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SHORT-RUN APPLICATIONS OF ORANI: AN IMPACT PROJECT PERSPECTIVE*

ALAN A. POWELL

University of Melbourne

I. INTRODUCTION

Cronin's attack (1985) on the ORANI model, and on its use, consists essentially of the following claims:

(i) The model as a whole has not been validated.

(ii) The closure of the model is deficient (for example, it completely fails to treat monetary and financial variables, and its treatment of the trade balance is unsatisfactory).

(iii) Pricing behaviour in the model is counterfactual.

(iv) Employment behaviour is unconvincing in the light of empirical observation.

(v) Commodity exports are too responsive to changes in prices and costs.

(vi) The assumption of a full flow-on of prices into wages is too extreme.

(vii) The time interval corresponding to the short run in ORANI is poorly defined : "the model lies outside calendar time and outside the observable universe".

(viii) "Custom built, partial equilibrium models" offer a better alternative.

Of the eight objections listed above, the five indicated by a Roman numeral in bold type reflect choices about closure and/or parameter values under the control of the model user. These five objections do not necessarily reflect disagreement with the structure of the model so much as complaints about how it has been used. As a senior official of an IMPACT Project participating agency, Mr Cronin has immediate access to the ORANI model, which on occasion has been used by the Bureau of Industry Economics in the preparation of policy submissions. Thus his comments about what he regards to be unsatisfactory features of the model have been helpful when he has used his preferred closures and/or parameter settings to produce alternative simulations. The differences between the policy implications of these simulations, and those produced by the IAC, by members of the IMPACT Project team, or by other users whose views are at variance with his, help to clarify the sensitivity of the model to various choices made by the user. This was his approach in (1984), but unfortunately

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not in the paper (1985) to which the current paper is a response. In particular, in the context of Cronin's principal worry (the effects on industries of structural pressures such as tariff changes), his continuing to follow a more constructive approach would put us in a position to know which of his objections 'matter' in the sense of producing policy advice contrary to that favoured by him. As it is, with respect to most issues we lack an operational measure with which to judge the size of the gulf between him and those he criticizes. It is not sufficient to claim that some simplification made in a model violates perceived fact; by their nature, all simplifications (and therefore, all models) are non-factual. It has to be shown that, relative to the context in which the model is being used, the simplifications in question 'matter'. Cronin fails to do this, and thereby misses an opportunity to focus discussion on issues where the pay-offs to further research could be expected to be greatest.

His remaining three points (nos (i), (vii) and (viii)) consist of two misleading statements and an unproven (indeed, in the context of his pape , an unargued) assertion. Statement (i) is misleading because it implies the existence of data sufficient to conduct validation trials of the sorts routinely applied to quarterly macrodynamic models. As explained below (and as I have pointed out elsewhere (1981)), time series data are available for only a tiny percentage of the many thousands of variables appearing in ORANI. Statement (vii) is misleading because it fails to reference some six IMPACT Project papers, (Cooper (1983), Cooper and McLaren (1980, 1982, 1983), Cooper, McLaren and Powell (forthcoming and 1983)) which deal specifically with the quite difficult methodological task of defining, operationally, the length of run in comparative static models. *Inter alia* these papers deal also with the development and application of indirect methods to validate models such as ORANI. Three of these papers (Cooper (1983), Cooper, McLaren and Powell (forthcoming and (1983)) also give an estimate of the extent to which features of ORANI's macroeconomic closure disliked by Cronin 'matter' in the policy-analytic sense defined above.

The balance of this paper is structured as follows. Section 2 contains a discussion of the available closures of ORANI from the vantage point of the options they provide for users who, like Cronin, feel uncomfortable with the short-run closure favoured by the model builders. In Section 3 the issue of disputed parameter values is addressed. Finally, in Section 4, I offer some concluding remarks.

2. Closures Available In ORANI

2.1 *The Standard Short-Run Closure*

The applications of ORANI under attack by Cronin mostly involve the closure known in the IMPACT literature as the 'neoclassical short run with slack labour markets' (hereafter, 'standard short-run closure'). This closure is neoclassical (rather than neo-Keynesian) in that relative prices are a critical element in the determination of the values of quantities in the solution. It is short-run in the sense that the policy or other shock under analysis is not allowed to affect the amounts of plant and equipment in use. The shock is, however, allowed to affect the demands faced by capital goods

producing industries, and the outputs of these industries, which responds to endogenous changes in the investment plans of all industries. A natural way of thinking about the short run, therefore, is as the gestation period of investment. While undoubtedly there will be, in the real world, variations in this lag across industries, one to two years might accord with commonsense for a typical industry. 'Approximately one year' was the value put forward in early IMPACT writings (*e.g.* Powell (1977)) before the path-breaking research of Cooper and McLaren (1980, 1982, 1983) led to empirical estimates of about double this value. Finally, 'slack labour markets' apply in this closure because it is assumed that all occupations are in excess supply at the going set of real wages. To many of us this seems a reasonable approximation to reality for the Australian labour market over the last decade.

2.2 *The ORANI-MACRO System*

The standard version (Dixon *et al* 1982) of ORANI, when used in a standard short-run closure as a stand alone system, lacks macroeconomic closure in two senses: first, in that certain variables of macroeconomic interest are set exogenously; second, in that, apart from the exchange rate, and the prices of commodities and factors, monetary and financial variables do not appear in ORANI at all. As noted by Powell *et al* (1983), three macroeconomic variables routinely are set exogenously:

"(i) one of the price level or the exchange rate (as numeraire),

(ii) one of the real wage or the aggregate level of employment,

(iii) one of real absorption (C+I+G) or the balance of trade surplus (X-M).

"These three choices are forced on users of ORANI (in stand-alone mode) because there are no mechanisms in the model suitable for determining:

(I) the extent to which induced changes in the real exchange rate will be realized as changes in the domestic inflation rate relative to the foreign rate or as changes in the nominal exchange rate;

(II) the extent to which induced changes in the buoyancy of the labour market will be realized as changes in real wages or as changes in employment;

(III) the extent to which induced changes in national income will be realized as changes in aggregate absorption or as changes in the balance of trade."

Neither the IMPACT modellers, nor insofar as we can tell, Cronin, would suggest that Walrasian theory at its current stage of de elopment would be of much use in supplying the missing closures alluded to above. Essentially two options are available: (a), to supplement ORANI with a small macrodynamic model (this seems to be the thrust of the suggestion of Johansen quoted by Cronin); or (b), to undertake further developments of Walrasian theory. With Reserve Bank co-operation, extensive development along the lines of (a) took place at IMPACT over the years 1977-84 (see especially Cooper and McLaren, ((1980) (1982) (1983)); in the last of these years work also commenced on (b) (for further details see Powell *et al* 1983).

The ORANI-MACRO system consists essentially of the RBII model interfaced with ORANI. Simulations on the combined system allow RBII, interactively with ORANI, to endogenize the nominal price level, the nominal exchange rate, real and nominal wages, consumption, investment and the balance of trade. The key result so far as Cronin's worries are concerned is that making due allowances for the feedbacks of a tariff shock onto the macroeconomic environment only introduces second-order corrections to the projections obtained from standard short-run applications of ORANI in stand-alone mode.

TABLE I:
PRINCIPAL RESULTS OF A 25 PER CENT TARIFF INCREASE
IN THE ORANI-MACRO SYSTEM*

Endogenous Variable	(1) ORANI Response allowing for effect of tariff change on the macro-economic environment	(2) Standard ORANI Response
Output	-0.089	-0.123
Prices	1.862	1.805
Employment	-0.167	-0.205
Real Imports	-1.322	-1.528
Value of Exports ($US)	-2.824	-2.523

* Standard version of ORANI (Dixon *et al* (1982)), 1968-69 data base, standard short-run closure, stand-alone simulation. All values are percentage changes.

Source: Cooper (1983). See also Cooper, McLaren and Powell (forthcoming) or Powell, Cooper and McLaren (1983).

The results in Table 1 illustrate the above result. According to ORANI in stand-alone mode, a 25 per cent across-th -board increase in tariffs in an environment in which real wages, the nominal exchange rate and real aggregate demand (*viz.*, absorption) are held exogenously constant, after about two years results in contractions in GDP and employment of 0.123 percent and 0.205 percent respectively. By this it is meant that after about two years these variables would vary from the values which they would have taken if there had been no tariff shock, by the percentages indicated. The GDP deflator is projected by ORANI to stand 1.805 percent higher than it would otherwise have done after the two year lag.

The tariff shock, however, does not leave the macroeconomic environment unchanged. According to the combined model system, the nominal exchange rate, the real wage rate, real consumption, real investment, and capital stocks in.use, all adjust in response to the shock. The net feedback of these adjustments into ORANI account for the differences between columns (1) and (2) in Table 1.

2.3 *Fixprice Closures*

Cronin (1985) makes a fleeting reference to a fixprice closure of ORANI (Dixon, Powell and Parmenter (1979)) but fails to mention the implications of such closures. What motivates the use of these fixprice closures?

By several authors, including many of those quoted by Cronin (e.g. Coutts *et al* (1978), Okun (1975)), it is believed that the prices of industrial goods and other products subject to 'customer markets' do not respond to short run changes in demand, especially if it is thought by producers that these influences may only be temporary. Cronin's linkage of this literature to the ORANI standard short run is curious,

(a) because the macrodynamic short run upon which this literature focuses is typically a matter of one or a few quarters,

and

(b) because the shock for which the ORANI results are regarded by Cronin as least satisf ctory (*viz.*, a tariff change), patently is not a temporary aberration, and would therefore enter producers' expectations without the usual heavy attenuation accorded to short-run market signals.

The behaviour of prices over the macrodynamic short run (say 1-4 quarters) is not a matter of disputation between Cronin and the IMPACT modellers. Although the latter do not feel altogether comfortable with fixprice closures of ORANI (the reasons would take us too far afield), such closures ave been investigated with a view to demonstrating that the structure of the model (as distinct from its closure) is quite capable of producing results with a Keynesian flavour (see *e.g.* Dixon *et al* (1979), section 3.5). Such closures are obtained by exploiting the feature of ORANI which endows it with so much flexibility; namely, the option of swapping variables between the endogenous and exogenous lists. Whereas in the standard short-run closure the stocks of capital in use in each industry are exogenous and unit profitability (more accurately, the implicit unit rental rates) are endogenous, in fix-price closures these roles are reversed. This is meant to simulate the macrodynamic short run under conditions in which there is excess capacity and an inflexible supply price for the services of capital. Together with a resetting of the substitution elasticity between capital and labour to the value zero, this causes prices in ORANI to behave as if following a mark-up rule. Further, if exports are made exogeno s, ORANI's qualitative behaviour is scarcely distinguishable from a Keynesian based macro model.

Two fascinating results emerge from these experiments with fixprice closures. Firstly, although the relevant trade-off schedules are different as between the fixprice and the standard closures, and although the time frames vary, the macroeconomic policy stances towards real wage costs and aggregate demand supported by ORANI simulations are not sensitive to the choice of closure (Dixon *et al* (1979)). Moreover, the results seem to be robust under a change in the model's data base (compare Parmenter (1983) with Norman (1981)). Secondly, although the relative sizes of the price and quantity responses of particular industries to a change in protection are sensitive to the closure (as they should be — the adjustment periods being so different), the qualitative features of the results in both closures concur. This is especially true of tariff changes

on individual commodity groups. Wright and Cowan (1980) compared fixprice with standard short-run projections for the Clothing and Motor vehicles and parts industries. The shocks were tariff cuts specific to these industries. These results are reproduced in Table II.

TABLE II:

COMPARISON OF RESULTS OF SIMULATING A TEN PER CENT REDUCTION IN THE POWER OF THE TARIFF FOR A LABOUR INTENSIVE INDUSTRY (CLOTHING) AND A CAPITAL INTENSIVE INDUSTRY (MOTOR VEHICLES AND PARTS) IN STANDARD SHORT-RUN AND IN FIXPRICE CLOSURES*

	Clothing		Motor vehicles and parts	
Variable	Standard Short Run	Fixprice	Standard Short Run	Fixprice
Own industry output	-1.2860	-1.3086	-6.5371	-9.5971
Own industry employment	-1.4027	-1.3056	-9.4596	-9.5971
Own industry price	-0.1545	-0.0572	-3.1201	-0.3595
Consumer price index	-0.0684	-0.0758	-0.5407	-0.3856
Balance of trade	0.0006	0.0128	-0.0176	0.0116
Aggregate employment	-0.0054	0.0365	-0.0550	0.0456

* All values are percentage changes with the exception of the balance of trade which is in billions of 1968-69 Australian dollars. The power of the tariff is defined as one plus the *ad valorem* tariff rate (when the latter is expressed as a proportion).

Source: Wright and Cowan (1980).

Finally it should be noted if Cronin believes that

> "the unsupportable feature of SRO [short-run ORANI] is the specification that all markets behave as fully flexible auction markets in the short run",

then the suggestion of Wright and Cowan (1980) in favour of mixed flexible/fixprice closures is an option available to him and to other users.

2.4 *The Exchange Rate and Trade Balance in the Short Run*

The standard ORANI short run is a period long enough for complete adjustment in all relative prices, for the net movements in inventories to be zero, for new investment plans to be made and for new equipment to be ordered, produced and installed (but not yet switched on). It is a period long enough for labour usage to have adjusted to the new cost-minimizing level. Such a period is by definition long enough for transient influences, such as a shock in a monetary variable (the nominal exchange rate, say), to have worked themselves out.

In a standard Walrasian system such as ORANI, absolute prices do not appear. Cost minimizing factor combinations and revenue maximizing product mixes are found by equating relative price ratios to marginal rates of substitution and transformation respectively. In stand-alone applications of such a model the nominal price level and the nominal exchange rate are relevant only to the extent that they affect relative prices. As explained above in Section 2.1, either of these nominal variables is satisfactory as a numeraire for the model (of course, any other nominal price could be chosen). As far as our trading terms go, the *real* exchange rate is the relevant variable. This might be defined as the quantum of foreign goods that must be traded at the going nominal exchange rate and domestic price level in order to purchase one man-hour of standard quality Australian labour. If it is assumed that the shock in question (a tariff change, say) does not affect the rate of inflation in foreign countries, and further that changes in the CPI move fully into money wages within two years, then the relevant real exchange rate is the ratio of the nominal exchange rate ($A per Swiss Franc, say) to the Australian CPI. Any combinations of variations in the latter two variables which lead to the same percentage change in their ratio will produce identical results in ORANI, in the sense that the projections of all real variables and all relative prices are totally insensitive to the partition of a given movement in the real exchange rate between its two components. This is just as true of the trade balance (expressed as a fraction of GDP) as of any other real magnitude. To put it less formally, a nominal exchange rate appreciation of one percent is identical in ORANI to a one percent domestic inflation which is not allowed to erode real wages. If Cronin (or any other model user) objects that a contemplated nominal exchange rate change (say, under a managed exchange rate regime) would have an effect on real wages lasting two years or more, then the model can be solved with a nominated change in real wages as an exogenous input (this is exactly what the MACRO-ORANI link achieves in an automated fashion). Notice, though, that the action in real variables in generated by changing relative prices, not by the nominal change as such. As Corden (1974) points out, nominal devaluations are totally ineffective in the face of real wage resistance.

In the standard short-run closure criticized by Cronin, the balance of trade (rather than real absorption) is allowed to vary in response to the shock under analysis (see item (iii) in the list of choices detailed in Section 2.2. above). For shocks which might be expected to have a substantial impact on GDP within two years — increased mineral exports, say — the roles of these two variables have often been reversed (see, *e.g.* Dixon *et al* (1979), ch.4). The important point to note here is that neither in perspectives derived from international trade theory, nor in ORANI simulations, does real GDP vary in response to currency fluctuations unless relative factor rewards vary. Given the rigidities of the Australian labour market, projecting such variations is outside the scope of models such as ORANI, which treats such variations as an exogenous input.

Cronin raises and dismisses various options for external closure of ORANI without reference to the documented standard procedures in either short- or long-run applications thereof. He treats the ORANI standard short run as if it should be a period of months (rather than years), and complains that the short-run mechanisms relevant for such a period are lacking (a feature noted by the IMPA T modellers in even the earliest discussion papers — see e.g. (Powell and Lawson (1975)). He fails to provide suggestions for an operational long-run external closure, or to comment on proposals for such made publicly by the IMPACT team as early as 1981 (Dixon *et al* (1984)).

2.5 *Long-run Closures*

Since Cronin only makes a passing reference to long-run applications of ORANI, only the briefest details need be given here. The basic idea behind long-run closures is that Australia forms a small part of the world capital market and so, in the long run, the rates of return on different types of investment are exogenous to Australia. Whereas in the standard short-run closure, rates of return adjust to a shock with no change in the sizes of industries, in the long run these roles are reversed, with the capital stocks of industries adjusting to preserve the externally given rates of return. This swap of variables between the endogenous and exogenous lists has always been technically possible with ORANI; its use for long-run closures w s pioneered by Dixon, Harrower and Powell (1977) and by Vincent (1980). The main shortcoming (correctly identified by Cronin, but publicly identified much earlier by the project team — see *e.g.*, Vincent (1980)) was the failure to treat foreign capital flows and foreign ownership of the capital stock. Thus Cronin is right to observe that in these long-run simulations, GDP (as distinct from GNP) cannot be relied upon as a measure of domestic welfare. (He did not, incidentally, establish that the focus on GDP had led to errors in the particular long-run applications criticized by him: that remains an open research question). The addition of the necessary equations to ORANI was proposed and implemented on a miniature version by the project team in 1981 (Dixon *et al* (1984)); the treatment was further elaborated n 1983 (Horridge and Powell (1984), and implemented on the full model by Horridge during 1984 (draft documentation being available to the BIE since October in that year, see Horridge (1985)). Since Cronin appeals to authors such as Rogers (1983) who fully repudiate (along Cambridge (U.K.) ideological lines) the very application of Walrasian ideas to production models, one dares not hope that these developments in long-run modelling will impress our critic. In view of the more extensive closure (which includes domestic consumption and savings behaviour), however, he might be persuaded to drop his claim that ORANI is not a general equilibrium model — a claim that sits very strangely with the interest in ORANI evidenced at international conferences of general equilibrium modellers in London (Ontario)(1980 and 1982), Laxenburg (Austria) (1980), San Diego (1981), Stockholm (1982), Canberra (1983), London (U.K.) (1984), New York (1984) and Sopron (Hungary) (1984).

3. Disputed Parameter Values

3.1 *Employment*

Industry employment is another area where standard short-run results from ORANI are regarded as unsatisfactory by Cronin. In particular these results apparently violate the empirical generalization known as Okun's Law, which states that in the upswing of the business cycle, the percentage increase in employment is less than the percentage increase in output; and conversely, in the downturn, the fall in output exceeds the fall in employment. The first point to make is that ORANI tariff simulations have little, if anything, to do with the business cycle. An ORANI standard short-run result is of the form: 'if such and such a change in the tariff is implemented,

then, about two years later, employment in such and such an industry will be so much (x percent) higher (lower) than it would otherwise have been, and output in that industry will differ from its *ceteris paribus* value by so much (y percent)'. Cronin's objection is that the ratios (x/y) always exceed unity in standard short-run applications of ORANI, and commonly have values of about 1.6.

As we have seen, in the standard short-run closure of ORANI, plant and equipment in use is not allowed to respond to the shock in question (a tariff change, say). This highlights the difficulty of matching observable data with ORANI projections. In any calendar time period the observed changes in output result not only from changes in labour usage but from changes in everything else, including installed capacity and technology. If one wants to make comparisons between the historical record and an ORANI result, components of change due to these other influences have to be subtracted before taking the ratio of the output change to the change in labour usage. Only in some of the empirical studies cited by Cronin are the sources of output change finely enough identified to allow comparisons with ORANI. Among the studies satisfying this criterion, the most relevant is the Australian study by Phipps (1983), who analyses annual time series data on eight ASIC divisions over the period 1962-63 to 1976-77. His results for manufacturing are of most interest since they relate to the sector in which the ORANI theory, according to Cronin, is most likely to cause trouble. In ORANI the short-run employment demand functions are of the form

$$\left(\begin{array}{l}\textit{percentage change in employment}\\ \textit{in industry } i\end{array}\right) = \left\{\begin{array}{l}\alpha_i\ (\textit{percentage change in real output in industry } i)\\ \qquad +\\ \sigma_i\ (\textit{percentage change in product price in industry } i - \textit{percentage change in wage rate paid}\\ \textit{by industry } i)\\ \qquad +\\ (\textit{technological shift terms})\end{array}\right. \qquad (1)$$

The parameters α_i and σ_i are set respectively to unity (reflecting homotheticity and 0.5 for all industries i in ORANI's short-run parameter file. Phipps provides estimates (with associated t ratios) of $\alpha = 0.981\ (13.97)$ and $\sigma = 0.521\ (4.552)$ for these parameters in the manufacturing sector (ASIC Division C). Thus in manufacturing, the observed historical data on employment is indeed consistent with the ORANI theory and short-run parameter settings. The ORANI story is also broadly consistent with Phipps' reading of the time-series data in Construction (Division E) and in Entertainment, etc. (Division L) where the corresponding estimates are $\alpha = 0.753\ (5.028)$, $0.773\ (1.748)$ and $\sigma = 0.562\ (3.159)$, $0.459(1.428)$ respectively. Estimates in other ASIC divisions give lower (and on the whole, less statistically significant) values for both parameters.

The coverage of Phipps' study may be measured in terms of the proportion of the national wage bill corresponding to the ASIC Divisions for which he reports disaggregated estimates. On the latest ORANI database (Bruce (1985)), this is about

68 per cent. No evidence is presented for the remaining 32 per cent. The sectors for which, at the 5 per cent level, neither α differs from unity, nor σ from 0.5, account for 36 percentage points of the total coverage (*i.e.*, more than half).

The highly unsatisfactory results (σ = - .019, t = 0.355) obtained by Phipps for Agriculture (ASIC Division A -- about 6 per cent of the wage bill), provide only weak evidence against the ORANI parameter settings. Using data from the BAE's Australian Grazing Industry Surveys, Vincent, Dixon and Powell (1980) also found σ to be extremely poorly determined, the likelihood surface being very flat with respect to this parameter. Clearly more research is needed. Phipps' apparently well determined estimates of $\sigma = 0.312$ ($t = 3.595$) for Mining (ASIC Division B — about 2 per cent of the wage bill) and $\sigma = 0.217$ ($t = 3.891$) for Electricity, Gas and Water (ASIC Division D — also 2 per cent), deserve further attention and, possibly, incorporation into the ORANI parameter file.

The major problem areas raised by Phipps' study are ASIC Division F (Wholesale and Retail Trade — about 13 per cent of the wage bill) and Transport, Storage and Communication (ASIC Divisions G and H, about 9 per cent of the wage bill between them). The elasticities of substitution estimated here are extremely low and poorly determined: $\sigma = .006$ ($t = 0.062$) for Division F and $\sigma = .043$ ($t = 0.598$) for Divisions GH. Possible reasons for the apparently unsuccessful estimation of σ include the difficulty of measuring the output of the margins industries independently of their inputs, and the possibility that technical changes over the period violated Hicks neutrality (a maintained assumption in Phipps' study). Because these points estimates, besides having poor statistical precision, are so low as to strain credulity, I do not find them a convincing argument in favour of deviating from the default setting of $\delta = 0.5$ for ASIC Divisions F, G and H. The net import of the relevant part of Cronin's critique, therefore, is that values of σ might be revised for industries accounting for about four per cent of the national wage bill, and that more research is needed in several areas.

In any event, Phipps' study demonstrates that the available empirical evidence supports the behaviour of manufacturing output and employment as generated by ORANI simulations. Cronin's exaggerated statement of the tension between ORANI and independent empirical evidence perhaps is based on a confusion between total differentials (whose finite counterparts are directly observable) and partial differentials (whose counterparts are not). Also, much of the evidence referenced by Cronin works at too high a level of aggregation to be compared meaningfully with ORANI.

3.2 *Behaviour of Exports*

In ORANI, exportable commodities fall into two classes: those for which the ORANI theory/database is judged to be suitable for endogenizing export flows (mainly agriculture, mining and foodstuffs), and those for which this is judged not to be the case (mainly manufactures).· In the latest data base (Bruce (1985), Higgs (1985)), endogenous exports (identified in Table III) account for 64 percent of the value of all exports. Cronin disagrees with the settings of parameters which endow the producers

of some endogenous export commodities with partial equilibrium supply elasticities in excess of unity, and with the adoption of export demand elasticities η of the order of -20 for commodities other than wool ($\eta = -1.3$). He argues that both sets of values are too high in absolute value for the ORANI standard short run. He also states that the ORANI short run is a period 'so long that exports will double in response to a five percent reduction in production costs', a statement so misleading as to require explicit refutation before considering the substa tive issues.

TABLE III:
ENDOGENOUS EXPORT COMMODITIES IN ORANI*

	Share of Commodity Exported (a) (percent)	Share of Total Exports Represented by Commodity (b) (percent)	Elasticity of Export Demand
1. Wool	88	10.5	-1.3
3. Wheat	76	5.6	-12.5
4. Barley	83	1.2	-20.0
5. Other cereal grains	39	0.5	-20.0
14. Ferrous metal ores	84	6.5	-10.0
15. Non-ferrous metal ores	37	4.0	-8.0
16. Black coal	69	9.3	-20.0
20. Meat products	31	10.1	-10.0
27. Other food products	28	4.2	-20.0
32. Cotton ginning, wool	60	1.3	-2.6
66. Basic non-ferrous metals	55	11.3	-10.0
		64.5	-7.0(b)

* Latest database — (Bruce (1985)). (The commodity A2 sheep was deleted from the list of endogenous exports shortly after Bruce completed his paper).

(a) These values are the basic value of export sales as a proportion of the basic value of output.

(b) Weighted average (for all exports) with weights from previous column.

It is not clear whether 'exports' means 'aggregate exports' or the exports of a particular commodity; whether costs mean total costs or variable costs (and if the former, how the cost of fixed inputs is to be imputed); and whether the alleged relationship between the percentage change in exports and the percentage reduction in costs is partial equilibrium or general equilibrium. Moreover, since costs are endogenous variables in ORANI, even clarification of the foregoing would not be sufficient to eliminate ambiguity, the result depending on the particular exogenous shock which caused the reduction in costs. However, consider the following interpretation:

The export demand schedules move upwards and to the right so that the ratios of prices paid for inputs to prices received for outputs at the initial output level of all exporters fall by five percent. By how much do aggregate exports expand in a general equilibrium solution of ORANI?

The answer is obtained by direct simulation with the ORANI model. On the latest data base (Bruce (1985)), shifting the foreign demand schedules up by one percent leads to a 0.87 percent expansion (after about 2 years) in aggregate export volume (corresponding to a 1.76 percent increase in the foreign currency value of exports); a five percent reduction in the ratio of costs to product prices would then lead to a 4.35 percent increase in exports (not 100 percent as suggested by Cronin). (The 1968-69 data base (see Dixon *et al*, (1982)) would give similar results; the 1974-75 data base could yield magnitudes 2 or 3 times greater. This consideration led to the development by Adams (1985) and Higgs (1985) of a 'typical year' data base for agriculture.)

Cronin's argument with the export demand elasticities for individual commodities in ORANI is long standing (*see*, e.g., (1978)). Since observed export volumes depend on overseas demand, local demand, and local supply, one would not be surprised if attempts to estimate export demand elasticities using single equation techniques on time series data ran into trouble. Aggregation to the one commodity level before estimation could be expected to make almost impossible the detection of overseas demand responses for individual commodities; yet these aggregate single equations time series estimates are cited as relevant by Cronin. If one believes Australia has the market power that these elasticities (in the range -0.12 to -0.75 as quoted) imply, then it would be in Australia's interest as a whole to impose export taxes (the optimal tariff argument). Given our relatively small share in the world production of commodities other than wool, it is hard to accept that we indeed have such market power. (On this issue, and on the values of the demand elasticities, see Scobie and Johnson (1979)).

There is serious tension in Cronin's belief that Armington elasticities (*i.e.*, the demand side substitution elasticities between imports in an input-output class and the domestic commodity of the same name) for Australian imports in the ORANI parameter file are too low while the export demand elasticities (in absolute value) are too high. If the rest of the world is treated as a single unit, the demand functions for an Australian export might be written

$$x = z + S\sigma(p^W - p^A), \tag{2}$$

where x is the percentage change in rest-of-world imports of the Australian commodity, z is the percentage change in the relevant activity variable for the rest of the world (real income for consumers, real output for producers); S is the share of non-Australian producers in total demand for the product in the rest of the world; σ is the Armington elasticity expressing the degree of substitutability, from the viewpoint of foreign customers, between the Australian commodity and the foreign competing product; p^W and p^A respectively are the percentage changes in the price of the foreign and Australian commodities of the same input-output class. The Australian commodities which are endogenous exports in ORANI are staples. It would be reasonable, therefore, to expect the relevant Armington elasticities to be higher than the ORANI Armington elasticities for industrial products. A value of $\sigma = 10$ would not be excessive for staple products. For most products other than wool, S in equation (2) is

close to unity. If we ignore the income/expansion effects of a change in the Australian price (which in any event would be second order), the elasticity of export demand confronting us is simply $-\sigma S$. We do not find it counter-intuitive that the average value of σ across Australian endogenous exporters would be of the order of 10 (to be consistent with the average value of $\eta = -7$ of Table III, we require $\sigma S = 10.9$). Nor do we believe that the empirical studies cited by Cronin shed any light on this. To do so, they would have to be couched in terms of price variables like the ratio of the Australian wheat price to the rest of the world wheat price, *etc.*

Cronin's second line of attack on the export demand elasities (1978) is the segmented markets hypothesis. On this view, there is not one world Market for a commodity, but several, effectively sealed off from each other. He then argues that in terms of the market available to Australia, S is small. Fallon's attempt (1981) to make reasonable adjustments for such factors, however, does not substantially decrease the resultant demand elasticities facing Australian exporters.

Above I have shown that the export dema d elasticities in ORANI take values whose orders of magnitude are more reasonable than aggregate time series estimates quoted by Cronin. Is it crucial that the export demand elasticity should be a number like -7 rather than (say) -1.7? In response to Cronin's earlier criticism (1978), members of the IMPACT team did extensive sensitivity analysis, Dixon *et al* (1985). Their conclusions were as follows:

> "Quantitatively, what is most notable about the [macroeconomic] results is their insensitivity to variations in the export demand elasticities. Certainly it is only at very low, probably implausibly low, elasticities that the usual ORANI based conclusion [that 'increases in tariffs will destroy as many jobs as they create and will not improve the balance of trade']... is called into question."

The sensitivity of three other ORANI based conclusions was also evaluated; namely, the robustness of the propositions

(1) "that import-competing industries would not be in danger of immediate collapse under the effects of reductions of 25 percent or even more in their rates of protection;

(2) "that the regional effects of overall increases in protection are uneven with benefits concentrated in one State, Victoria ...

and

(3) "that tariff reform will not lead to unmanageably large adjustment problems in the short run."

It was concluded that

> "the export demand elasticities in ORANI can be varied over a wide range without leading to tariff simulation results which are inconsistent with the [above] ... conclusions. To use ORANI to support a position seriously at variance with these conclusions, we would have to believe that export demand elasticities are, on average, less than one."

3.3 *The Length of the ORANI Short Run*

The length of the ORANI short run may be regarded as a parameter of the model. Its estimation requires mapping the behaviour of variables in a comparative static time frame into real time. This cannot be done directly.

Research by Cooper and McLaren (1980), (1982), (1983) (not discussed by Cronin) attacked the problem as follows. ORANI contains aggregate variables which appear in the RBII model (Jonson and Trevor (1981)). These variables are measured quarterly and track the observed real world data with reasonable precision (using this term in the context of macrodynamic modelling). The behaviour of these variables in MACRO (a slightly modified RBII) sets the standard for empirical validation. A method for interfacing ORANI and MACRO is then devised which is conditional on the (as yet) unknown length of the ORANI short run. It is required that those variables which are endogenous to both models should have values, in the interfaced sys em, which are in agreement at the unknown lag equal to the ORANI short run. The latter is then found as the period of time elapsing between the injection of a shock in government spending and the achievement of such consistency in the double endogeneities (*i.e.*, variables endogenous to both models; namely, output, the domestic price level, employment and imports). The period so estimated is 7.9 quarters (Cooper (1983)). Cronin fails to comment either on the methodology or this estimate.

3.4 *Wage Indexation*

The flow-on of consumer prices into wages is handled in ORANI via wage-indexation parameters which are user selected. As explained above, the choice of 100 per cent wage indexation enables us to keep track of the influence of the effects of real wage changes, as distinct from other effects. Either judgementally, or by using the ORANI-MACRO system, real wage changes can be accommodated. ORANI has nothing to say about the prospects for squeezing real wages via changes in tariffs, exchange rates, or taxes. These judgements are left to the model user.

4. Concluding Remarks

Without appealing to experience with any existing set of industry-specific partial equilibrium models, Cronin sees them as a superior alternative to ORANI. One does not have to make an "either/or" choice, however. Special purpose models with an industry or sectoral focus can be, and have been, used in conjunction with ORANI. For applications requiring a high degree of resolution on industrial detail, this is the only feasible method of capturing all of the specific information without losing the economy-wide context. Examples are provided by Meagher, Parmenter, Rimmer and Clements (1983), who imbedded a model of grape growing, wine and brandy production, and alcoholic beverages consumption within ORANI; and by the IAC, who placed a special purpose model of the market for milk and milk products into economy-wide context by imbedding it within ORANI (1983).

Cronin's dissatisfaction with the ORANI model dates from 1976, when he was a member of the project team. His criticisms then, and since, have been valuable. When his suggestions have had operational content, we have followed them up. Where he has focussed on specifics (as in his paper (1984) to the trade parameters workshop), his contribution has served to sharpen the debate. Unfortunately, though, the paper to which I am responding is not so constructive. Broad assertions are made, allegedly on the basis of empirical evidence. When the evidence is examined, however, much of it is either found not to be relevant to the issues, or to actually support the ORANI position (as in the case of the behaviour of employment in manufacturing). There is a substantial IMPACT literature on a number of issues raised by Cronin which is not mentioned by him. One cannot help feeling that he is not fully aware of the volume of work that has been done in response to his, to our own, and to others' criticism of our work.

This work will continue. Absence of scale economies and/or non-competitive market structures is an area of weakness in ORANI. Until Harris' very recent contribution (1984 a and b), operational general equilibrium models incorporating these features did not exist. It is intended to take up this challenge at the IMPACT Project in the coming years (indeed work has already commenced).

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[Editors]

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