SUPPLY RESPONSE IN GRAPE PRODUCTION TO A VINE PULL SCHEME

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November 1994

UNE Working Papers in Economics No. 15

Editor

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ISBN 1 86389 221 4

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Abstract

In this paper the supply response of grape growing enterprises to a vine pull program is modelled. Impacts of changing the prices of outputs and inputs on the adjustment behaviour of growers are shown. Increases in output prices lengthens the economic life of vines while an increase in input prices, debt principal or interest rates shortens the economic life of the vines. In the case of grape production (and other long term fruit crops) the extended planning horizon and the associated costs structure prevents adjustment occuring rapidly. These two factors help explain why adjustment in grape growing enterprises does not match that predicted by micro economic theory.

1. Introduction

In this paper the impacts of a vine pull scheme on the management decisions of grape producers are identified by analysing supply response in grape production. The analysis is based on microeconomic investment theory (BAE 1983; Chiang 1984; Henderson & Quandt 1980).

2. Vine Pull Scheme

Vine pull schemes (in grape production) and tree pull schemes (in citrus, apple and stone fruit production) have been a feature of the political economy of Australian agriculture during the past 20 years. During times of depressed prices and or income for crops with long planning horizons, governments have come under pressure to ameliorate the adjustment pressures facing participants by instituting special assistance programs such as vine pull programs. Such were the dire circumstances facing grape producers in Australia during the early to mid 1980's that the Federal Government announced in 1985 that it would fund a vine pull scheme to run over three seasons (1985 to 1987).

The aims of the Scheme were two fold. First, to reduce a perceived over-supply of grapes, as this oversupply was believed to be depressing incomes in the grape growing industry. Second, to facilitate the adjustment out of the industry of low income and presumably inefficient growers.

3. Analysis

Consider the decision to invest in the planting of vines. The present value of such an investment assuming that the producer must borrow funds is given by:

$$PV = P_g \int_0^T G(t)e^{-rt} \partial t - P_x \int_0^T X(t)e^{-rt} \partial t - \int_0^T F(T)e^{-rt} \partial t + S(T)e^{-rT}$$
(1)

where	r	is the interest rate;
	Pg	is the price of grapes;
	рх	is the price of inputs;
	G(t)	is grape production as a function of time;
	X(t)	is production costs as a function of time;
	F(t)	is annual debt repayments; and
	S(T)	is the salvage value of the grape enterprise

and
$$F(T) = F(T,r,I_0)$$

That is, the annual rate of debt repayment is a function of the commercial life of the investment (T), the interest rate (r) and the amount borrowed (I_0).

The present value of the profit from the investment is maximised when the first derivative with respect to time is zero. Hence

$$\frac{\partial(PV)}{\partial t} = P_g G(T)e^{-rT} - P_x X(T)e^{-rT} - F(T)e^{-rT} + S'(T)e^{-rT} - rS(T)e^{-rT} = 0$$
(2)

Rearranging terms yields the following result:

$$P_{g}G(T) - P_{x}X(T) - F(T) + S'(T) = rS(T)$$
(3)

That is, the present value is maximised when, in year T, revenue less input costs, debt repayment costs and the annual decline in salvage value equals the interest earnt by investing the proceeds from salvage.

Note that the equation may be rewritten as:

$$P_{g} G(T) - P_{x} X(T) = F(T) - S'(T) + rS(T)$$
(4)

Note that as S'(T) is negative, assuming the salvage value of the enterprise declines over time, then the right hand side is necessarily positive.

$$Z(T) = P_g G(T) - P_x X(T)$$
(5)

If the salvage value of the enterprise is zero then, at the optimum, Z(T) will equal F(T) from expression (4). If the salvage value is positive the optimum life of the investment is given by:

$$Z(T^{*}) = F(T^{*}) - S'(T^{*}) + rS(T^{*})$$
(6)

Where T* is the optimum life. The relationship between the two optima is obtained as: Assume there is no salvage value, then at the maximum:

$$Z(T) = F(T)$$

so,

$$Z(T)^{*} = Z(T) - S'(T^{*}) + rS(T^{*})$$
(7)

Assuming diminishing marginal returns and since S'(T) > 0 then

$$Z(T^*) > Z(T)$$
$$T^* < T$$

That is, the optimum life when salvage is positive is equal to the optimum life with zero salvage, adjusted for the annual marginal change in return from salvage proceeds.

Assuming diminishing marginal returns, as $Z(T^*)$ must be greater than Z(T), T^* must be less than T. Thus if salvage value is positive, or increases, then the optimal commercial life of the investment is reduced and so, the vines will be pulled at a younger age. Similarly, it can be shown that if the producer did not need to borrow funds then the optimal commercial life of the vines is extended.

Consider now the impact of prices and costs. For T to be a maximum then:

$$\frac{\partial^2(PV)}{\partial T^2} = P_g G'(T) - P_x X'(T) - F'(T) + S''(T) - rS'(T) < 0$$
(8)

Totally differentiating the first derivative, expression (2), gives:

$$\partial T \left[P_g G'(T) - P_x X'(T) - F'(T) + S''(T) - rS'(T) \right] = -\partial P_g G(T) + \partial P_x X(T) + \partial r [F'(r) + S(T)] + \partial I_0 F'(I_0)$$
(9)

or, more, simply,

$$\partial T[\delta] = -\partial P_g G(T) + \partial P_x X(T) + \partial r[F'(r) + S(T)] + \partial I_0 F'(I_0)$$
(10)

Where δ represents the expression for the second partial derivative with respect to time, that is, the righthand side of the expression (8).

If input prices and the interest rate are held constant then the affect of a change in grape price on the optimal life of the investment is given by:

Hence:

$$\frac{\partial \mathbf{T}}{\partial \mathbf{P}_{\mathbf{g}}} = -\mathbf{G}(\mathbf{T})\,\delta^{-1} > 0 \tag{11}$$

Similarly:

$$\frac{\partial T}{\partial P_{x}} = X(T) \, \delta^{-1} < 0 \tag{12}$$

$$\frac{\partial T}{\partial I_0} = F'(I_0) \,\delta^{-1} < 0 \tag{13}$$

$$\frac{\partial T}{\partial r} = (F'(r) + S(T)) \,\delta^{-1} < 0 \tag{14}$$

Consequently an increase in the price of grapes lengthens the economic life of vines while an increase in input prices, debt principal or interest rates shortens the economic life of the vines.

The analysis is represented diagrammatically in Figure 1.



Figure 1: Hypothetical profile of returns to grape producers.

The curve Z(t) describes the net revenue from a vine during its life, assuming a constant price. Vines reach commercial yields within two to seven seasons depending on the variety and whether production is from new root-stock or new graftings. For the purpose of the analysis, assume commercial yields are reached in the fourth year on average and continue for forty years or more. Assume also that maintenance costs are reasonably fixed for much of the life of the vine. On these assumptions the net revenue earned from the vine each season over its lifetime will follow a path similar to Z(t).

The curve F(t) describes the impact of the length of the commercial life of the vine on average fixed costs. Overheads incurred in planting the vine are spread over the life of the vine. The longer the vine continues producing the longer the period over which fixed costs are spread. The optimal commercial life of vine occurs at the point where the two curves F(t) and Z(t) intersect and expected profit is maximised. In the figure this intersection indicates a commercial life of forty years, which is typical. The hatched area represents the total profit earned over the lifetime of the vine. At T₁, the enterprise reaches breakeven point.

Consider now the impact of a fall in the price of grapes (p_g) or a rise in the prices of inputs (p_x) . In figure 2 below these changes are summarised as a shift in the revenue curve form $Z_1(t)$ to $Z_2(t)$. Clearly, the optimal commercial life of the investment in vines is reduced. The shaded area indicates the fall in profitability.



Figure 2: Impact of a Fall in the Price of Grapes (pg)

The impact of an increase in the rate of interest on borrowed funds is demonstrated in Figure 3. The repayment curve $F_1(t)$ shifts to $F_2(t)$. The commercial life of the vine is, again, reduced. The shaded area indicates the fall in profits.



Figure 3: Impact of an Increase in Interest Rates (r).

The degree to which the commercial life of the investment in vines is reduced by, say a fall in grape prices can be assessed as follows. If salvage is assumed to be zero, then Z(T) equals F(T) as the optimum. As:

$$Z(T) - F(T) = 0$$

$$\frac{\partial^2(PV)}{\partial T^2} = Z'(T) - F'(T) < 0$$
(15)

And since F'(T) < 0, then the optimum occurs when the absolute value of Z'(T) is greater than F'(T) and Z'(T) is negative. If, as apparently is the case, Z'(T), the change in net revenue is near zero or positive for a lengthy period of the productive life of grape vines, then the investment horizon is correspondingly length and will be unresponsive to changes in market conditions. Consequently, a change in the price of grapes for example, will only accelerate the removal of vines nearing the end of their commercial life and so, will have only a marginal impact on the production of grapes.

Consider the impact of the Vine Pull Scheme. If assistance is received for removing vines, this can be interpreted as increasing the salvage value of the enterprise. As described earlier, an increase in the salvage value decreases the commercial life of the investment. Consequently, the provision of assistance to pull vines will encourage producers to remove vines, nearing the end of their commercial life, earlier than would other wise be the case. Since the commercial life of vines is also shortened by a fall in the price of grapes, then the Scheme will encourage most, the removal of older vines of varieties with poor market prospects.

4. Summary

The essential point of the analysis is that the grape producer is confronting a planning horizon for forty years or more when investing in new root-stock or graftings. Since preferences for wine, and so the demand for grape varieties, can alter substantially within the course of a decade, and as conditions in the residual markets can vary from season to season, grape production represents a quite risky long-term investment. That imbalances occur between the supply and demand for grapes, both in aggregate and by variety, should not be surprising.

Once the investment is made, the incentive to adjust to short term price movements depends on the cost structure of the grape enterprise net of the overheads associated with the vine itself. Usually fixed costs average 20 to 30 per cent of production costs. When a short run fall in price occurs, provided the variable costs of production are met, the economically rational action is to continue production even though fixed costs cannot be fully covered. In principle, grape producers may be acting rationally by

remaining in the industry, even though returns may be 20 to 30 per cent below production costs for one, two or even three seasons.

In brief, the supply of grapes is quite unresponsive to market signals in the short term. In the long term, the extended planning horizon and the costs structure of grape growing enterprises represent powerful forces preventing rapid adjustment in the grape growing industries.

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