A Policy Making Framework for the New Zealand Wine Industry

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Abstract

This paper discusses a dynamic simulation model of the New Zealand wine industry which is being developed at Victoria University to examine the impact of environmental and policy changes on the short and long term behaviour of the industry. It is a highly aggregated model which includes sectors for: planting and harvesting of grapes; production, exports and imports of wine; stock movements and financial flows. The model provides a policy making framework for the analysis of changes in grape yields, climatic conditions, excise duty on domestic consumption, minimum grower returns, exchange rate movements and international competitiveness.

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1 Introduction

The national vineyard, the size of which is one of the most important determinants of the size of the wine industry, has grown from 387 hectares (ha) in 1960 to 6000 ha in 1991. The industry in 1960 comprised fewer than fifty family owned vineyards, each with its own production facility for wine. Production totalled 4.1 million litres, 84% of which was "fortified" wine (sherry and port).

Heavy investment in the industry by New Zealand and overseas brewers and liquor distributing companies during the 1960s and 1970s assisted the development of a few larger wine companies. With the development of these large wineries came the concept of contract grape growing through the persuasion of farmers to plant vines. In 1960, 96% of grapes were grown by wine producers themselves, a figure which had declined to 44% by 1980, to 30% by 1984, and to 25% by 1989. (Ministry of Agriculture and Fisheries 1981 & 1986; Cooper 1988; Wine Institute of New Zealand 1981-1992)

The need for co-ordination within the industry gave rise to the formation of the Wine Institute of New Zealand (WINZ) in 1976. WINZ receives its authority from the Winemakers' Act 1976, which provides for compulsory membership of WINZ for those holding a licence to make grape wine. However, WINZ has no power to control the actions of its members.

Production of wine is heavily influenced by climatic conditions affecting the size of the harvest. For example, the yield of 13.4 tonnes per ha in 1983 was followed by a yield of 8.9 tonnes per ha in 1984 due mainly to substantial changes in weather conditions. This was equivalent to a potential reduction of 24,750 tonnes in the 1984 harvest of grapes. Notwithstanding climatic variations in the harvest size, there was a significant divergence between production, based on the harvest from producing vineyards, and the quantity of wine which the market could absorb. This led to increased stock-holdings which reached a maximum for the industry in 1985 of 84 million litres, or nearly two years sales.

In December 1985 the industry accepted a plan put forward by Government whereby a payment of $6175 per ha would be made to grape growers willing to extract surplus vines prior to the 1986 harvest, thus relieving wine companies of their obligations to take the grapes. Some wine companies topped up this amount as an additional incentive. A total of 1797 ha was "pulled out" under this scheme, the effect of which was to reduce the size of the national vineyard to 4500 ha with a potential harvest size of 55,000 tonnes. This capacity was somewhat below domestic market needs, and allowed for a reduction in stock levels within the industry.

Figures 1-3 summarises some of the main statistics associated with the wine industry in New Zealand over the period from 1981 to 1992. As can be seen the industry has been characterised by considerable fluctuations during this period. This paper discusses the development of a system dynamics model which is under development at Victoria University to analyse the dynamic behaviour related to the New Zealand wine industry. It is intended that this model can be used to gain greater understanding into the forces shaping the industry and to help support the role of the Wine Institute within the industry. Also the model can be used to determine the effects of environmental and policy changes on the industry, including the impact of variations in annual grape yields, excise duties and price movements.

2 Method

The model of the wine industry is being developed using the system dynamics methodology (Forrester 1961; Coyle 1977). The suitability of system dynamics as a method for policy and strategy analysis has also been discussed by Cavana (1981) and Morecroft (1984). The approach taken has involved the following 10 steps:

(1) Gathering of data associated with the demand and supply of both grapes and wine within New Zealand, including imports and exports;

(2) Analysis of this data to determine major trends and relationships between industry components, eg. what affects the growers' decisions to plant;

(3) Interviews with participants in the wine industry to determine whether the relationships hypothesised in step 2 are, in fact, what drives the industry;

(4) Development of an influence diagram to represent the relationships;

(5) Construction of a STELLA simulation model on a Macintosh personal computer to reflect the influence diagram;

(6) Use of industry data to set initial values and define causal relationships in the model;

(7) Validation tests of the model, eg. debugging, time series tests, loop analysis;

(8) Comparison of the model behaviour with historical trends;

(9) Performance of sensitivity tests, and scenario, policy and strategy analyses;

(10) Drawing of conclusions and recommendations.

3 Analysis of Wine Industry Data

Figures 1-3 summarise the wine industry data, including statistics related to wine production and consumption, plantings and "pullouts" of grape vines, harvesting of grapes, yields and prices. These graphs are based on industry statistics (Cooper 1988; Wine Institute of New Zealand 1981-1992; Montana Wines Ltd 1971-1984; Department of Statistics 1987). However, only the main features of this data and the underlying relationships will be discussed here.

3.1 Wine Statistics

Once planted, vines take three years to produce grapes, and, traditionally in New Zealand, the crop is always harvested, whatever the prevailing price of grapes. The long term nature of grape growing has been emphasised by the Wine Institute of New Zealand (1992, p13):

> *"Grape growing, the agricultural base of the industry, is a long term business. Vines do not start producing until three years after planting, take five years to reach full production, then have an economic life of 45-50 years."*

The crop yield (tonnes of grapes per hectare) can vary significantly from year to year, the average over the past decade being about 12 tonnes per ha. On average, 767 litres of wine is produced from each tonne of grapes crushed, although the actual yield varies from grape variety to variety. Since the early 1980s, when laws specifying the minimum grape juice content of wine were introduced, this figure has been relatively constant (and somewhat lower than previously). Stocks of wine held by wineries and distribution channel members has varied considerably over the last 10 years. Wine stocks per drinking age person has tended to oscillate around 40 litres.

Figure 1 shows the consumption of wine compared with the real retail price (in Figure 3) indicating a negative relationship. Further analysis of the data showed that the average percentage change in consumption divided by the percentage change in price was -1.18 over the years 1985-1992, comparing favourably with the Wine Institute estimate of the price elasticity of demand of -1.

Analysis of the relationships between imports and prices, reveals that as the relative price of NZ wine falls, so do imports, as they become less competitive in the New Zealand market, and exports rise because NZ wine becomes more competitive on the international market.

3.2 Crop Statistics

In 1983 the wine industry was oversupplied with grapes. In response to this, the Government funded a programme whereby growers were paid to pull out surplus vines. The majority of vines pulled under the scheme occurred between 1985 and 1986, during which time very few vines were planted (see Figure 2). The total area planted dropped from about 6000 ha in 1984 to 4400 ha in 1986. The decision to plant new vines after 1986 was based on a shortage of the more fashionable grape varieties, and was aided by the fact that some growers were able to use the vine trellis remaining in the area of vines pulled, thus dramatically reducing the development cost. Since 1990 the decision to plant grapes has been more closely related to the returns to growers. This relationship is positive, ie as the real returns fall, so does the rate of planting. In 1992 the total area planted with grape vines was 6100 ha, of which 5800 ha were producing grapes.

3.3 Wine Prices

Figure 3 shows average retail prices of wine for the years 1981-1992, together with the real ex-winery price and the effective price to growers expressed in constant 1992 dollars per litre (excluding GST). These prices are positively related and reflect a downward trend since the early 1980s, with a sharp drop in prices between 1984 to 1986 during the period of substantial oversupply. Also derived from the data was the following relationship between wine stocks and real retail prices:

(Target stocks/stocks -1) x 0.25 = the percentage change in real retail price.

From the real retail price of wine, the wine makers' revenue may be calculated. This calculation is performed by subtracting the retailers' margin (typically 40% of the retail price), and excise duty, the latter set in 1988 at $1.50 per litre, adjusted 6-monthly by the CPI. The excise duty in 1992 was $1.70 per litre. A relationship between the price per litre received by the wine maker, and the price per tonne paid to the grower, has also been formulated based on the historical relationships.

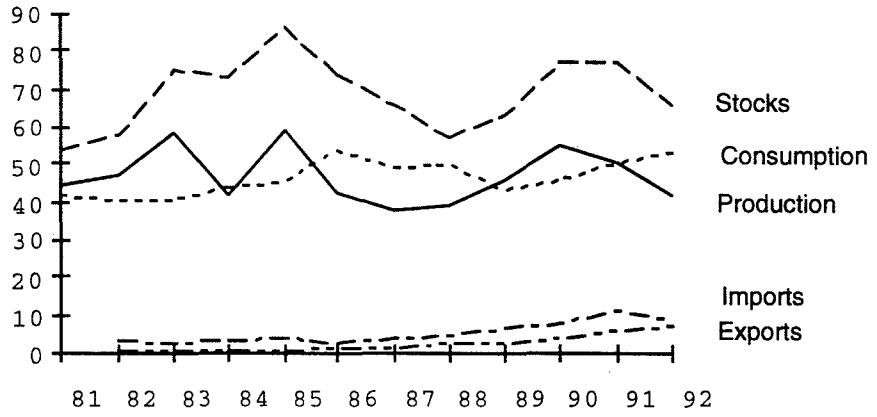

Figure 1: Wine Statistics (million litres)

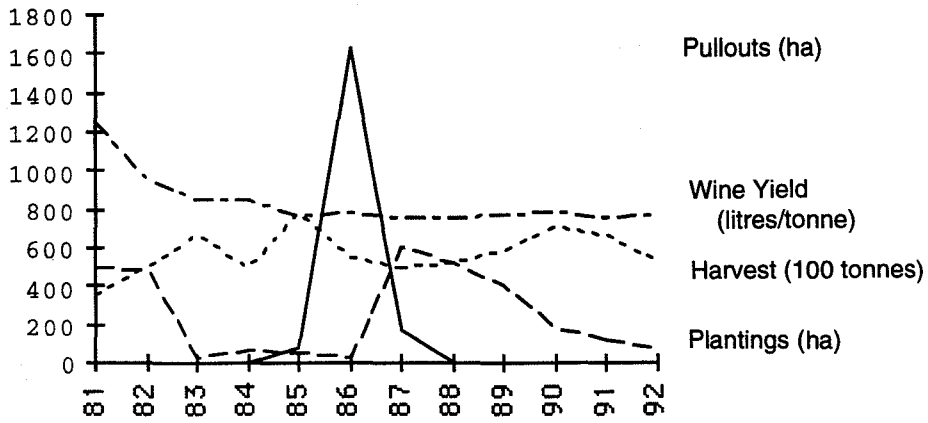

Figure 2: Vineyard and Harvest Statistics

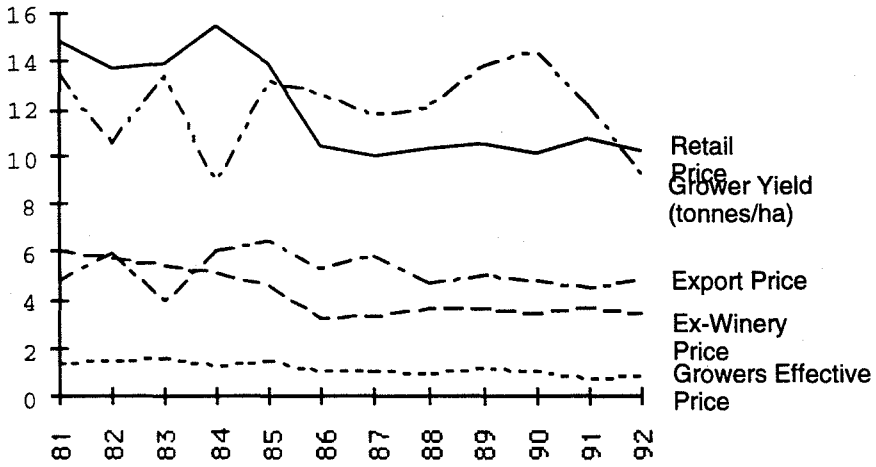

Figure 3: Real wine prices ($1992/litre)

4 Model Structure

For simplicity, the preliminary model has been constructed on an aggregate basis - using New Zealand as a single vineyard and market, and assuming grapes to be homogeneous. It is realised that this is less than perfect, as, in the wine industry, regional and grape varietal distinctions are important. Other limitations in the model include:

- the price elasticity of demand, which has been assessed at -1.18 in the model, although it is known that the figure will change over time as a result of market forces;
- the "world price of wine" which has been assumed to be constant;
- detailed variables affecting the decisions of growers to plant vines rather than other crops are not included;

- the effect of phylloxera (a vine pest) on the planting programmes of growers in the future has been ignored.

Figure 4 shows the simplified influence diagram for the New Zealand wine industry. The method used to construct this diagram is outlined in Wolstenholme and Coyle (1983). As noted in Cavana and Coyle (1984, p29):

> *"The solid arrows represent, not the direction of the physical flows, but the consequences or influences arising from these flows. A positive (+) sign on a link indicates that a change in the variable at the tail of a link will cause the variable at the head of a link to change in the same direction, whereas a negative (-) sign indicates a change in the opposite direction."*

The symbol "**D**" indicates the presence of a significant material or information delay in the relationship. Five major (simplified) feedback loops are apparent. Loops 1 to 4 are negative (ie they generate goal seeking behaviour) and loop 5 is positive (ie it generates growth or collapse behaviour):

(1) WINE STOCKS ---->$^{-}$ PRICE ---->$^{-}$ CONSUMPTION ---->$^{-}$ WINE STOCKS

(2) VINE PLANTING--->$^{D+}$ WINE PRODUCTION--->$^{+}$ WINE STOCKS--->$^{-}$PRICE--->$^{+}$
PRICE TO GROWER-->$^{+}$VINE PLANTING

(3) WINE STOCKS--->$^{-}$ PRICE--->$^{+}$ NZ/INT.PRICE RATIO-->$^{-}$ EXPORTS----->$^{-}$ WINE STOCKS

(4) WINE STOCKS--->$^{-}$ PRICE--->$^{+}$NZ/INT. PRICE RATIO--->$^{+}$IMPORTS--->$^{+}$ WINE STOCKS

(5) EXPORTS--->$^{-}$ WINE STOCKS--->$^{-}$ PRICE--->$^{+}$VINE PLANTING---^{D}->$^{+}$WINE PRODUCTION--->$^{+}$ EXPORTS

For example, Loop 1 (a negative feedback loop) indicates that if wine stocks are increased by, say an increase in production, then this will lead to a decrease in wine prices, which in turn leads to an increase in consumption and hence decreased stock levels in the future. Hence actual stock levels are being controlled to match target levels by adjustments to wine prices and consumption levels.

Based on this influence diagram a computer model was constructed using the STELLA II dynamic simulation modelling package (Richmond et al. 1990) on a Macintosh personal computer.

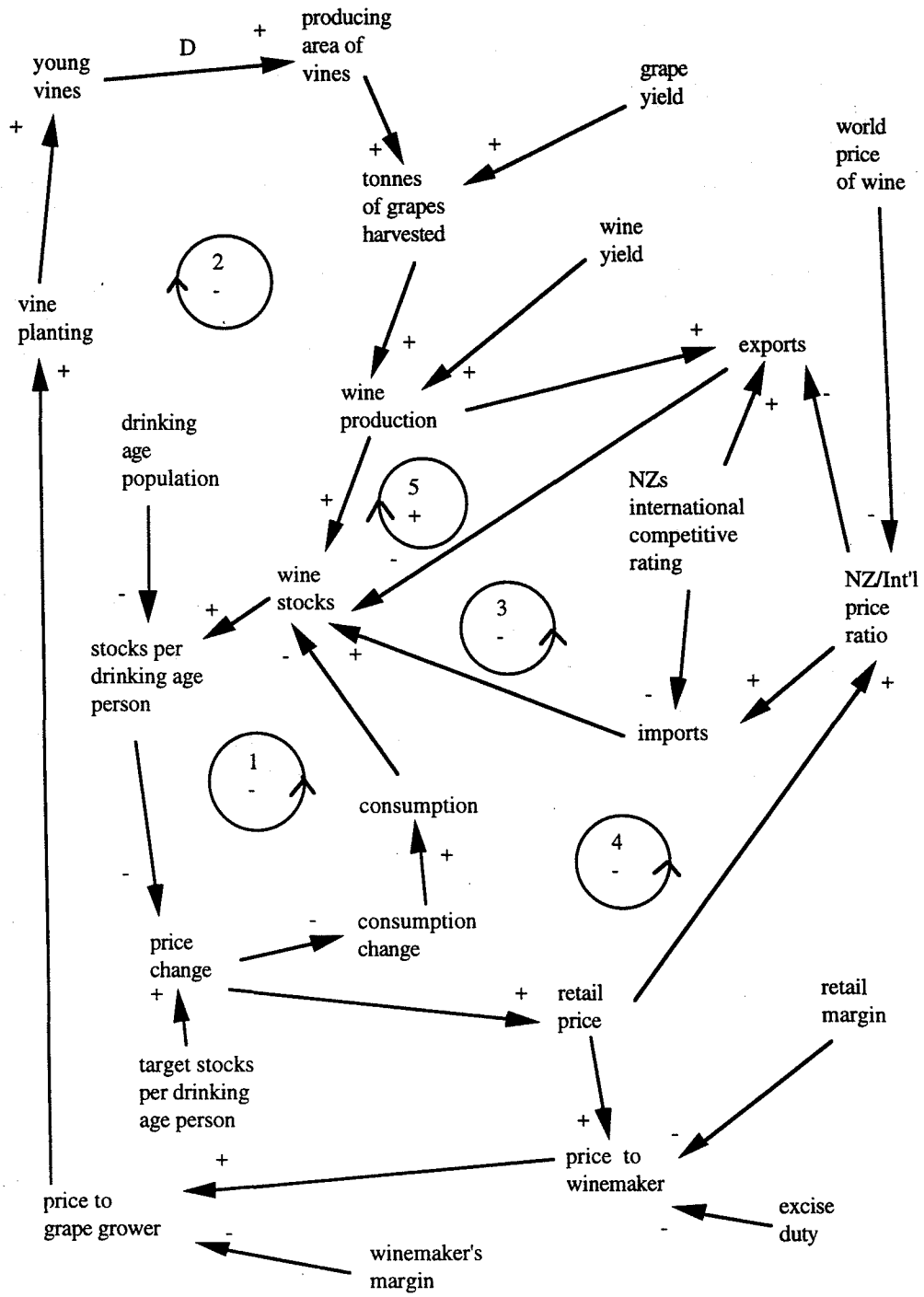

Figure 4: Simplified Influence Diagram of the NZ Wine Industry Preliminary Model

5 Model Behaviour

The model has been subjected to a range of validation and verification tests, including testing each of the major feedback loops in isolation. It is worthwhile noting that the dynamics of the model generally reflect the dynamic relationships in historical data. In particular, the period of cycles is similar to historic wine industry cycles. It should also be noted that in the medium term, as real prices fall, the price paid to growers will not be enough to encourage plantings, thus resulting in constant production levels. However, as domestic and export demand increases, stocks will fall and prices rise, thus encouraging planting again.

A number of variables exist in the model which can be changed to reflect possible environmental changes in the "real world". These include target stocks per drinking age person, wine excise duty, the minimum grape prices needed to encourage planting, New Zealand international competitiveness and changes in grape yield. However, only an experiment involving changes to the industry structure will be provided here to illustrate the use of the model.

5.1 Effects of Changes to Industry Structure

The model developed so far replicates historical industry trends. It is worthwhile, however, investigating the effects of the removal of the Wine Institute (WINZ) from the industry.

WINZ can play a critical role by surveying industry participants, and publishing the results. Industry participants may thus use this information in their individual decision-making processes concerning price and planting rates. Removal of WINZ from the industry would result in delays in the provision of such information. This can be simulated by introducing a delay of one year between stocks per drinking age person and the resultant price effect.

Figures 6 (a) & (b) show the result of such a change. These graphs are directly comparable with the base scenario shown in Figures 5 (a) & (b). The oscillations in the model become more violent.

Legend:
1 = wine consumption (litres)
2 = wine production (litres)
3 = exports of wine (litres)
4 = imports of wine (litres)

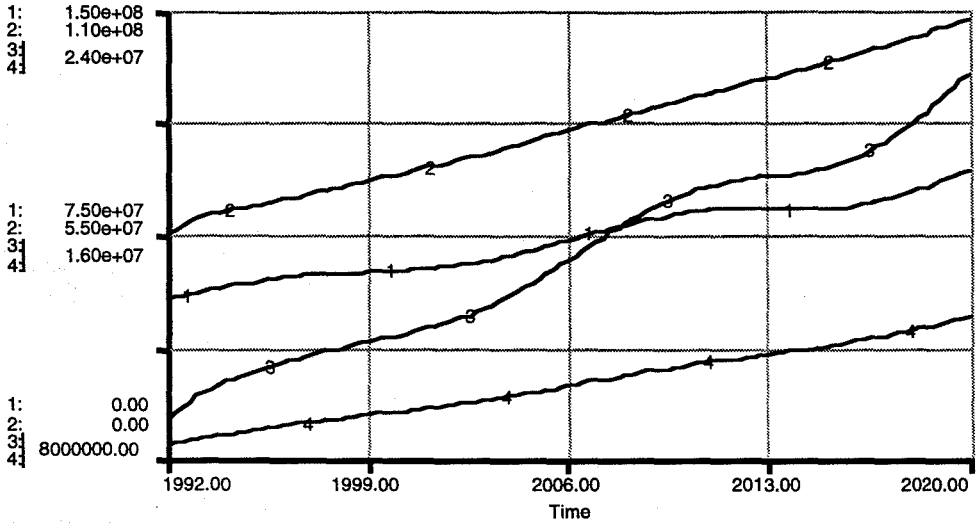

Figure 5(a): Base Scenario

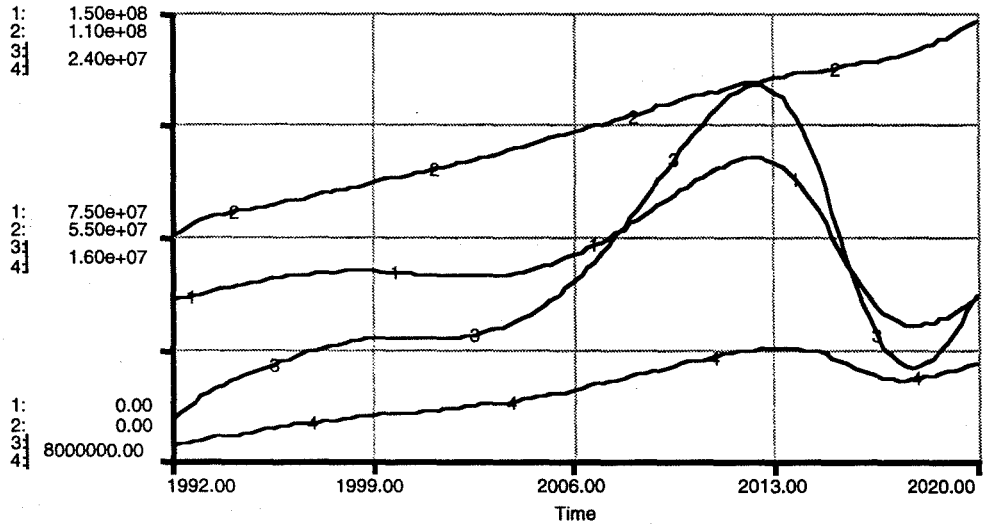

Figure 6(a): Effect of Delay in Information

Legend: 1 = wine stocks (litres)
2 = stocks per drinking age person (litres/person)
3 = real retail price of wine per litre ($1992/litre)
4 = producing area of vines (ha)
5 = vine plantings (ha)

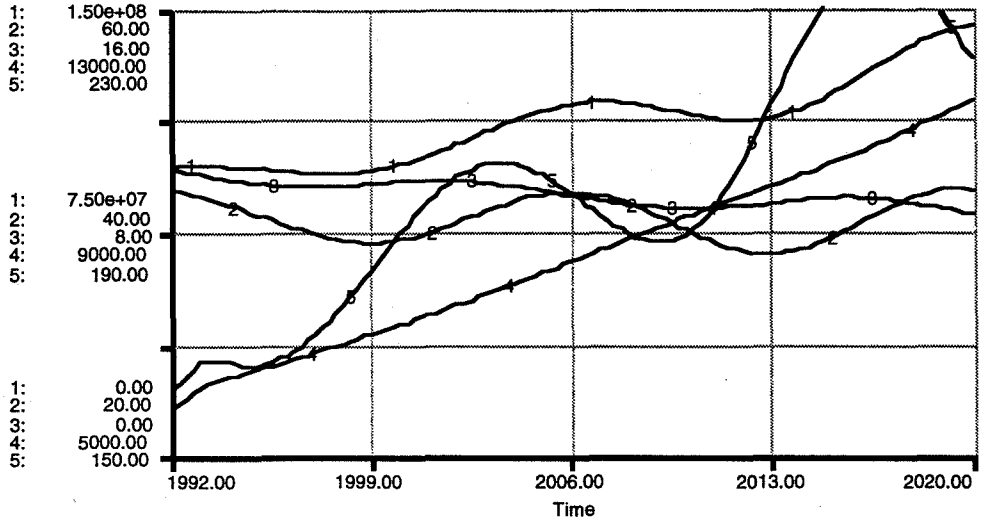

Figure 5(b): Base Scenario

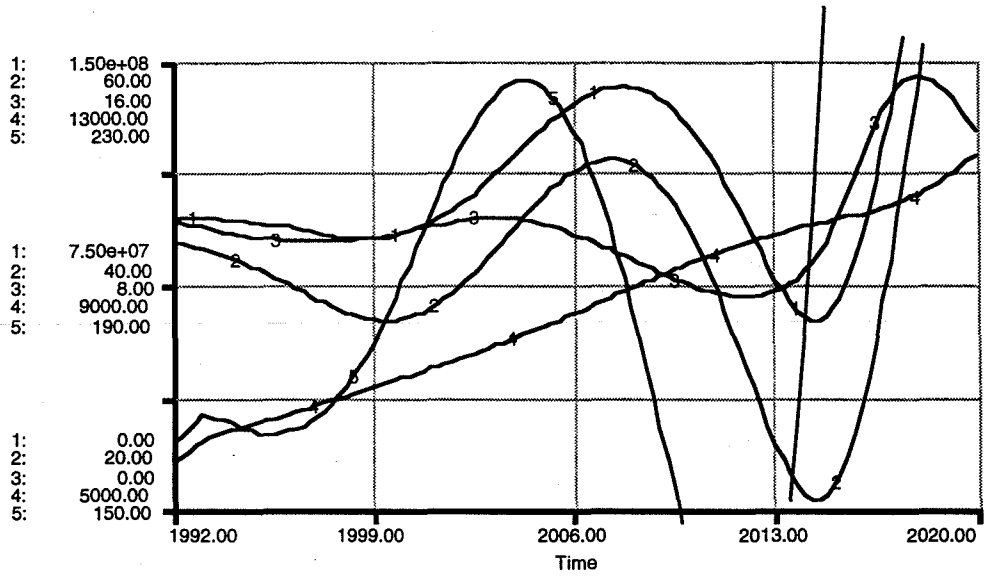

Figure 6(b): Effect of Delay in Information

6 Conclusions

The wine industry is characterised by high sunk costs, both in the winery and the vineyard. Growers are reluctant to abandon the harvest or to pull out vines, even when prices are low. As long as the cost of harvesting grapes is lower than the revenue which they generate (machine harvesting results in relatively low costs), growers will harvest and sell the crop. This factor, together with the delay of 3 years before vines mature, results in a "ratchet" effect on grape supply, leading to periods of oscillating oversupply and undersupply of wine, causing wide fluctuations in prices in the longer term. As was seen in 1985, in order to reduce grape oversupply without serious disruption to the industry and financial ruin to many wine companies, the Government sponsored a major "pull-out" scheme.

The dynamic simulation model under development at Victoria University will allow participants in the wine industry to gain three important insights:

(i) anticipation of the long term impact of environmental changes (eg excise tax changes, international price and currency movements, government policy changes, etc);

(ii) assessment of the impact of structural and policy changes within the wine industry (eg changes in target stocks, information effects of industry structure, planting decisions, etc); and

(iii) the understanding that cyclical changes are normal and may be short term. These "normal" cyclic changes can be clearly seen in the model output provided above, and thus may allow growers and wine makers to make more informed long term strategic decisions concerning grape and wine supply.

It is intended that this dynamic model be further developed in collaboration with the Wine Institute and members of the wine industry in New Zealand.

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