The Short-Term Economic Effects of Environmental Constraints on Forest Industries

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Recently there has been much concern regarding the use of forest resources in Australia. Proposals have been made to governments that would safeguard the forest environment but add to the costs of forest and logging industries. An analysis of the short-run effects of such proposals using the ORANI general equilibrium model suggests that downstream wood-using industries and the economy in general would suffer small declines in output but that activity and employment in the forest and logging industry itself may increase.

I. Introduction

In recent times there has been considerable public discussion concerning the utilization of forest resources.[1] One development has been the establishment by the Victorian state government of a Timber Industry Inquiry (Ferguson 1985). The Inquiry has investigated and reported on all aspects of the timber industry in Victoria and suggested options for the long-term development of Victoria's timber and forest products industries. An important recommendation of the Inquiry which has since been accepted by the state government concerns the criteria for managing the forest resource (Government of Victoria 1985). In the past management has been guided by the principle of sustained yield supplemented by subjective judgements concerning multiple use. The Inquiry has proposed that forests should be managed so that net social benefits are maximized. In operational terms this has been interpreted in four principles, economic viability, sensitivity to environmental concern, long-term sustainability and public participation in the planning process. Ferguson (1985, pp. 118–127) fully discusses the issues of past and recommended management objectives. He points out that concerning sustained yield "the underlying model assumes that the sole objective of management is to maximize the average annual production of wood in perpetuity subject to maintaining the annual cut at a constant level in terms of volume". The widening of management guidelines to explicitly include environmental aims is likely to lead to additional constraints on the operations of the forest and logging industry.

In this paper, the short-term effects of constraints on the forest and logging industry are explored using a general equilibrium model. These short-term effects are of immediate concern to people working in forest industries who fear a reduction in production and employment in the industries facing change. The results reported here suggest that these fears may be exaggerated.

In the next section, background information regarding the forest and logging industry is provided. The forest and logging industry is defined and some important characteristics of the industry are discussed. Relevant aspects of the debate over environmental safeguards are outlined and the employment characteristics of forest and logging and other wood-based industries are described. A crucial relationship between current output and capital formation in the

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[1] In 1980, three world-conservation groups, including the United Nations environmental program, published a world conservation strategy (*see* International Union for Conservation of Nature and Natural Resources (1980)). This was followed by two Australian discussion papers (*see* The National Conservation Strategy Task Force (1982) and The State Conservation Strategy Task Force (1983)).

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forest and logging industry is explained. The third section of the paper presents the results of an ORANI simulation of the economic effect of environmental restrictions on the forest and logging industry. The results are discussed in the fourth section. In the final section of the paper some conclusions are drawn in relation to the likely short-term effects of environmental restrictions and suggestions made concerning likely long-run effects on employment.

II. Background

A major theme in two recent Australian conservation reports (National Conservation Strategy Task Force 1982; State Conservation Strategy Task Force 1983) and in the recent Timber Industry Inquiry (Ferguson 1985) is that afforested areas, including those designated for timber production, should be seen and managed as multi-use resources. Over the past decade there has been strong growth in the use of afforested areas for tourist and recreational activities (Ferguson 1985, p. 198). Concomitantly there have been growing demands that existing flora and fauna be protected. The effect of these developments has been that government bodies advising on the use of resources have made recommendations incorporating the restriction of logging on environmental grounds (Land Conservation Council 1983). In response, people associated with logging and related industries have publicly expressed fears that implementation of these recommendations will reduce the economic viability of their industry, and result in the closure of some plants and increased unemployment, particularly in non-metropolitan areas.

The regional importance of forestry and forest-based industries is shown in Table 1. This table shows that almost 90 per cent of employment in the forest and logging industry occurs outside the capital cities. The sawmill products industry, which is the first step in the refinement of wood, is also concentrated outside the capital cities. Seventy per cent of the jobs which it provides are in country areas. Further downstream, the position is reversed. Employment in the plywood and veneers industry is split, half to the capitals and half elsewhere. However the joinery and wood products industry employs 70 per cent of its workers in the capitals. More recent information describing the regional importance of forestry and forest-based industries is provided for Victoria by Ferguson (1985, pp. 11–13). Ferguson shows that in 1981 in Victoria, the proportion of employment located outside of Melbourne was about 78 per cent in forestry and logging, 65 per cent in sawmilling, 66 per cent in panel products and about 50 per cent in pulp and paper industries. The forest-based industries are also major sources of employment in some regions. Ferguson shows that in the North-Eastern, East Gippsland and Central Gippsland Statistical Divisions, wood-based industries accounted for 21, 49 and 31 per cent of total manufacturing employment in 1981.

The role of the forest and logging industry in the economy is shown in the national input-output tables (Australian Bureau of Statistics 1983). Activity in the forest and logging industry includes both the physical extraction of logs and the provision of services required for the upkeep and development of the forestry resource. The main users of logs are the wood-based industries shown in Table 1. Services associated with the upkeep of forests (mainly the activities of the state forests commissions) are counted as current consumption by the government sector. The development of forests

Table 1: Regional Distribution of Employment in Forest-related Industries in Australia, June, 1976

Location of Employment	Forest and logging	Sawmill products	Plywood and veneers	Joinery and wood products	Total
Capital cities	1 127	6 475	2 802	15 054	25 458
Elsewhere	9 316	15 912	2 789	6 091	34 108
Total	10 443	22 387	5 591	21 145	59 566

Source: Industries Assistance Commission (1981, p. 11).

for future use is treated as capital work on its own account. That is, investment in the industry includes not only the purchase of machinery used in its activities (tractors, chainsaws, *etc.*) but also the thinning and re-planting of forests, refurbishment of access roads, *etc.*, operations which are classified as current output of the forestry and logging industry itself. As will be explained in the next section, the extent to which the forest and logging industry undertakes capital work on its own account is crucial to the short-run impact of environmental restrictions on the industry.

III. The ORANI Simulations

ORANI is a general equilibrium model of the Australian economy which is sufficiently disaggregated to distinguish explicitly the wood-based industries listed in Table 1.[2] The model was used to project the short-run consequences of the imposition of environmental constraints on the forest and logging industry. Any such constraints would be likely to vary from locality to locality but their general nature would be similar to those described in the report of the Land Conservation Council (1983). The guidelines in that report include recommendations that logging should not be permitted in buffer zones a certain distance on either side of water courses, that logging should not be permitted in areas where slopes exceed thirty degrees, and that areas of significant vegetation communities should be protected. The report also provides recommendations for specific sites. For example, it suggests that logging might be banned or restricted in sites which are important for conservation or recreation reasons.

From an economic viewpoint the impact of such restrictions would be to increase costs in the forest and logging industry. For instance, if access to a valuable timber stand were close to a particularly beautiful area or an ecologically sensitive community, loggers might be required to build snigging tracks (rough tracks through forest country used by timber-getters) over less favourable routes or longer distances. In another instance logging might be barred altogether from a high-yielding stand because it also contained some rare or endangered plant or animal. Loggers would have to resort to lower yielding, less economically viable stands.

For simulation purposes, the impact on costs of environmental restrictions is summarized by assuming that, at fixed input prices, the amount of all produced and primary inputs required to maintain the existing output level in the forestry and logging industry would rise by 10 per cent.[3] Hence, if all inputs were in perfectly elastic supply and if output remained constant, costs would increase by 10 per cent. However, a crucial assumption underlying the short-run simulations is that industry-specific capital stocks are fixed. In this situation, output in the forestry and logging industry could only be maintained by a rise in the labour/capital ratio and at the expense of a cost increase in excess of 10 per cent. Whilst the industry would attempt to increase its capital input by increasing its level of investment, the model assumes a gestation lag on capital formation which prevents the new capital from being available for use in production within the short-run period. As will be shown, in the general equilibrium solution the rise in the costs, and hence in the selling prices, of the forest and logging industry will affect the demand for its output so that the activity level does not remain constant.

Table 2 shows the effects on the output of selected industries, of the simulated cost increases in the forest and logging industry. The major downstream wood-based industries, numbers forty to forty-seven, show the expected declines in output. These occur because, as the

[2] The ORANI model is described in Dixon, Parmenter, Sutton and Vincent (1982). The model's data base includes nine industries closely related to forestry. These are forest and logging, sawmill products, plywood and veneers, joinery and wood products, furniture and mattresses, pulp and paper products, fibreboard, paper products (not elsewhere classified) and newspapers and books.

[3] This is equivalent to imposing a 10 per cent, neutral technological deterioration on the industries' production function. The choice of the size of the shock, 10 per cent, is arbitrary. Little information is available concerning the likely costs imposed by particular environmental legislation. For example, Ferguson (1985) contains no estimates of the magnitude of likely costs to the forest and logging industry. However ORANI is solved in the linear percentage change form. Consequently the effect of shocks of different sizes can be found by multiplying the results presented here, by the ratio of the size of the shock chosen, to ten. The effects of technological improvements are obtained by scaling the results in the manner suggested and reversing the sign of the results.

costs of raw timber to each industry increase, so the price of its product rises and demand for the product falls. For these simulations it was assumed that wages are fully indexed to the consumer price index[4]. Hence, a price increase in any industry producing for local consumption will be passed on, via wage increases, as a cost increase to all other industries. Table 2 shows a number of industries, not directly connected with forest and logging which, in our simulation, suffer declines in output because of this mechanism.

negligible. Such is the case for communication, banking, education and welfare (industries 97, 98, 107 and 108). However, exporting industries, the agriculture-based industries (industries 1, 2 and 3) and the miners (industries 12 and 13), are assumed to face elastic foreign demand curves, so that their outputs decline substantially. Import competing industries such as clothing, footwear and motor vehicles and parts (industries 38, 39 and 68) also face foreign competition but in ORANI the elasticity of substitution between imports and

Table 2: Effect of a Cost Shock on Industry Output

Industry No.	Industry description	Per cent change in output for ten per cent increase in forest and logging inputs
10	Forest and logging	+2.356
Wood-based industries—		
40	Sawmill products	−1.072
41	Plywood and veneers	−0.506
42	Joinery and wood	−0.114
43	Furniture, mattresses	−0.108
44	Pulp and paper	−0.228
45	Fibreboard	−0.027
46	Paper products n.e.c.	−0.079
47	Newspapers and books	−0.027
Industries contributing to investment in forest and logging—		
76	Agricultural machinery	+0.329
77	Construction equipment	+0.834
Exporting industries—		
1	Pastoral zone	−0.094
2	Wheat/sheep zone	−0.054
3	High rainfall zone	−0.131
12	Iron	−0.021
13	Other metallic minerals	−0.063
Import-competing industries—		
38	Clothing	−0.010
39	Footwear	−0.070
68	Motor vehicles and parts	−0.034
Service industries—		
97	Communication	−0.008
98	Banking	−0.007
107	Education	−0.000
108	Welfare	−0.003

Source: Projections from ORANI using 1974–75 input-output data based on Australian Bureau of Statistics (1981).

The extent to which industries are projected to contract when their costs increase depends upon the ease with which they can pass on cost increases, that is, upon the elasticity of demand for their products. Where the elasticity is assumed to be low, as in the service industries, the output effects are

[4] Whilst the assumption of full-wage indexation is reasonable in the current climate of the Accord, it is not likely to be vital to the results. An alternative assumption of partial indexation would reduce the magnitude of the negative effects on output of all industries.

domestic output is assumed to be high (though much less than infinity). Declines in output in these industries are also substantial.

It was noted in section II that the output of the forest and logging industry is absorbed in three main uses. The first is the group of downstream wood-based industries. In the simulation their demand for wood is quite inelastic. The ORANI production functions do not allow the substitution of other inputs for wood[5]. Moreover, the sales of the wood-based industries are oriented heavily to the domestic market. The government sector is the second major customer of the forest and logging industry. (Recall that the industry includes the activities of state forests commissions as part of its output). In the simulation government current consumption is exogenous. The final usage category is capital work on own account. It is a shift in this category which explains the positive projection for the forest and logging industry in Table 2[6]. The mechanism in ORANI by which environmental restrictions would induce the industry to increase its investment was explained at the start of this section. (A real-world example might be the need to survey and replan those areas of the forest in which logging is not subject to restrictions). Capital work on own account constitutes a sufficiently important component of the total activity of the industry that the increase in demand for its capital services more than outweighs the reduction of demand for timber in the downstream wood-based industries. The increased investment in the forest and logging industry also explains the positive effects on the output of two other industries in Table 2 that are significant suppliers of inputs to capital formation in forest and logging. These are agricultural machinery and construction equipment (industries 76 and 77).

IV. Discussion

The key result of the simulation was the increase in output in the forestry and logging industry which occurred when the costs of inputs to the industry were raised. The mechanism which produces this result has been explained above. Now, the plausibility of the results are discussed in the light of econometric and other evidence. The result rests on two key assumptions; that the forest and logging industry faces an inelastic demand curve, and that the forest and logging industry increases investment in response to the imposition of environmental constraints. These assumptions are discussed in turn.

Ferguson (1979) has modelled the demand for sawn timber as a function of own price, per capita income and the proportion of housing starts to total dwelling commencements; and the demand for paper products as a function of own price and per capita income. He found that the price elasticity of demand for sawn timber was between −1.3 and −2.5 (an average of −1.7) for four Australian states, and the price elasticity of demand for paper products was −0.6 for Australia as a whole.

The comparable price elasticities implied by the ORANI simulation may be obtained from the output responses of the relevant industries to changes in the price of their products. The three most relevant industries are the sawmill products industry, the pulp and paper products industry and the paper products (not elsewhere classified) industries. In the simulation the output responses of these industries to a 1 per cent increase in own price was −0.36, −0.35 and −0.22 per cent respectively. The response in the sawmill products industry translated to an increase in the demand for the output of the forestry and logging industry of −1.08 per cent by the sawmill products industry. The change in the price of the output of the forest and logging industry was 12.85 per cent so the price

[5] The ORANI production functions allow the substitution of labour (but not other inputs) for capital. The elasticity of substitution between labour and capital is assumed to be 0.5. For discussion regarding the assumption of fixed proportions between physical inputs see section IV. As stated there this is a reasonable assumption in the short run, however in the longer run it is likely that higher prices for timber goods would encourage some replacement by plastic and metal substitutes.

[6] It should be noted that an increased output for the forestry and logging industry as a whole will not be spread evenly through the components of the industry. The industry is composed of two distinct parts; forestry and services to forestry, comprising about 40 per cent of the total and which is mainly the activities of state forestry commissions, and logging comprising the remainder which is largely private sector establishments engaged in the felling of trees and hewing or rough shaping of timber (Australian Bureau of Statistics 1979, p. 149). In the simulation presented here it is likely that although the output of the industry as a whole will increase in the short-term, the output of the logging part may decline.

elasticity of demand for the output of the forest and logging industry in the sawmill products industry was only -0.08 per cent. That is, the price elasticity of sawmill products of -0.36 translates to a price elasticity of -0.08 for forest and logging output. Since sawmill products uses 44 per cent of the output of the forest and logging industry this result will have a major influence on the overall price elasticity of demand for forest and logging output.

Ferguson's results are obtained from data which represent the total effect of all factors which have affected consumption over the period of the regression (1954 to 1972). Doran and Williams (1982) have pointed out that with respect to the demand for sawn timber, taste and technology factors are just as important as price. The Bureau of Agricultural Economics (1977 and 1985) have supported the view that substitution away from timber products in house construction is often a consequence of factors other than price. They give examples of two such factors, the lead time between order and delivery, and the type of building being constructed. (The trend to construction of flats rather than houses in recent years has mitigated against wood usage since less timber is used in the construction of flats than in the construction of houses). Since Ferguson's elasticities for sawn timber consumption have been obtained in an environment when only the last of these factors is held constant, they will not be comparable to the ORANI results. If for instance the factors mentioned above are positively correlated with price then, in the regression, a part of the change in demand caused by these factors will be attributed to price and the estimated price elasticities will be too high. If on the other hand they are negatively correlated with price the estimated elasticities would be too low. Similarly his results for paper products will not account for factors other than price although in this case the elasticities he obtained are not too dissimilar to those implied by ORANI.

Given that there is some doubt about the elasticities for sawn timber the ORANI results have been recalculated using an elasticity of -1.7 (rather than the implied value of -0.35). The effect of the higher elasticity is that instead of the output of the forest and logging industry increasing by 2.36 per cent, it decreases by 1.8 per cent.[7] So even in this situation, the environmental constraints which force a 10 per cent increase in inputs per unit of output have only reduced the level of output by 1.8 per cent.

In the ORANI model the criterion which determines investment for an industry is the rate of return to the industry compared to the rate of return to other industries. In this simulation environmental constraints have been imposed which induce a 10 per cent increase in physical inputs and fixed factors for a given level of output. Since the total stock of capital is fixed in the short term, output can only be maintained by an increase of labour with respect to capital (*i.e.*, substitution of labour for capital). Consequently the rental price of capital and the rate of return on capital will be driven up, above the expected rate of return to other industries. Investment in ORANI is allocated across industries by equating the expected rates of return between industries. So investment in the forest and logging industry will increase in order to reduce the expected rate of return in that industry to the level of all other industries. How representative is this, of investment criteria used by the forest and logging industry?

Ferguson (1985, pp. 106-108, pp. 118-127) points out that in the past, State Forest Departments have undertaken investment on the basis of "sustained yield". One interpretation of sustained yield, also leads to an increase in investment in response to the imposition of environmental constraints.

The constraints are likely to lower the yield of physical output from the current investment in the forest and logging industry. However the areas of forest designated for logging are generally only a part of the total forest resource available to state governments

[7] The net result of the 12.85 per cent increase in the price of the output of the forest and logging industry is an increase in output of 2.36 per cent. This increase may be disaggregated into a fall in demand of 1.08 per cent from the largest downstream user, the sawmill products industry, falls in demand by other downstream users, such as the pulp and paper products industry (0.23 per cent) but a rise in demand from investment in forest and logging. About 44 per cent of output goes to the sawmill products industry. The question is what would be the effect if demand in that industry were 4.8 times as elastic as implied by the ORANI results (1.7/0.35); that is, if the elasticity was about 1.7 as claimed by Ferguson. A 5.2 per cent (4.8 x 1.08) drop in the demand for the output of the forest and logging industry would be sufficient to reverse the activity response of the industry as a whole. In the simulation all other effects have caused an increase in output of 3.44 per cent (2.36 + 1.08) so presuming they stay the same the net effect on output would be a fall of 1.8 per cent.

(Ferguson 1985, ch. 7). Since in Ferguson's words "the sole objective of management is to maintain a constant volume of cut (physical output)", a lower yield leading to a lower volume of cut in the designated areas will simply induce investment in other areas. Whilst Ferguson recommends that in the future, this criterion be abandoned in favour of one based on net social benefits (*see* discussion in Part I) in the short term it will still be the basis on which investments are made.

V. Conclusion

One of the main objections to proposed environmental legislation restricting the forest and logging industry has been the detrimental effect it might have on economic viability and employment in forest-based industries, particularly in the country areas in which they are located. The analysis reported in this paper suggests that in the short-term most of the detrimental effects of such legislation would bear on downstream industries rather than on forest and logging itself. In fact the projections indicate that activity in the forest sector might increase temporarily because of the increased capital work required to facilitate the continuation of logging after imposition of environmental restrictions. Since the downstream industries are not as concentrated in country localities as is the forest and logging industry itself, the regional effects could well be favourable.

It is important to note that the analysis refers only to the short run. In the longer run we would expect environmental restrictions to have a negative effect on the *output* of the forest and logging industry for at least two reasons. Firstly, the investment mechanism which we have identified as stimulating the industry is a short-run phenomenon. Secondly, in the long run we would expect the elasticity of demand for timber to be greater than is allowed in the model specification used for this study. A longer-run perspective would require that timber users have the opportunity to substitute other inputs (metals, plastics, *etc.*) for timber. As far as *employment* in forest and logging is concerned, however, the longer-run picture is not so clear. For these particular assumptions, so long as output in the industry does not contract by as much as 10 per cent, employment would increase since the restrictions are assumed to imply an increase of 10 per cent in the input of labour required per unit of output.

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