 countries in 1991 and 1992.

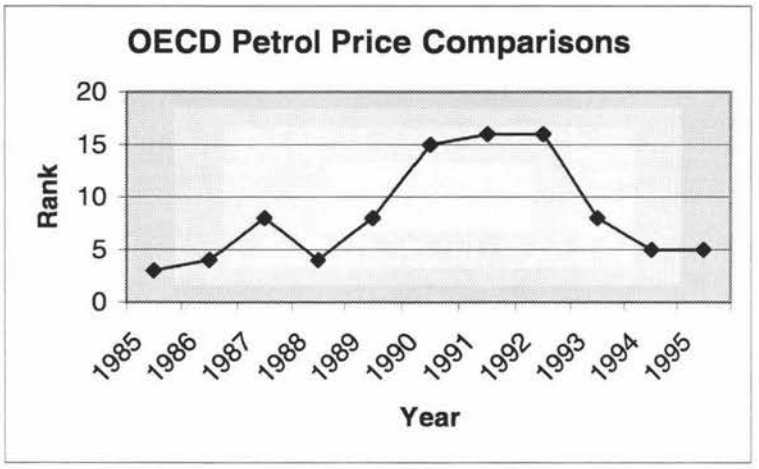


Figure 5.4: OECD Comparisons.

This is in line with the vertical integration theory. As shown early by Greenhut and Ohta (1979) and Davies (1987) vertical integration of successive oligopolists leads to a decrease in the final product price. Although looking back at figure 5.1 New Zealand's retail petrol price does not appear to fall after vertical integration, deregulation did see the end of the ever-increasing prices of the 1980's. Figure 5.2 however does show us that relative to petrol prices in the rest of the developed world, New Zealand's petrol price did fall. This also ties in with the Ministry of Energy's Market Analysis Unit (1989) finding that there was a reduction in the supply cost of petrol following deregulation.

One could also argue that these companies found themselves in 'foreign territory' in the newly deregulated industry. That is there was initial price competition, before the firms realised the associated risks of price competition, and thus reverted to some form of tacit collusion and non-price competition.

In 1993 our relative price again began to increase and in 1994 and 1995 we had the fifth highest petrol price in the OECD.

The IEA (1997) notes that New Zealand's importer margin had fallen immediately after deregulation, but had increased since 1990, especially so since 1994.

CHAPTER 6: ECONOMETRIC ANALYSIS

6.1 THE MODEL

The period of this study into petrol prices in New Zealand is from 1978 to 1998. This gives me an equal representation of ten years in a regulated industry and ten years in a deregulated one. I will be able to see what has happened to the industry profit margins during these twenty years. This will allow me to establish how effective deregulation has been in increasing competition and efficiency within the market, and its associated effects on consumer welfare.

So what factors affect the price of petrol in New Zealand. Obviously it is directly affected by the price of oil world-wide, the value of the New Zealand dollar against other currencies, and the taxes imposed on petrol. It may also be influenced by the state of the economy and demand for petrol.

The price that the oil companies charge is also likely to be affected by changes to their cost structures. Two major costs incurred by the petrol companies, and indeed by many companies, are capital and labour costs. Changes in these costs will affect company profit margins and thus the price of petrol.

Thus we have a function like the one below, where oil company profit margins is the independent variable and all others are explanatory variables.

PM = f (NZRP, NZIP, ER, TAX, GDP, IR, LC, DEREG)

where: PM = Profit margin;
NZRP = New Zealand retail price;
NZIP = New Zealand's import price;
ER = New Zealand – US exchange rate;
TAX = The excise tax on petrol;
GDP = A measure of NZ's GDP;

IR = A measure of NZ's interest rate;

LC = A measure of NZ's labour costs; and

DEREG = A dummy variable to account for deregulation.

The dummy variable DEREG is included to account for the two distinct periods within this data. It takes the value 0 for all periods before deregulation and 1 for all periods after deregulation.

6.2 THE DATA

All data is quarterly, and is from the first quarter of 1978 though to the second quarter of 1998.

The New Zealand retail prices (NZRP) are taken from the Statistics New Zealand series Hot Off The Press: New Zealand Retail Prices of Selected CPI Items (Catalogue No.18.503). Prices are for premium grade, 96-octane petrol, and are a nation-wide average. This average covered thirteen North Island and seven South Island cities up until April 1991, but since then it only covers ten North Island and five South Island cities.

The import prices (NZIP) are from Overseas Trade Statistics, a yearly Department of Statistics publication (1987-1998). They are from the external trade price and volume indexes, and are quoted CIF (cost, insurance and freight). Given New Zealand's relative geographical isolation from the rest of the world these transport costs are an important consideration.

The tax figures (TAX) have been taken from various editions of the New Zealand Yearbook, and are the motor spirit excise duties per litre of petrol. These figures can be found in section 28.2 (taxation) of the yearbooks from 1984 to 1998.

The gross domestic product figures (GDP) have been compiled using two Statistics New Zealand publications, Hot Off The Press: Gross Domestic Product (Catalogue No. 08.500), and New Zealand System of National Accounts. The figures are seasonally adjusted and are at constant 1991/92 prices.

The exchange rate (ER), interest rate (IR), and labour cost (LC) data are taken from the International Monetary Funds (IMF) publication International Financial Statistics. The IMF sources their data from Statistics New Zealand.

The exchange rate is the US dollar per NZ dollar period average market rate. This is the trading banks midpoint rate.

The interest rate is the per annum end of period discount rate. The discount rate is the rate at which the Reserve Bank lends money to market dealers and trading banks. It is therefore the basis for all interest rates in New Zealand.

The labour cost is an index of weekly wage rates with the base of 100 set in 1985. These are nominal weekly wage rates of adult employees, in all industries.

The table below shows the average values for each variable for the period of this study as well as the averages for the periods before and after deregulation. It also shows the standard deviation of each variable over the periods.

Variable	*Total*		*Pre-deregulation*		*Post-deregulation*	
	Avg.	S.D.	Avg.	S.D.	Avg.	S.D.
NZRP ($/lt)	0.81	0.21	0.67	0.21	0.96	0.041
NZIP (index)	1349	393	1406	510	1290	201
TAX (c/lt)	8.29	2.09	6.74	1.80	9.91	0.65
GDP ($mill.)	17810	2340	16085	1300	19622	1748
ER (US$/NZ$)	0.68	0.16	0.75	0.20	0.61	0.052
IR (% p.a.)	12.9	4.7	15.2	4.9	10.4	2.9
LC (index)	123	41.1	88	25.6	160	9.0

Table 6.1: Variable Averages.

New Zealand's average retail petrol price for the 20-year period was 81 cents per litre. The pre-deregulation period was characterised by a steadily increasing

petrol price, while the ten years following deregulation has seen a fairly constant price around the mid ninety cents per litre mark. For ease of reference, figure 5.3 is reprinted below.

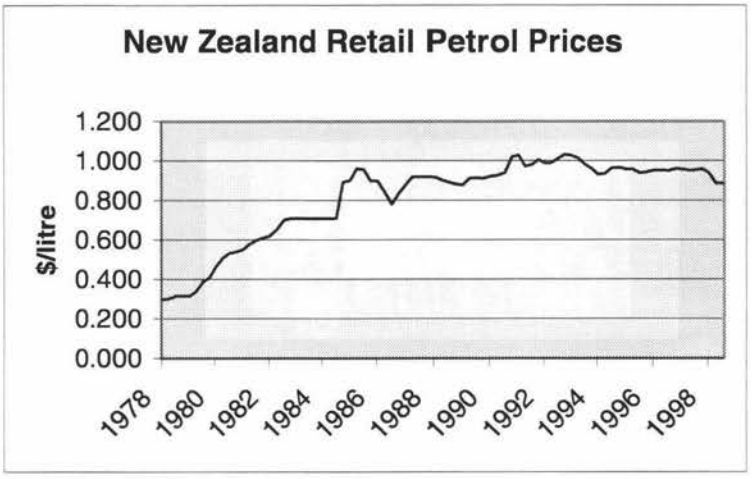


Figure 6.1: New Zealand Retail Petrol Prices.

The import price of petrol has been much more erratic, partly as a result of the oil crisis of 1979-1980, and the Gulf War in 1990. The average import price was actually higher pre-deregulation than post-deregulation.

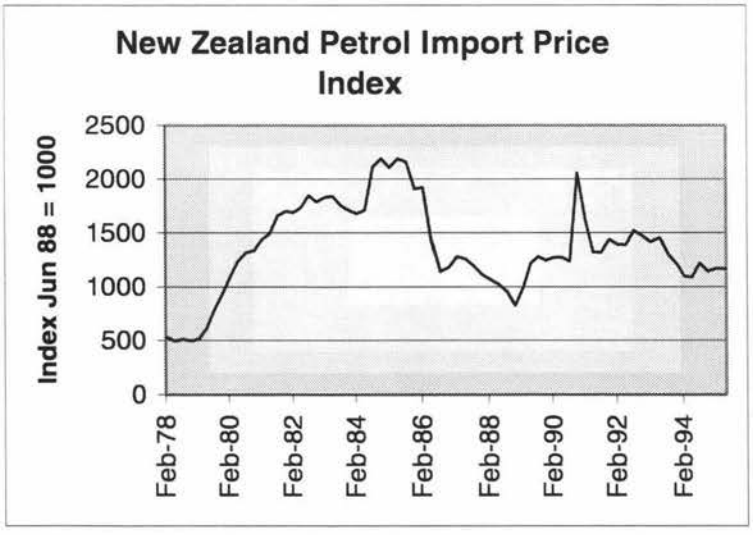


Figure 6.2: New Zealand Petrol Import Price Index.

Growth in New Zealand's gross domestic product was reasonably steady up until 1986. From 1986 to 1992 we experienced a very low level of economic growth.

Higher growth was experienced from 1992 until late 1997 when the Asian crisis hit. GDP fell in the first two quarters of 1998.

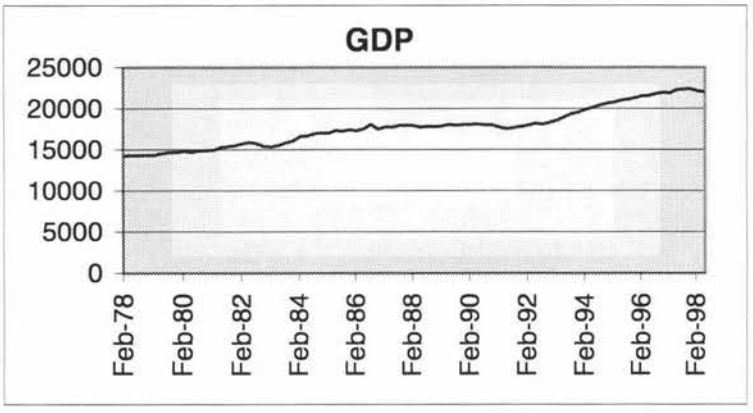


Figure 6.3: New Zealand's GDP.

The exchange rate between the New Zealand and US dollars fell rapidly from a high of 1.0616 US dollars per New Zealand dollar in the last quarter of 1978 to it's low of 0.4551 in mid 1985. Since deregulation the exchange rate has varied between 50 to 70 US cents to the New Zealand dollar.

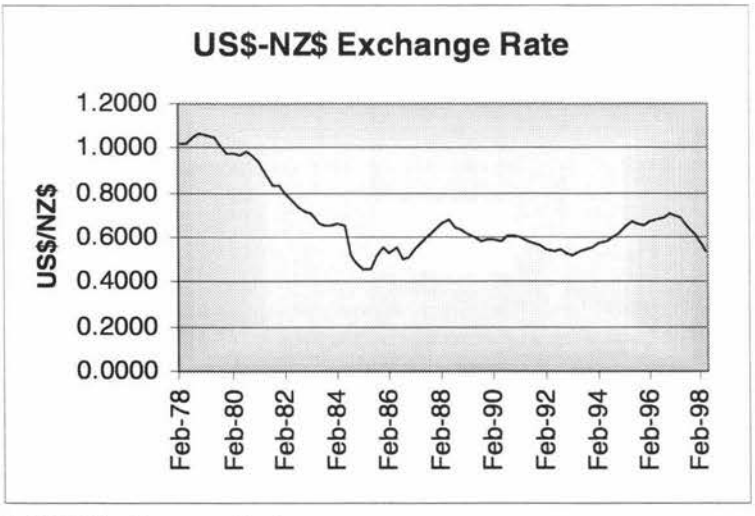


Figure 6.4: US-NZ Exchange Rate.

Interest rates averaged 12.9% for the twenty years in of the study. The ten years before deregulation saw very high interest rates averaging over 15% per annum,

and peaked at 28.2% in the first quarter of 1987. Interest rates for the later ten-year period averaged only 10.4% with rates less than 6% appearing late in 1993.

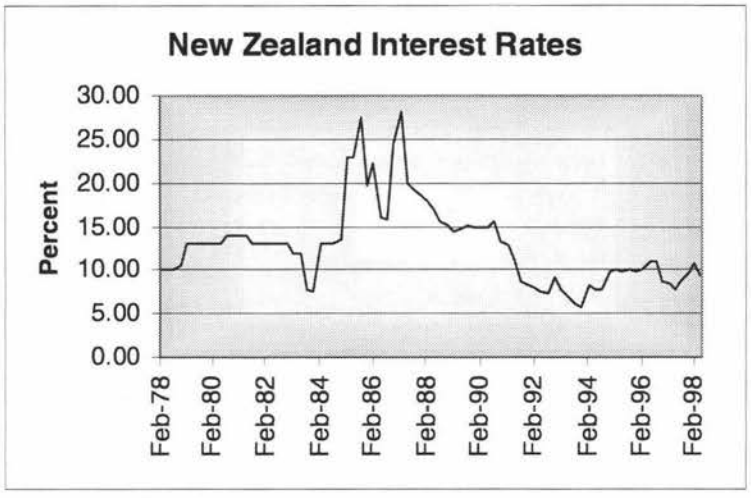


Figure 6.5: New Zealand's Interest Rates.

The cost of labour has increased throughout the period of this study, with the exception of the time of the wage and price freeze. This growth however has slowed during the 1990's.

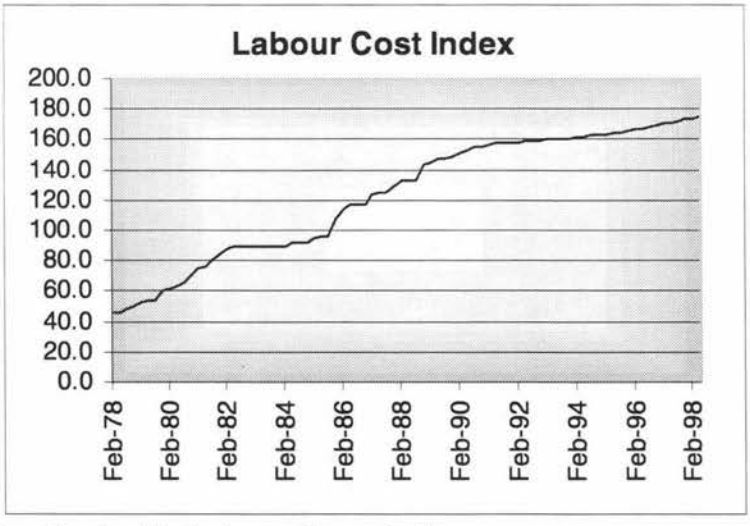


Figure 6.6: New Zealand's Labour Costs Index.

In summary the post-deregulation period was characterised by lower exchange and interest rates, and higher labour costs and retail petrol prices. The latter period was also far less volatile than the ten years before deregulation. Looking

at the standard deviations of the variables we can see that for all but GDP the standard deviation is substantially less post-deregulation than it is pre-deregulation.

6.3 MODEL ESTIMATION

The econometrics program I have used to estimate this model was Shazam version 8.0.

I have run an ordinary least squares (OLS) regression on this data. The New Zealand retail price is my dependent variable, while all other variables are independent.

The method of ordinary least squares is attributed to the German mathematician Carl Friedrich Gauss. I will first outline the assumptions of this method, and then explain the least-squares principle.

Assumption 1: That the mean of the error terms is zero.

$$E(u_i|X_i) = 0$$

Assumption 2: There is no autocorrelation or no serial correlation between the u's.

$$\begin{aligned} \text{cov}(u_i,u_j) &= E[u_i - E(u_i)][u_j - E(u_j)] \\ &= E(u_iu_j) \qquad \text{because of assumption 1} \\ &= 0 \qquad \text{for } i \neq j. \end{aligned}$$

Assumption 3: Absence of heteroskedasticity.

$$\begin{aligned} \text{var}(u_i|X_i) &= E[u_i - E(u_i)]^2 \\ &= E(u_i)^2 \qquad \text{because of assumption 1} \\ &= \sigma^2 \end{aligned}$$

Assumption 4: Zero covariance between u_i and X_i.

Assumption 5: The regression model has been specified correctly.

An additional assumption is required for a multi-variable model. That is that there must be no collinearity between the explanatory variables. This means that no explanatory variables can be expressed as linear combinations of the other explanatory variables.

For deregulation to have had its intended effects on the industry, the coefficient of DEREG should be negative and significant. If it is negative and significant then deregulation has indeed been successful in increasing competition in this industry. If it is positive and significant then deregulation has in fact lessened competition within the industry. If this is the case then there may be evidence to suggest that the vertical integration brought about by deregulation has had significant anti-competitive effects. This would have interesting implications given the current government's efforts to separate the generation of and the supply of power in the electricity industry.

I have also split the data into two groups, pre-deregulation and post-deregulation, and run an OLS regression on each of these. From this I can compare these two periods, and run tests for structural change. It is necessary to do this as the deregulation may have changed the relationship between these variables. The two tests I have run are the Chow test and the Goldfeld-Quandt test.

The Chow test gives us a test for structural change. It is used is test the hypothesis that the coefficients are the same in each of the sample groups. It is calculated using the sum of squared errors for the two sub-groups and the whole data set, and the number of observations in each set. This statistic is then compared to the critical value from an F distribution. The null hypothesis is that there is no structural change. We reject this null hypothesis if the test statistic is greater than the corresponding critical value.

The Goldfeld-Quandt statistic gives us a test for different error variance between two sub-groups of observations. The null hypothesis is $H_o:\sigma_1^2=\sigma_2^2$. That is the

variance of the two groups is the same. This statistic is also compared to a critical value from an F distribution.

6.4 RESULTS

6.4.1: 1978-1998

The results of my OLS regression are shown in the table below:

Variable	Estimated Coefficient	Standard Error	T-Ratio
NZIP	0.9222E-04	0.1127E-04	8.18
TAX	0.3675E-01	0.6913E-02	5.32
GDP	0.1359E-05	0.4199E-05	0.32
ER	-0.2031	0.5036E-01	-4.03
IR	0.1150E-02	0.1099E-02	1.05
LC	0.2938E-02	0.5044E-03	5.83
DEREG	-0.6287E-01	0.1985E-01	-3.17
CONSTANT	0.1502	0.9142E-01	1.64

Table 6.2: Determinants of New Zealand's Petrol Prices 1978-1998.

This gives us the following equation for New Zealand's retail petrol price:

$$NZRP = \underset{(1.64)}{0.1502} + \underset{(8.18)***}{0.92\text{E}{-}04}\,NZIP + \underset{(5.32)***}{0.37}\,E{-}01\,TAX + \underset{(0.32)}{0.14\text{E}{-}05}\,GDP - \underset{(-4.03)***}{0.20}\,ER$$

$$+ \underset{(1.05)}{0.11\text{E}{-}02}\,IR + \underset{(5.83)***}{0.29\text{E}{-}02}\,LC - \underset{(-3.17)***}{0.63\text{E}{-}01}\,DEREG$$

The numbers in brackets below each variable give their respective t-ratios. The number of 'stars' below this indicates the level of significance. Three stars indicate that the variable is significant at the 1% level, two stars at the 5% level, and one star at the 10% level.

The New Zealand import price, tax, gross domestic product, interest rate, and labour cost all enter the equation positively. That is an increase (decrease) in any one of these variables will result in an increase (decrease) in the retail price of petrol. This is intuitively what we would expect, as these four of these five variables are the major costs incurred by the petrol companies. Basic economic theory tells us that a rise in demand will lead to a rise in the price of the commodity in question, all other things held constant. Remembering that GDP is our proxy for demand in the New Zealand economy this is also the result we get here.

The exchange rate enters the equation negatively. That is an increase (decrease) in this variable will result in a decrease (increase) in the retail price of petrol. This result is as expected, as an increase in the exchange rate makes all imports relatively cheaper, including petrol.

The gross domestic product and interest rate variables are not significant at any level of significance.

The most interesting result, and the most important, is that for the dummy variable DEREG. The coefficient for DEREG is negative, indicating that deregulation has had positive effects on competition in the industry. The coefficient is significant even at the 99% level of significance.

This model has an adjusted R-square of 0.98. That is 98% of the variation in the dependent variable (New Zealand's retail price) is explained by the independent variables.

6.4.2: Pre-deregulation

Variable	Estimated Coefficient	Standard Error	T-Ratio
NZIP	0.1204E-03	0.1706E-04	7.06
TAX	0.3082E-01	0.9492E-02	3.25
GDP	0.3521E-04	0.1864E-04	1.89
ER	-0.4209E-01	0.9121E-01	-0.46
IR	0.1625E-02	0.1491E-02	1.09
LC	0.2549E-02	0.6102E-03	4.18
CONSTANT	-0.4873	0.3214	-1.52

Table 6.2: Determinants of New Zealand's Petrol Prices 1978-1988.

$$NZRP = \underset{(-1.52)}{-0.49} + \underset{(7.06)***}{0.12\text{E}{-}03}\,NZIP + \underset{(3.25)***}{0.31E{-}01}\,TAX + \underset{(1.89)*}{0.35\text{E}{-}04}\,GDP - \underset{(-0.46)}{0.42\text{E}{-}01}\,ER + \underset{(1.09)}{0.16\text{E}{-}02}\,IR + \underset{(4.18)***}{0.25\text{E}{-}02}\,LC$$

The results for the ten-year period before deregulation are very similar to the overall results. Again the import price, tax, gross domestic product, interest rate, and labour cost all enter the equation positively. The interest rate variable is again not significant, while the gross domestic product variable is significant only at the 90% level. The exchange rate coefficient is again negative, however it is no longer significant.

This model has an adjusted R-square of 0.98.

6.4.3: Post-deregulation

Variable	Estimated Coefficient	Standard Error	T-Ratio
NZIP	0.1034E-03	0.1945E-04	5.32
TAX	0.1517E-01	0.1009E-01	1.50
GDP	-0.5063E-05	0.8145E-05	-0.62
ER	0.6737E-01	0.9253E-01	0.73
IR	-0.7356E-02	0.1492E-02	-4.93
LC	0.3832E-03	0.1238E-02	0.31
CONSTANT	0.7469	0.1305	5.72

Table 6.2: Determinants of New Zealand's Petrol Prices 1988-1998.

$$NZRP = \underset{(5.72)^{***}}{0.75} + \underset{(5.31)^{***}}{0.10\text{E}{-}03}\,NZIP + \underset{(1.50)}{0.15E{-}01}\,TAX - \underset{(-0.62)}{0.51\text{E}{-}05}\,GDP + \underset{(0.73)}{0.67E{-}01}\,ER - \underset{(-4.93)^{***}}{0.74\text{E}{-}02}\,IR + \underset{(0.31)}{0.38\text{E}{-}03}\,LC$$

The results for the ten-year period after deregulation are also very similar to the overall results. This of course is to be expected as each sub-group has approximately half the observations of the total period being studied.

The import price once again enters the equation positively and is significant to the 1-% level. The major difference is in the GDP coefficient, which has gone from being positive and significant, to negative but insignificant. That is for the ten-year period prior to deregulation GDP did not have its theoretical affect on the price of petrol. The exchange rate coefficient is positive but insignificant. The interest rate enters the equation negatively and is significant at the 1-% level. This could be explained by the relatively low interest rates in this period as opposed to the years before deregulation. The labour cost coefficient is also positive and insignificant. Tax is again positive but insignificant.

This model has the lowest adjusted R-square of 0.81.

6.4.4: Structural tests

The pre-deregulation and post-deregulation periods have 42 and 40 observations respectively. The Chow test returns a value of 6.5647. Given the F distribution with degrees of freedom 1 = 6 (the number of parameters) and degrees of freedom 2 = 70 (the total number of observations less two times the number of parameters), our corresponding p-value is 0.000. Thus we absolutely reject the null hypothesis of no structural change.

The Goldfeld-Quandt test returns a value of 226.3. The degrees of freedom for the Goldfeld-Quandt test are the number of observations each subgroup less the number of parameters. Given the F distribution with degrees of freedom 1 = 36 and degrees of freedom 2 = 34, our corresponding p-value is 0.000. Thus we also reject the null hypothesis that the variance of the first group is equal to the variance of the second group.

Thus we can conclude that there has been significant structural change in the New Zealand petrol industry as a result of deregulation. We therefore must be careful when comparing and drawing conclusions on the two periods in question.

6.4.5: Summary

Before deregulation the government set the price of petrol. After deregulation petrol companies were able to set it themselves. Thus a comparison can be made as to what variables affected the price of petrol under government pricing, versus what variables affected the price of petrol under petrol company pricing.

Variables that were significant when the government set the price were the import price, the tax on petrol, and the labour cost. When the price was set by the petrol companies, the tax and labour costs were no longer significant. The interest rate was significant and negative. The exchange rate was not significant in either period. This can be explained by the fact that the import price was already quoted in New Zealand dollars, thus the exchange rate is built in here.

CHAPTER 7: CONCLUSIONS

The deregulation of the New Zealand petrol industry in 1988 undoubtedly had dramatic effects on the industry. The structure of the industry changed drastically. The biggest changes were the acquisition of retail outlets by the wholesalers, and the move to allocate transport costs into the price of petrol. Thus the retail and wholesale sectors, which prior to deregulation were very much separate, became one. Substantial differences in the price of petrol between the major cities and smaller rural towns arose.

The aim of the legislation was to increase the competitiveness of the industry. Whether or not this has occurred is a matter of debate. There is some evidence to suggest that, at least initially, deregulation did have positive effects on the price competition of the industry. This evidence is by no means conclusive, and declines over time. Non-price competition has become the major tool used by the petrol companies to try to increase market share.

There is also evidence to suggest that the petrol companies have been making supernormal profits. Price competition has been much weaker than it could have been, and thus the consistent cries of collusion. If there has been any collusion, then it has only been tacit collusion. That is the firms have recognised their interdependence, and realised that a price would be self-defeating. We cannot blame the petrol companies for this, as after all, like most businesses, their primary goal is to make a profit for their shareholders. This behaviour is not illegal under New Zealand's competition laws.

Although deregulation took place over ten years ago, perhaps the most important changes have happened in the last twelve months. I am of course referring to the emergence of Challenge and Gull Petroleum to the industry. Unprecedented price competition has seen petrol prices fall to there lowest level since late 1989. This is without question a result of the new competition.

This raises the question, what would petrol prices be today if those new firms had not emerged. Using the petrol determinant equation for the post-deregulation period, given in chapter six, and inputting the latest values for the given variables, a value of 92.7 cents per litre is obtained. This means that petrol is approximately four cents per litre cheaper because of the increased competition caused by the new firms. This represents savings to consumers in excess of $100 million a year.

This brings me to my final comment, that of possible future research. It would be very interesting to rerun the regressions of chapter six in a couple of year's time, with a new dummy variable to account for the arrival of Challenge to the market. This was not possible in this thesis, as only two quarters of data were available in which Challenge was part of the industry. I would expect the arrival of new entrants to have a greater positive effect on price competition than that generated by deregulation.

APPENDIX A: DATA FOR ECONOMETRIC ANALYSIS

	NZRP	NZIP	GDP	TAX	ER	IR	LC
Feb-78	0.296	531	14286	4.25	1.0226	10.00	45.6
May-78	0.303	495	14314	4.25	1.0166	10.00	46.3
Aug-78	0.316	514	14297	4.25	1.0503	10.00	49.3
Nov-78	0.316	499	14341	4.25	1.0616	10.50	50.0
Feb-79	0.316	514	14330	4.25	1.0561	13.00	52.6
May-79	0.339	614	14560	4.25	1.0434	13.00	53.9
Aug-79	0.389	784	14658	4.25	1.0131	13.00	54.3
Nov-79	0.407	925	14714	4.25	0.9789	13.00	59.9
Feb-80	0.463	1088	14798	4.25	0.9746	13.00	61.9
May-80	0.507	1238	14745	6	0.9681	13.00	62.6
Aug-80	0.533	1318	14854	6	0.9826	14.00	65.2
Nov-80	0.540	1335	14928	6	0.9678	14.00	71.7
Feb-81	0.553	1439	14971	6	0.9396	14.00	74.4
May-81	0.580	1493	15300	6	0.8818	14.00	75.7
Aug-81	0.600	1661	15414	6	0.8298	13.00	79.9
Nov-81	0.610	1700	15529	6	0.8286	13.00	84.8
Feb-82	0.620	1690	15757	6	0.7953	13.00	87.6
May-82	0.653	1739	15900	6	0.7623	13.00	88.9
Aug-82	0.700	1849	15729	6	0.7327	13.00	88.9
Nov-82	0.710	1788	15400	6.4	0.7172	13.00	88.9
Feb-83	0.710	1829	15343	6.4	0.7055	12.00	88.9
May-83	0.710	1843	15543	6.4	0.6586	12.00	88.9
Aug-83	0.710	1755	15871	6.4	0.6532	7.80	88.9
Nov-83	0.710	1712	16071	6.4	0.6581	7.50	88.9
Feb-84	0.710	1680	16614	6.4	0.6583	13.00	88.9
May-84	0.710	1712	16686	6.4	0.6509	13.00	91.6
Aug-84	0.710	2111	16943	6.4	0.5169	13.00	91.6
Nov-84	0.892	2188	17043	8.9	0.4878	13.50	91.6
Feb-85	0.900	2105	17029	8.9	0.4593	23.00	94.4
May-85	0.960	2188	17358	8.9	0.4551	23.00	96.4
Aug-85	0.957	2159	17271	8.9	0.5209	27.50	95.8
Nov-85	0.900	1909	17408	8.9	0.5582	19.80	107.7
Feb-86	0.898	1921	17317	8.9	0.5253	22.20	114.9
May-86	0.842	1423	17521	8.9	0.5555	16.00	116.6
Aug-86	0.780	1141	18071	8.9	0.5053	15.70	116.7
Nov-86	0.836	1182	17511	8.9	0.5096	24.60	117.3
Feb-87	0.881	1281	17760	8.9	0.5478	28.20	124.3
May-87	0.920	1259	17739	8.9	0.5804	20.00	124.8
Aug-87	0.920	1199	17978	8.9	0.6054	19.20	125.0
Nov-87	0.920	1122	17954	8.9	0.6352	18.55	128.6
Feb-88	0.919	1071	17982	8.9	0.6621	17.80	132.5
May-88	0.903	1026	17713	8.9	0.6834	16.95	133.0
Aug-88	0.893	956	17828	9.9	0.6449	15.65	133.2
Nov-88	0.882	823	17810	9.9	0.6335	15.10	143.6
Feb-89	0.877	991	17893	9.9	0.6193	14.50	145.1
May-89	0.912	1218	18097	9.9	0.5984	14.60	147.0
Aug-89	0.913	1282	17976	9.9	0.5862	15.15	148.0
Nov-89	0.912	1245	18093	9.9	0.5900	15.00	149.0
Feb-90	0.921	1271	18097	9.9	0.5934	14.80	151.2
May-90	0.926	1276	18129	9.9	0.5785	15.00	153.2
Aug-90	0.940	1238	18055	10.9	0.6088	15.55	154.7

	NZRP	NZIP	GDP	TAX	ER	IR	LC
Nov-90	1.020	2059	17998	10.9	0.6071	13.25	155.6
Feb-91	1.028	1624	17739	10.9	0.5974	12.75	156.8
May-91	0.974	1324	17531	10.9	0.5846	11.00	157.8
Aug-91	0.980	1320	17707	10.9	0.5739	8.60	157.9
Nov-91	1.006	1441	17818	10.9	0.5607	8.30	158.0
Feb-92	0.990	1394	17952	10.9	0.5437	8.00	158.4
May-92	0.990	1391	18184	10.9	0.5401	7.50	158.7
Aug-92	1.011	1520	18069	10.9	0.5427	7.40	159.3
Nov-92	1.034	1475	18304	10.9	0.5259	9.15	159.6
Feb-93	1.028	1417	18579	10.9	0.5196	7.90	160.0
May-93	1.016	1456	18980	9.4	0.5407	6.95	160.5
Aug-93	0.984	1299	19354	9.4	0.5507	6.20	160.8
Nov-93	0.964	1217	19553	9.4	0.5519	5.70	161.1
Feb-94	0.933	1100	19861	9.4	0.5697	8.30	161.6
May-94	0.935	1087	20139	9.4	0.5815	7.75	161.9
Aug-94	0.964	1220	20395	9.4	0.6016	7.90	162.7
Nov-94	0.966	1144	20626	9.4	0.6219	9.75	163.0
Feb-95	0.959	1171	20778	9.4	0.6406	10.00	163.7
May-95	0.959	1167	21003	9.4	0.6684	9.90	164.1
Aug-95	0.940	1203	21121	9.4	0.6625	10.15	165.1
Nov-95	0.942	1267	21251	9.4	0.6542	9.80	166.1
Feb-96	0.952	1279	21516	9.4	0.6721	10.05	166.9
May-96	0.952	1246	21591	9.4	0.6815	11.00	167.3
Aug-96	0.951	1276	21802	9.4	0.6914	10.90	168.3
Nov-96	0.961	1400	21948	9.4	0.7055	8.80	169.4
Feb-97	0.959	1476	21902	9.4	0.6971	8.50	170.5
May-97	0.952	1288	22262	9.4	0.6905	7.70	171.5
Aug-97	0.952	1316	22347	9.4	0.6469	8.75	172.3
Nov-97	0.961	1448	22411	9.4	0.6176	9.70	173.1
Feb-98	0.941	1145	22178	9.4	0.5780	10.75	173.7
May-98	0.888	1119	21996	9.4	0.5340	9.40	174.4

The definitions of the above variables are given in section two of chapter six.

APPENDIX B: ECONOMETRIC OUTPUT

LEAST SQUARES REGRESSION

1978-1998

```
|_SAMPLE 1 82
|_READ YEAR NZRP NZIP TAX GDP ER IR LC DEREG
    9 VARIABLES AND       82 OBSERVATIONS STARTING AT OBS       1

 |_STAT NZRP NZIP TAX GDP ER IR LC DEREG
 NAME       N     MEAN       ST. DEV      VARIANCE     MINIMUM    MAXIMUM
 NZRP      82   0.81130      0.21043     0.44281E-01   0.29600     1.0340
 NZIP      82    1349.0       393.34     0.15471E+06    495.00     2188.0
 TAX       82    8.2860       2.0936      4.3832        4.2500     10.900
 GDP       82    17810.       2342.3     0.54864E+07    14286.     22411.
 ER        82   0.67833      0.16406     0.26916E-01   0.45510     1.0616
 IR        82    12.853       4.6824      21.925        5.7000     28.200
 LC        82    123.11       41.137      1692.3        45.600     174.40
 DEREG     82   0.48780      0.50293     0.25294       0.00000     1.0000

|_OLS NZRP NZIP TAX GDP ER IR LC DEREG / RSTAT PCOV

 REQUIRED MEMORY IS PAR=     14 CURRENT PAR=    500
  OLS ESTIMATION
       82 OBSERVATIONS      DEPENDENT VARIABLE = NZRP
 ...NOTE..SAMPLE RANGE SET TO:       1,      82

  R-SQUARE =    0.9831      R-SQUARE ADJUSTED =    0.9815
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.81702E-03
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.28583E-01
 SUM OF SQUARED ERRORS-SSE=  0.60459E-01
 MEAN OF DEPENDENT VARIABLE =  0.81130
 LOG OF THE LIKELIHOOD FUNCTION =  179.360

VARIABLE  ESTIMATED  STANDARD T-RATIO    PARTIAL   STANDARDIZED ELASTICITY
  NAME   COEFFICIENT  ERROR     74 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
NZIP     0.92217E-04 0.1127E-04  8.180   0.000 0.689    0.1724     0.1533
TAX      0.36746E-01 0.6913E-02  5.316   0.000 0.526    0.3656     0.3753
GDP      0.13587E-05 0.4199E-05 0.3236   0.747 0.038    0.0151     0.0298
ER      -0.20312     0.5036E-01 -4.034   0.000-0.425   -0.1584    -0.1698
IR       0.11496E-02 0.1099E-02  1.046   0.299 0.121    0.0256     0.0182
LC       0.29378E-02 0.5044E-03  5.825   0.000 0.561    0.5743     0.4458
DEREG   -0.62865E-01 0.1985E-01 -3.167   0.002-0.345   -0.1502    -0.0378
CONSTANT 0.15023     0.9142E-01  1.643   0.105 0.188    0.0000     0.1852

VARIANCE-COVARIANCE MATRIX OF COEFFICIENTS
NZIP      0.12708E-09
TAX      -0.57658E-08  0.47787E-04
GDP      -0.48456E-11  0.16549E-07  0.17629E-10
ER        0.28540E-06  0.15729E-03  0.81410E-08  0.25359E-02
IR        0.23915E-08 -0.41669E-05 -0.12487E-08 -0.90456E-06  0.12071E-05

LC        0.10302E-08 -0.22958E-05 -0.17700E-08  0.32984E-05  0.17593E-06
          0.25440E-06
```

```
DEREG      0.27782E-07 -0.42278E-04  0.77162E-08 -0.37577E-03  0.10795E-04
          -0.34126E-05  0.39414E-03
CONSTANT -0.40206E-06 -0.43280E-03 -0.21988E-06 -0.37646E-02  0.11715E-04
           0.15006E-04  0.51941E-03  0.83571E-02
              NZIP          TAX           GDP           ER            IR
              LC            DEREG         CONSTANT

 DURBIN-WATSON = 0.6308    VON NEUMANN RATIO = 0.6386    RHO =  0.71242
 RESIDUAL SUM =  0.61895E-14  RESIDUAL VARIANCE =  0.81702E-03
 SUM OF ABSOLUTE ERRORS=   1.6609
 R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9831
 RUNS TEST:   25 RUNS,   40 POS,    0 ZERO,   42 NEG  NORMAL STATISTIC
= -3.7749
```

1978-1988

```
|_SAMPLE 1 42
|_STAT NZRP NZIP TAX GDP ER IR LC
NAME         N    MEAN      ST. DEV      VARIANCE     MINIMUM      MAXIMUM
NZRP        42  0.67283     0.21366     0.45652E-01  0.29600      0.96000
NZIP        42   1405.5      510.31     0.26041E+06   495.00       2188.0
TAX         42   6.7369      1.7956      3.2240       4.2500       8.9000
GDP         42   16085.      1296.1     0.16798E+07   14286.       18071.
ER          42  0.74800     0.20091     0.40366E-01  0.45510      1.0616
IR          42   15.162      4.8900      23.912       7.5000       28.200
LC          42   87.850      25.599      655.29       45.600       133.00

|_OLS NZRP NZIP TAX GDP ER IR LC / RSTAT PCOV

REQUIRED MEMORY IS PAR=    10 CURRENT PAR=   500
 OLS ESTIMATION
      42 OBSERVATIONS     DEPENDENT VARIABLE = NZRP
...NOTE..SAMPLE RANGE SET TO:      1,     42

 R-SQUARE =   0.9844     R-SQUARE ADJUSTED =   0.9817
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.83591E-03
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.28912E-01
SUM OF SQUARED ERRORS-SSE=  0.29257E-01
MEAN OF DEPENDENT VARIABLE =  0.67283
LOG OF THE LIKELIHOOD FUNCTION =  93.0602

VARIABLE  ESTIMATED   STANDARD  T-RATIO   PARTIAL  STANDARDIZED ELASTICITY
  NAME   COEFFICIENT   ERROR    35 DF P-VALUE CORR.  COEFFICIENT  AT MEANS
NZIP    0.12037E-03 0.1706E-04  7.055   0.000 0.766     0.2875      0.2514
TAX     0.30818E-01 0.9492E-02  3.247   0.003 0.481     0.2590      0.3086
GDP     0.35209E-04 0.1864E-04  1.889   0.067 0.304     0.2136      0.8417
ER     -0.42092E-01 0.9121E-01 -0.4615  0.647-0.078    -0.0396     -0.0468
IR      0.16254E-02 0.1491E-02  1.090   0.283 0.181     0.0372      0.0366
LC      0.25485E-02 0.6102E-03  4.177   0.000 0.577     0.3053      0.3328
CONSTANT -0.48734     0.3214   -1.516   0.138-0.248     0.0000     -0.7243

VARIANCE-COVARIANCE MATRIX OF COEFFICIENTS
NZIP      0.29108E-09
TAX      -0.22624E-07  0.90104E-04
GDP       0.17354E-09 -0.47408E-07  0.34751E-09
ER        0.12159E-05  0.10307E-03  0.11426E-05  0.83196E-02
```

```
IR          0.10588E-08 -0.69940E-05 -0.39377E-08 -0.16636E-04  0.22226E-05
LC         -0.14459E-08 -0.18118E-05 -0.71170E-08 -0.15011E-04  0.25525E-06
           0.37229E-06
CONSTANT   -0.38466E-05  0.37543E-03 -0.56839E-05 -0.25433E-01  0.65286E-04
           0.10337E-03  0.10327
             NZIP          TAX          GDP          ER           IR
             LC            CONSTANT

DURBIN-WATSON = 0.7388    VON NEUMANN RATIO = 0.7568    RHO =  0.63480
RESIDUAL SUM =  0.77716E-15  RESIDUAL VARIANCE =  0.83591E-03
SUM OF ABSOLUTE ERRORS=  0.89498
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9844
RUNS TEST:   10 RUNS,   24 POS,    0 ZERO,   18 NEG  NORMAL STATISTIC = -
3.6926
```

1988-1998

```
|_SAMPLE 43 82
|_STAT NZRP NZIP TAX GDP ER IR LC
NAME         N    MEAN        ST. DEV      VARIANCE      MINIMUM       MAXIMUM
NZRP        40  0.95670     0.40542E-01  0.16437E-02  0.87700        1.0340
NZIP        40   1289.7      201.30        40522.       823.00        2059.0
TAX         40   9.9125     0.64537       0.41651       9.4000        10.900
GDP         40   19622.      1748.1       0.30558E+07   17531.        22411.
ER          40  0.60518     0.52452E-01  0.27512E-02  0.51960       0.70550
IR          40   10.429      2.9377        8.6300       5.7000        15.650
LC          40   160.13      9.0284        81.512       133.20        174.40

|_OLS NZRP NZIP TAX GDP ER IR LC / RSTAT PCOV

REQUIRED MEMORY IS PAR=    10 CURRENT PAR=   500
 OLS ESTIMATION
     40 OBSERVATIONS     DEPENDENT VARIABLE = NZRP
...NOTE..SAMPLE RANGE SET TO:     43,     82

 R-SQUARE =   0.8372     R-SQUARE ADJUSTED =   0.8076
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.31617E-03
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.17781E-01
SUM OF SQUARED ERRORS-SSE=  0.10434E-01
MEAN OF DEPENDENT VARIABLE =  0.95670
LOG OF THE LIKELIHOOD FUNCTION =  108.275

VARIABLE  ESTIMATED  STANDARD   T-RATIO   PARTIAL STANDARDIZED ELASTICITY
  NAME   COEFFICIENT  ERROR      33 DF  P-VALUE CORR. COEFFICIENT AT MEANS
NZIP     0.10341E-03 0.1945E-04  5.316     0.000 0.679    0.5134    0.1394
TAX      0.15171E-01 0.1009E-01  1.504     0.142 0.253    0.2415    0.1572
GDP     -0.50634E-05 0.8145E-05 -0.6216    0.538-0.108   -0.2183   -0.1039
ER       0.67372E-01 0.9253E-01  0.7281    0.472 0.126    0.0872    0.0426
IR      -0.73556E-02 0.1492E-02  -4.931    0.000-0.651   -0.5330   -0.0802
LC       0.38315E-03 0.1238E-02  0.3094    0.759 0.054    0.0853    0.0641
CONSTANT 0.74689     0.1305      5.722     0.000 0.706    0.0000    0.7807

VARIANCE-COVARIANCE MATRIX OF COEFFICIENTS
NZIP       0.37835E-09
TAX       -0.40977E-07  0.10172E-03
GDP        0.42503E-10  0.59700E-07  0.66346E-10
ER        -0.45661E-06 -0.22206E-03 -0.47802E-06  0.85617E-02
```

```
IR        -0.84589E-09 -0.26433E-05 -0.22759E-08 -0.31385E-04  0.22254E-05
LC        -0.95084E-08 -0.68446E-05 -0.91333E-08  0.55681E-04  0.81277E-06
           0.15338E-05
CONSTANT   0.89195E-06 -0.86892E-03 -0.17291E-06 -0.16002E-02 -0.62412E-04
          -0.28449E-04  0.17038E-01
              NZIP          TAX          GDP          ER           IR
              LC           CONSTANT

DURBIN-WATSON = 1.3497    VON NEUMANN RATIO = 1.3843    RHO =  0.29086
RESIDUAL SUM =  0.19290E-14  RESIDUAL VARIANCE =  0.31617E-03
SUM OF ABSOLUTE ERRORS=  0.52231
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.8372
RUNS TEST:   14 RUNS,   17 POS,    0 ZERO,   23 NEG  NORMAL STATISTIC = -
2.1480
```

STRUCTURAL TESTS

```
|_SAMPLE 1 82
|_READ YEAR NZRP NZIP TAX GDP ER IR LC DEREG
    9 VARIABLES AND       82 OBSERVATIONS STARTING AT OBS       1


|_OLS NZRP NZIP TAX GDP ER IR LC

 REQUIRED MEMORY IS PAR=    13 CURRENT PAR=   500
  OLS ESTIMATION
       82 OBSERVATIONS     DEPENDENT VARIABLE = NZRP
 ...NOTE..SAMPLE RANGE SET TO:      1,     82

  R-SQUARE =   0.9809     R-SQUARE ADJUSTED =   0.9793
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.91535E-03
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.30255E-01
 SUM OF SQUARED ERRORS-SSE=  0.68651E-01
 MEAN OF DEPENDENT VARIABLE =  0.81130
 LOG OF THE LIKELIHOOD FUNCTION =  174.150


VARIABLE  ESTIMATED  STANDARD  T-RATIO     PARTIAL STANDARDIZED ELASTICITY
  NAME   COEFFICIENT  ERROR    75 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
NZIP     0.96649E-04 0.1184E-04   8.163   0.000 0.686    0.1807    0.1607
TAX      0.30003E-01 0.6961E-02   4.310   0.000 0.446    0.2985    0.3064
GDP      0.25894E-05 0.4425E-05  0.5852   0.560 0.067    0.0288    0.0568
ER      -0.26306     0.4939E-01  -5.326   0.000-0.524   -0.2051   -0.2199
IR       0.28714E-02 0.1011E-02   2.841   0.006 0.312    0.0639    0.0455
LC       0.23935E-02 0.5019E-03   4.769   0.000 0.482    0.4679    0.3632
CONSTANT 0.23308     0.9271E-01   2.514   0.014 0.279    0.0000    0.2873
|_DIAGNOS / CHOWONE=42

 REQUIRED MEMORY IS PAR=    17 CURRENT PAR=   500
 DEPENDENT VARIABLE = NZRP            82 OBSERVATIONS
 REGRESSION COEFFICIENTS
   0.966486816561E-04  0.300027749215E-01  0.258939284389E-05 -
0.263059013582
   0.287135885315E-02  0.239353609166E-02  0.233077618392
```

```
SEQUENTIAL CHOW AND GOLDFELD-QUANDT TESTS
  N1   N2     SSE1          SSE2          CHOW    PVALUE    G-Q     DF1   DF2 PVALUE
  42   40 0.29257E-01 0.11710E-01  6.5647    0.000  226.3     35    33  0.000

            CHOW TEST - F DISTRIBUTION WITH DF1=    7 AND DF2=   68

..INPUT FILE COMPLETED..TYPE A NEW COMMAND OR TYPE: STOP
TYPE COMMAND
```

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