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DROUGHT AND THE MULTIPLIER*

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The effects of a 20 per cent across-the-board drought-year reduction in farm output upon G.N.P., imports and the balance of payments are estimated via an econometric model of the Australian economy. The effects do not appear to be overly large and taper off rapidly in succeeding years.

The rural sector of the Australian economy is characterized by a multitude of schemes of various types designed to raise or control or stabilize the prices of the various commodities produced, and hence, hopefully, to stabilize incomes. The wool industry, once the exception to this pattern, shows by its interest in a reserve price plan an inclination to conform. However, there remains variability of output due to climatic factors, as is demonstrated dramatically in a drought. Although recent work has suggested that climatic variability may be far less important as a source of income fluctuations than shifts in demand in our major rural industry, wool production,[1] a drought such as we have experienced in 1965-66 leads to a heightened interest in potentially costly mitigation measures such as a national fodder reserve. If individual farmers do not find it profitable to maintain reserves to protect themselves against drought, as the evidence suggests is the case,[2] the rationale behind any national scheme must turn on the impact of the drought on the economy as a whole.

This note is offered as a preliminary study of this topic. It does not claim to be any more than an approximate assessment, based on assumptions which more detailed work may prove in need of considerable amendment. The general approach is to assume that a "severe" drought (defined below) occurred and to trace out the effects on the national economy via a few aggregates, using an econometric model.

The econometric model we use is that modification of Nevile's model[3]

* We are indebted to J. L. Dillon for suggesting that we work on this topic. No blame, however, can attach to him for our procedure, or our conclusions.

[1] See A. Powell. "Production and Income Uncertainty in the Wool Industry: An Aggregative Approach". *Australian Journal of Agricultural Economics*, Vol. 4, No. 1 (July 1960), pp. 88-96.

[2] The main evidence is that graziers have not, in fact, provided themselves with reserves, in spite of a barrage of propaganda over the past fifty years. This decision of farmers receives support from the small amount of economic analysis which has been directed at this problem. Thus, in a recent paper, it is concluded that "Certainly the results of this study give little support to the view that graziers' investment in harvested fodder is suboptimal and that State intervention through subsidy or a national fodder reserve is therefore justified. Proponents of such a scheme would seem to bear the onus of proof that there is a marked divergence between the private and social net benefit from harvested fodder reserves." See J. L. Dillon and A. G. Lloyd. "Inventory Analysis of Drought Reserves for Queensland Graziers: Some Empirical Analytics". *Australian Journal of Agricultural Economics*, Vol. 6, No. 1 (September 1962), p. 67.

[3] J. W. Nevile. "A Simple Econometric Model of the Australian Economy". *Australian Economic Papers*, Vol. 1, No. 1 (September 1962), pp. 79-94.

which was developed to assess the effects of exogenous changes in farm income and exports brought about by the operations of a wool reserve price scheme.[4] The model does not require further elaboration here, although it need be noted that the parameters were estimated using data deflated by the implicit Gross National Expenditure deflator from *Australian National Accounts, 1948-49 to 1962-63*, with 1959-60 as base. For convenience, we assume that a drought occurs in that year.

Concerning the drought, we make a number of assumptions. Where it was necessary to choose amongst a number of possible assumptions we chose by the two criteria of simplicity for subsequent analyis and of choosing the assumption least favourable to the hypothesis that the effects of drought are slight. The assumptions are listed and discussed seriatim:

1. We assume that the effects of a drought are upon output and exports only, in the first instance. That is, we assume that the change in farm stocks is zero. This is, of course, an unrealistic assumption. Stocks are likely to be run down, in part to maintain exports. However, the multiplier effect of a reduction in exports is greater than of a reduction in farm stocks and the assumption removes the need to specify the quantitative effects on stocks.

2. Taking assumption 1 a step further we assume that

$$\Delta F_t = \Delta X_t \tag{1}$$

where ΔF_t, ΔX_t are defined as the changes in farm income[5] and exports induced by the drought. That is, given that there is no change in farm stocks, it is assumed that there is no change in domestic consumption of farm products in real terms, and that all effects are upon exports. This assumption probably leads us to overestimate the adverse change in the balance of trade. It has some justification in that even drought-level outputs of the major products are sufficient for domestic requirements, and in that the domestic prices of most major products consumed in Australia are subject to control. This is true, for instance, of wheat, sugar and dairy products.

Given assumptions 1 and 2, the econometric model reduces to

$$\Delta Y_t = k_1[0{\cdot}469\Delta Y_{t-1} - 0{\cdot}381\Delta Y_{t-2} + k_2\Delta F_t + 0{\cdot}074\Delta F_{t-1} - 0{\cdot}026\Delta F_{t-2}] \tag{2}$$

for

$$k_1 = 1/(0{\cdot}382 + m/[1 - m])$$

and

$$k_2 = 0{\cdot}475 + m/(1 - m)$$

where ΔY_t is the change in gross national product brought about by the drought. The constants k_1 and k_2 are determined by the marginal propensity to import m. The effect of a drought on imports is shown as

$$\Delta M_t = (m/1 - m)\ [\Delta Y_t - \Delta F_t]. \tag{3}$$

The estimated value for m in the original model, 0·471, may overestimate the marginal propensity to import. Hence, we have run the

[4] J. H. Duloy and J. W. Nevile. "The Effects of a Reserve Price Scheme for Wool on the Balance of Payments and Gross National Product". *Economic Record*, Vol. 41, No. 94 (June 1965), pp. 254-261.

[5] More precisely, gross operating surplus of unincorporated enterprises in primary production.

analysis for a range of values, 0·3 to 0·6. "Small" values of m, as to be expected, yield larger values of ΔY_t and smaller values of ΔM_t (both in absolute terms). However, these effects do not significantly affect our conclusions. All results in the body of this note relate to $m = 0{\cdot}471$; other results are tabulated in the Appendix.

3. We define a severe drought as one in which an across-the-board reduction of 20 per cent occurs in the volume of rural output. That this would be severe can be seen by looking at the reductions in output incurred during the 1944-45 drought, as shown in Table 1.

TABLE 1

Effect of the 1944-45 Drought upon the Output of Some Rural Products

Product	Unit	1943-44	1944-45	Percentage change
Wool	'000 lb. greasy	1,169	1,016	−13·1
Wheat	million bushels	110	53	−48·2
Sugar	'000 tons	524	670	+27·9
Meat	carcass '000 tons	1,043	983	−5·8
Milk for all purposes	million gallons	1,067	1,012	−5·2

4. A drought is not a once-and-for-all phenomenon. Its effects continue for a number of years. Arbitrarily, we define these residual effects as

$$\Delta Q_{t+1} = 0{\cdot}5\Delta Q_t$$

where ΔQ_t is the change in the volume of rural output in t from the level it would otherwise have been. It is probable that this process of asymptotic return to non-drought output overstates the speed at which pastoral production would return to normal, especially in the early years. It certainly understates the position for cropping, where a full crop is obtainable in the first non-drought season.

5. Were overseas demand for Australian rural products inelastic or of unit elasticity, our model would imply that droughts were of no concern. However, whilst demand is probably elastic, it is unlikely that changes in Australian production have no effect on price. In the absence of better information, we assume, again arbitrarily, that the effect of a 20 per cent reduction in output (and exports) is to lead to a 10 per cent reduction in the value of output.[6] This reduction in the

[6] On the following argument, this involves our assuming that η, the (constant) elasticity of demand, is −1·6 using the exact formula or −2·0 using the approximation below. Those whose taste is for a different elasticity may use the formulae to investigate the consequences for elasticity values of their choice. We have that

$$\Delta R/R = (\Delta Q/Q)^2/\eta + \Delta Q/Q(1 + 1/\eta)$$
$$\simeq \Delta Q/Q(1 + 1/\eta).$$

We use the approximation, together with the assumption that all changes in Q and F in periods subsequent to the drought are relative to their values in the drought year. Then, with costs constant,

$$\Delta F = \Delta R = r\Delta Q$$

where r is an unobserved constant given by

$$r = R_o/Q_o(1 + 1/\eta)$$

with R_o, Q_o being the values which would have obtained in the drought year, if no drought had occurred.

value of output was applied to the gross value of farm production from *Australian National Accounts, 1948-49 to 1962-63*, which, in 1959-60 stood at $2,656 million. Hence we assume a reduction of $266 million.

6. There is some doubt concerning the effect of a drought upon farm costs. Some, such as marketing and harvesting costs, are likely to fall. Depreciation seems unlikely to change. Others may rise. If any increases in costs were effected through increased demand outside the rural sector for low import-content goods, some off-setting stabilization would occur. Acting through ignorance, we assume no change in costs.

We now apply the reduction in the value of farm output ($266 million) to the model, such that ΔF_t (the change in gross operating surplus of unincorporated enterprises in primary production) was —$266 million in the first year. Hence our assumptions lead to a substantial percentage change in F_t, which was $1,312 million in 1959-60.

Given the above assumptions, we can compute ΔY_t, ΔM_t, and ΔB_t, these being changes in G.N.P., imports, and the balance of trade respectively, all in 1959-60 prices. The results appear in Table 2.

TABLE 2

Effects of a Drought upon G.N.P. and the Balance of Trade

($ million)

t	$\Delta F_t = \Delta X_t$	ΔY_t	ΔM_t	ΔB_t
1	−266	−285	−17	−249
2	−133	−263	−116	−17
3	−67	−85	−17	−50
4	−34	+11	+39	−72
5	−17	+11	+25	−68
6	−9	−9	0	−9

Note: The figures are rounded to the closest $ million. The marginal propensity to import, m, is taken as 0·471.

It will be noted that the multiplier effects of changes in farm income are small. ΔF_t equal to —$266 million leads to ΔY_t equal to —$285 million. The depressing effect on G.N.P. was exhausted after about three years. To see the effect on G.N.P. in perspective, G.N.P. in 1959-60 was approximately $13,800 million, so that the change in G.N.P. in the first year would have been about —2 per cent of G.N.P. that year.

Of more interest are the values for the changes in imports (ΔM_t) and changes in the balance of trade ($\Delta B_t = \Delta X_t - \Delta M_t$). In only the first year is ΔB_t substantial. In later years, a reduction in imports occurs to partially offset the depressing effect of the drought on exports.

This study has been characterized by a very high degree of aggregation. A more satisfactory study would look closely at the different effects of droughts on different products to obtain better estimates of output changes, and how these are distributed over time. It would enquire into the likely effects on receipts of these output changes for different commodities, and would entail a detailed study of farm costs. An econometric model expanded for the rural sector is indicated. The present analysis includes all these requirements as deficiencies. We have been concerned with changes in real terms and have abstracted from

monetary effects and their reaction back on real variables. Droughts may have an effect on wage fixation, both by an increase in consumer prices and, in the opposite direction, by an increased resistance to wage increases because of the impact of drought on exports. We have abstracted from all such considerations. However, we are inclined to believe, because most of our assumptions were chosen not to minimize the effects of drought, that a fuller study would not upset our main conclusions.

These are that the effects on G.N.P. are small; that the reduction in exports is more substantial relative to the magnitudes involved in the balance of payments, but that such adverse movements are of short duration due to a reduction in imports; and, taking into account the relative magnitude of the induced changes on external account and the stochastic nature of drought, the effect on the balance of trade is not of particular concern given the levels of overseas reserves generally obtaining. These reserves, held as a hedge against adverse changes on external account, seem adequate for the purpose of mitigating the national effects of drought.

APPENDIX

Effects of a Drought given Various Levels of the Marginal Propensity to Import, m

($ million)

m	t	1	2	3	4	5	6
	ΔF_t	−266	−133	−67	−34	−17	−9
0·3	ΔY_t	−297	−321	−124	+40	+62	+7
	ΔM_t	−13	−81	−25	+32	+34	+7
	ΔB_t	−253	−52	−42	−65	−51	−15
0·4	ΔY_t	−289	−293	−101	+24	+28	−8
	ΔM_t	−135	−107	−23	+38	+30	0
	ΔB_t	−250	−26	−44	−71	−47	−9
0·5	ΔY_t	−284	−253	−81	+6	+6	−9
	ΔM_t	−18	−120	−14	+39	+23	−1
	ΔB_t	−248	−13	−52	−72	−39	−8
0·6	ΔY_t	−279	−219	−69	−9	−6	−9
	ΔM_t	−20	−130	−5	+37	0	0
	ΔB_t	−246	−3	−62	−70	−17	−9

Note: The figures are rounded to the closest $ million.