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A NOTE: A CLARIFICATION OF THE ROLE OF YIELD UNCERTAINTY IN INFLUENCING OVER-QUOTA PRODUCTION*

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The literature shows that the influence of yield uncertainty on production relative to quota is ambiguous in the case of a single market. This paper uses a two-market framework (quota market and secondary market) with multiplicative yield uncertainty to show that if over-quota production in the absence of yield uncertainty is profitable, then the presence of yield uncertainty is unambiguously a further stimulus to over-quota production. The analysis is discussed in the context of recent changes to the marketing arrangements for Western Australian potatoes.

Introduction

The Western Australian (WA) Government has recently announced modifications to the marketing arrangements for WA potatoes (WA Government 1993). Previous marketing arrangements featured pooling of higher priced domestic and lower priced export sales leading to the well-known inefficiency of production decisions (see for example, Parish 1962; Alston and Freebairn 1988). New marketing arrangements feature the removal of pooling with producers receiving a quota (Domestic Market Entitlement) for higher priced domestic sales and no constraints on export sales. It is expected that these modifications will improve the efficiency of potato production by reducing the average level of production, but it is not yet known whether this production typically will be in excess of the quota so that sales to the (secondary) export market continue to occur.

The literature on price pooling suggests that, in a situation where there is no yield uncertainty, growers will produce in excess of higher priced quota sales only if the marginal cost of quota production is less than the secondary market price (Parish 1962; Alston and Freebairn 1988). In addition, a separate literature on quotas and yield uncertainty suggests that, in the absence of a secondary (lower priced) market, the role of yield uncertainty in determining production relative to quota is ambiguous

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(Fraser 1986; Babcock 1990). In particular, 'production levels for profit-maximising producers under yield uncertainty will be either higher or lower than under production certainty, depending on the relationship between expected marginal revenue and marginal costs at the acreage level that fills the quota at mean yields' (Babcock 1990, p.964).[1]

The aim in this analysis is to consider jointly the roles of the level of the secondary market price and the presence of yield uncertainty in determining the extent of over-quota production.

The framework used is based on Fraser (1986) and features both multiplicative yield uncertainty and segmented (eg domestic and export) markets. A recent paper by Borges and Thurman (1994) develops a similar framework for the purpose of analysing the relative sensitivity of North Carolina peanut production to changes in quota market and secondary market prices.[2] By the use of this framework it can be shown that, if the level of secondary market price is such that over-quota production in the absence of yield uncertainty is expected to be profitable, then the presence of yield uncertainty is a further stimulus to over-quota production. Consequently, in this situation the ambiguous role of yield uncertainty identified by Fraser (1986) and Babcock (1990) in the case of a single market no longer applies. However, if over-quota production in the absence of yield uncertainty is not profitable, then it continues not to be possible to determine unambiguously the role of yield uncertainty in influencing planned production relative to quota. The paper ends with a brief summary and discussion of related empirical research.

Analysis

With the removal of pooling and the introduction of a quota on sales to the higher priced (domestic) market, the profit-maximising grower's objective function in the absence of yield uncertainty is given by:

$$(1) \qquad \max_{q_c} \; p_H q_q + p_x (q_c - q_q) - c(q_c)$$

where p_H equals the higher (domestic) price for quota sales, p_x equals the lower (export) price for over-quota sales, q_c equals quota sales, equals total production with no yield uncertainty and $c(_{q_c})$ equals the total cost of production $(c(q')>0)$. Taking the derivative of (1) with respect to q_c gives the result of the price pooling literature that optimal production after the

[1] Note that earlier work by Alston and Quilkey (1980) suggested the presence of demand and yield uncertainty created incentives for over-quota production. However, these incentives were not formally examined in an optimisation framework.

[2] I am grateful to an anonymous referee for directing this paper to my attention. Note that although both Babcock (1990) and Borges and Thurman (1994) base their frameworks on that of Fraser (1986), an important additional feature of their frameworks because of their focus on United States peanut production is the opportunity for growers to carry-forward unsatisfied quota. However, carry-forward of quota is not included here as it is not a feature of quota policy in Australia.

removal of pooling (and in the absence of yield uncertainty) is given by the level of production at which marginal cost is equal to the export price:

(2) $p_x = c'(q_c)$.

Note however that, because the price received per unit of output is discontinuous at q_q (Parish 1962; Alston and Freebairn 1988), (2) is subject to the constraint:

(3) $q_c \geq q_q$

Consider next the case of production in the presence of yield uncertainty. Following Fraser (1986) it is assumed that yield uncertainty can be incorporated using a multiplicative form:

(4) $q = \theta\, q_u$

where θ is a random variable with an expected value of unity, q_u equals planned production and q equals actual production. Note that the multiplicative specification of yield uncertainty has been extensively used in theoretical work because it is regarded as a more realistic approximation than other forms (such as the additive form) in the context of agricultural production (see Newbery and Stiglitz, 1981, Ch.5).[3]

In this situation the grower's expected profit (E()) is given by:

(5) $$E(\pi) = \int_o^{q_q/q_u} p_H\, \theta q_u g(\theta)\, d\theta + \int_{q_q/q_u}^{\infty} (p_H\, q_q + p_x\,(\theta q_u - q_q))g(\theta)d\theta - c\,(q_u)$$

where:$g\theta$ = probability distribution function of θ.

Taking the derivative of (5) with respect to q_u and equating to zero gives the grower's first order condition for maximising expected profit:

(6) $$\int_o^{q_q/q_u} p_H\theta g(\theta)d\theta + \int_{q_q/q_u}^{\infty} p_x\theta g(\theta)d\theta = c'(q_u)$$

which can be rearranged to give:

[3] Newbery and Stiglitz (181, p.65) state: "In our view, multiplicative risk seems a better approximation than additive risk, especially for a microeconomic theory of an individual farmer's decisions. Additive risk is at best a simplification used at the aggregate level for econometric estimation". In this context Babcock's (1990) empirical application was based on a transformation of experimental yield data which constrained the data to a particular mean and coefficient of variation. In addition, Borges and Thurman (1994) adopted a specification of yield uncertainty resembling the additive form by assuming a constant variance but allowing mean yields to vary across counties. Note also that Borges and Thurman (1994) subjected this constant variance assumption to Bartlett's test and found it was rejected at the 5% level but not rejected at the 2.5% level.

(7) $$p_H E(\theta|\theta q_u < q_q) + p_x E(\theta|\theta q_u \geq q_q) = c'(q_u).$$

Since:

(8) $$E(\theta|\theta q_u < q_q) + E(\theta|\theta q_u \geq q_q) = E(\theta) = 1$$

it follows from (7) that in the presence of yield uncertainty and without pooling the grower determines optimal planned production by equating expected marginal revenue to marginal cost. Moreover, expected marginal revenue is a weighted sum of the prices prevailing in the domestic and export markets and is therefore larger in value than the export price.

Finally consider the relative levels of optimal planned production without pooling but in the presence and absence of yield uncertainty. A comparison of (2) and (7) shows that as long as (2) holds with equality implying:

(9) $$q_c > q_q$$

then it follows that because p_H exceeds $p_x$the left-hand-side of (7) must exceed the right-hand-side at q_c. Therefore, the level of optimal planned production without pooling but with yield uncertainty (q_u) exceeds this level in the absence of yield uncertainty which itself exceeds the domestic market quota:

(10) $$q_u > q_c > q_q.$$

However, if a corner solution (i.e. $q_c = q_q$) applies in the absence of yield uncertainty because:

$$P_x < c'(q_q)$$

then the right-hand-side of (7) may exceed or be less than the left-hand-side at q_q:

(11) $$q_u \gtrless q_c = q_q.$$

Therefore, in this case there is analytical ambiguity regarding the relative level of q_u and q_q.

Conclusion

In the case of a single market the literature shows that the influence of yield uncertainty on production relative to quota is ambiguous and in particular depends on the expected profit margins on over-quota production. This paper has used a two-market framework (quota market and secondary market), with multiplicative yield uncertainty, to clarify to some extent this ambiguous role. Specifically it has been shown that if the level of the secondary market price is high enough to justify over-quota production in the absence of yield uncertainty, then the presence of yield uncertainty is unambiguously a further stimulus to over-quota production. However, the ambiguity of this role remains if over-quota production in the absence of yield uncertainty is not profitable.

The analysis in this paper has been prompted by changes to potato marketing in Western Australia which are currently being introduced and which feature the establishment of domestic market quotas and the removal of the pooling of returns from domestic and export sales. Also in this context, recent empirical research has estimated that the marginal cost of production at these newly-established quota levels is approximately fifty per cent or less of the average export price for the main potato-growing regions of Western Australia (Omedei, 1994). Therefore, combining these empirical results with the analysis in this paper suggests that the presence of yield uncertainty in potato production in Western Australia is unlikely to be a disincentive to production for export.

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