SOME TENTATIVE SUPPLY ELASTICITIES FOR SHEEP AND DAIRY PRODUCTS*

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Given the apparent assumption of a highly inelastic supply in much of our agricultural policy and the dearth of empirical estimates of " local " supply elasticities, it is perhaps worth recording—albeit diffidently—a few tentative estimates for sheep and dairy products. They are based on the fact that if we assume free competition and profit maximization, then a production function involving fixed factors Z_j and variable factors X_i and of the form

(1) $$Y = (\Pi Z_j^{\beta_j})(\Pi X_i^{\beta_i})$$

implies a *normative* elasticity of supply, η, for incremental product price changes given by

(2) $$\eta = \Sigma\beta_i/(1 - \Sigma\beta_i) + [p_y/(\Sigma\beta_i - 1)][\Sigma(\beta_i/p_i)(dp_i/dp_y)]$$

where p denotes price.[1] This elasticity refers to the adjustment in output required to attain a new profit maximizing equilibrium position relative to the input set $\{X_i\}$ after an incremental change in p_y, assuming the price change is insufficient to shift any factors between $\{Z_j\}$ and $\{X_i\}$. [2]

If the response period is relatively small, the second term of equation 2 will be negligible since the reaction of most p_i to an actual or expected change in p_y will be well-nigh zero. This will be especially so if some of the p_i are administered prices or if Y is an unimportant element of the total demand for X_i. Moreover, if constant returns to scale prevail (as some would argue must occur if the production function encompasses all relevant factors), the partial elasticity would be given by :[3]

(3) $$\eta = \Sigma\beta_i/\Sigma\beta_j.$$

While a number of " local " production function estimates are available, no useful empirical information is available on factor-product price reactions. Accordingly, we will only estimate partial or short-run elasticities relative to $\{X_i\}$. The derivation of such elasticities necessitates the use of production function estimates based on a finely divided factor array (i.e., finer than the traditional tripartite classification) so that some attempt can be made to segregate short-run fixed and variable factors. For Australia and New Zealand, three cross-sectional production function

*The present cabochon originated from a discussion with F. H. Gruen who, with R. G. Mauldon, commented on a draft. Neither is responsible for any residual flaws.

1. The role of diminishing returns in leading to a determinate elasticity is apparent in equation 2. For $\Sigma\beta_i \geqslant 1$, Y would be infinite and η meaningless.

2. Specification of $\{X_i\}$ and $\{Z_j\}$ hinges on the size of resource salvage and acquisition values relative to their VMP's. Thus the composition of the sets $\{X_i\}$ and $\{Z_j\}$ will not necessarily be the same relative to product price increases and decreases. Too, for product price increases (decreases) p_i of equation 2 is the acquisition (salvage) price of X_i. Should none of the factors have discrepancies between their salvage and acquisition values (including sentiment, etc.), all factors would be variable except for financial and institutional restrictions. See Johnson, G. L., " The State of Agricultural Supply Analysis ". *J. Farm Econ.*, 42 : 435-452. 1960.

3. The partial elasticity of supply relative to a decrease in p_i is given by $\beta_i/(1 - \Sigma\beta_i)$. Thus, in terms of the data presented later, a subsidy on superphosphate should be much more effective as a stimulant to Canterbury Plains sheep production than it should be for whole-milk in W.A.

estimates akin to equation 1 and suitable to the extent of probably not leading to crazy short-run estimates of η are available. Relevant details of these three studies are listed in Table I.

TABLE I

Cobb-Douglas Type Production Function Estimates

Item	Canterbury Plains, N.Z. (a)	Lower Murray Valley, S.A. (b)	Bunbury Region, W.A. (c)
Enterprise	Wool, fat lambs	butter	whole-milk
Year	1955-56	1955-56	1954-55
β estimates			
Labour	0.15	0.25	0.23
Land	.42	.39	
Capital (d)	.26	.32	.55
Superphosphate	.22	—	.07
Supplementary feed	—	.18	.13
Lime	.06	—	—
Agistment	—	.04	—
$\Sigma \hat{\beta}$	1.11	1.18	.98

(a) Mason, G., Resource productivities from a sample of light plains farms, Canterbury, N.Z. *Aust. J. Agric. Econ.*, this issue.
(b) Jarrett, F. G., Estimation of resource productivities as illustrated by a survey of the Lower Murray Valley dairying area. *Aust. J. Statistics*, 1 : 3-11. 1959.
(c) Schapper, H. P. and Mauldon, R. G. A production function from farms in the whole-milk region of Western Australia. *Econ. Record*, 33 : 52-9. 1957.
(d) Items included in this category in the various studies were as follows :—N.Z.: resale value of plant and machinery ; S.A.: depreciation on plant and farm improvements (buildings, fencing, etc.) plus selected operating expenses ; W.A.: miscellaneous costs excluding depreciation and output-determined items.

Assuming only factors other than the labour, land, and capital categories of Table I are effectively variable in the short-run,[4] and that over this period factor price reactions to any feasible change in product price are zero, estimated partial supply elasticities based on equation 2 are as follows :[5]

wool and fat lambs, N.Z.	0.4
dairying for butter, S.A.	0.3
whole-milk, W.A.	0.25

If we assume the estimated production functions of Table I do not refute the hypothesis of constant returns to scale and that factors other than

4. At a guess, this short-run probably implies a period of the order of 6-12 months for superphosphate and lime, a month or so for agistment, and maybe only a week or so for supplementary feed.
5. Given the role of salvage and acquisition values, these estimates and those that follow are most relevant to product price rises.

those listed are accounted for by the constant term of the estimated function, then the compromise deflation of the estimated N.Z. and S.A. production elasticities to reduce $\Sigma\hat{\beta}$ to unity leads to the following estimates of η :[6]

wool and fat lambs, N.Z.	0.3
dairying for butter, S.A.	0.2
whole-milk, W.A.	0.25

As noted in the title, these short-run supply elasticity estimates can only be regarded as suggestive. Strictly, they relate only to incremental price changes—otherwise some fixed factors would become variable. Nor (because of the data rather than of the method) do they allow for technological change. Too, as well as making no allowance for variations in resource fixity between firms, they suffer from the restrictions inherent in the algebraic form of equation 1 and from any bias present in the original production function estimates.[7] If, over the relevant range, such bias is thought to be either zero or cancelled out in our selection of short-run variable factors, then it is nearly sure that the estimated elasticities overestimate their real-world counterparts. Firstly, we have made no allowance for the effect of factor-product price reactions. Examination of equation 2 shows that this effect will be negative for increases in p_y. Secondly, our estimates are normative. Since they make no allowance for risk or uncertainty in price or production, nor for a lag in ascribing permanence to a change in actual or expected price, it is most likely that farmers would undershoot them.[8] Lastly, the wool-fat lambs estimate relates to semi-joint products. Since similar relative price movements in the joint products are less likely than disproportionate—if not reverse—price changes, the real-world effect is again likely to be overestimated by our estimate. *Tant pis* !

On the other hand, some of the components of the rather catch-all capital category of Table I are probably effectively variable in the short-run.[9] The neglect of such items would tend to lower the estimated elasticities relative to the real-world. On balance, therefore, it may be that the deflated elasticity estimates are not too astray from the actual elasticities that prevailed for the periods, places and enterprises examined. Some support for this possibility is provided by comparison of a few recent positive estimates of U.S. farm supply elasticities by Griliches with comparable normative estimates based on the procedures developed above. Such comparisons are detailed in Table II. Necessarily, the

6. We refrain from noting confidence intervals for the listed estimates. To do so would perhaps give them (paradoxically) an aura of respectability that is unwarranted given the *ad hoc* mechanics of estimation.

7. See : Heady, E. O. and Dillon, J. L. *Agricultural Production Functions.* Iowa State University Press, Ames. 1960. Chs. 6 and 7 ; and Nerlove, M. and Bachman, K. L. The analysis of changes in agricultural supply : problems and approaches. *J. Farm Econ.*, 42 : 531-54. 1960.

8. For some evidence of undershooting see Dillon, J. L. and Heady, E. O. Entrepreneurial decisions under free competition. (In press). *Metroeconomica* 13 (1). 1961.

9. In the only local study so far available of price reaction effects, Gruen found one third of a woolgrower sample were uninfluenced by a current fall in wool prices ; one third expected to curtail future expenditure, mainly developmental ; and the remainder made immediate economies, mainly by cancellation of superphosphate orders. Gruen, F. H., Wool prices, credit restrictions and development. *Rev. Mark. Agric. Econ.* 24 : 61-73. 1956.

production functions used to derive the normative estimates are selective—they are all those readily available which consider a broad product category against a factor array sufficiently segregated for the purpose at hand. As with the Australian—N.Z. data, the assumption made in deriving the normative elasticities is that only factors other than labour, land and other " fixed capital " services are variable in the short-run.[10]

TABLE II

Comparison of Positive and Normative Short-run Supply Elasticity Estimates for U.S. Agriculture (*a*)

Products	Authors	Period	Area	Elasticity
All farm	Griliches (b)	1911–58	U.S.	0.1–0.2
	Tintner and Brownlee (c)	1939	Iowa	0.12
	Tintner (d)	1942	Iowa	0.19
Crop	Griliches (b)	1911–58	U.S.	0.1–0.2
	Heady (e)	1945	Iowa	0.07
	Heady (e)	1951	Iowa	0.09
	Egbert, French and Heady (e)	1937–54	Iowa	0.20
Livestock	Griliches (b)	1911–58	U.S.	0.2–0.3
	Heady (e)	1951	Iowa	0.23

(a) Estimates by Griliches are positive ; all other elasticity estimates are normative, being based on production functions estimated by the authors noted.
(b) Estimates of the aggregate U.S. farm supply function. *J. Farm Econ.*, 42 : 282-93. 1960.
(c) Production functions from farm records. *J. Farm Econ.*, 26 : 566-71. 1944.
(d) A note on the derivation of production functions from farm records. *Econometrica*, 12 : 26-34. 1944.
(e) Details in Heady, E. O. and Dillon, J. L. *Agricultural Production Functions.* Iowa State University Press, Ames. 1960. Ch. 16.

Perusal of Table II indicates rather good agreement between the positive and normative estimates. Too, the normative estimates do not conflict Griliches' conclusion that the short-run supply elasticities have been rising over time. Still there are provisoes : Griliches' estimates are national, ours are regional ; as well, apart from the fact that we will never enter the golden age of perfect production function estimates, some of the parent functions (Tintner and Brownlee, Tintner, Egbert *et al*) relate to a population of record keeping farmers who may really have tried to maximise profits !

10. Were we considering narrow product categories, additional resources would be variable since—especially on corn-belt farms—there would be opportunities for transfer between enterprises, despite the fact that these resources are fixed relative to the whole farm. Accordingly, elasticities for specific products would tend to be larger than those listed in Table II.