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Notes on the Evans Model of Protection*

I Introduction

H. David Evans has given us an ambitious and internationally acclaimed study of protection in Australia.[1,2] While the age and crudity of his data base reduce the relevance of his specific results,[3] we find his methodological approach, based on the earlier contributions of Sandee [13] and Manne [11], of great interest.[4] Hence, a major part of our paper (Section II) is concerned with the theory of the Evans model, while in Sections III and IV we consider some specific problems in its empirical implementation.

Our description of the model (Section II) follows the style of the modern general equilibrium theorists. We formally define an equilibrium situation, and assess the definition quite independently of problems of computation. This contrasts with Evans who wrote in the tradition of the planning literature and set out his model in the form of a programming problem. Our view is that a better understanding is obtained if the definition of equilibrium is clearly separated from the discussion of computational procedures.[5]

Section III lists the major limitations of the Evans model. Evans, himself, was well aware of most of these,[6] and some of the special problems of linear models of international trade have been raised by Lage [10]. However, our view is that Evans' work is of sufficient importance to warrant further critical examination. The recent *Report of the Committee to Advise on Policies for Manufacturing Industry*

* An earlier version of this paper [2], was presented at the Fifth Conference of Economists, Brisbane 1975. The authors gratefully acknowledge the comments of participants, especially those of N. Norman, N. Klijn and A. Pagan. However, the views expressed here are the authors' alone. They do not necessarily reflect the position of other persons or of any organizations.

1 Evans' work has been published in numerous forms [4, 5, 6, 7, 8]. Our review is based mainly on his book [7].

2 In his *J.I.E.* review of Evans, Henderson [9] wrote, 'David Evans has advanced effective protection analysis by a couple of light years'.

3 The principal data inputs are the CBCS 34 sector Input/Output tables for 1958/9.

4 Besides Evans, there have been numerous other applications of the Sandee, Manne ideas. See [14] for a survey.

5 Computational procedures for the Evans model are not discussed in the present paper. Interested readers could consult our earlier paper [2], where they are discussed in detail.

6 Evans [8] outlined several theoretical improvements to his basic model. Unfortunately, these have not as yet reached the stage of empirical implementation.

(Jackson Report [12]) cites Evans [7] as the major Australian applied work on the economic impact of protection. The Report also stresses the urgent need for further work. A detailed analysis of Evans' contributions will provide a good starting point for future research efforts.

Section IV develops some of the points in Section III in the context of various recomputations of the Evans model. We also use our recomputations to discuss a theoretical issue concerning Evans' treatment of investment.

We hope that the paper is intelligible to those who have not read Evans. However, we should emphasize that it is only by reading his work that one can gain an appreciation of his meticulous and ingenious approach to a myriad of theoretical and data problems.

II The Theory of an Evans Equilibrium

The Evans model is a tool for the analysis of the long-run economic impact of tariff reforms in a small open economy. It is principally concerned with the effects of tariff changes on factor shares in the national income, the industrial composition of national output, the commodity composition and size of trade and the share of aggregate investment in GDP.

The model is 'long run' in the sense that it gives a snapshot picture of the economy ten years after the tariff reform.[7] No attempt is made to simulate the industrial disruption which may immediately follow the reform. It is assumed that after ten years, the economy will have reached a situation which we will call an Evans equilibrium (EE). In the basic model,[8] an EE is a list of non-negative vectors and scalars

$$\Xi = \{c, Y, x, m, e, J, k(10), T, \theta, w, \pi, p\}$$

satisfying the following conditions:

(1) c maximizes $U(c)$
subject to the constraint $p'c = Y$ where

(1a) $Y = wL + \pi' k(10) + T + \theta F - p'KJ$

(2) $p'(1 - A) - wl' - \pi' \leqslant 0$
$(p'(I - A) - wl' - \pi')x = 0$

(3)[9] $J_i = r_i(k_i(10) - k_i(0)), i = 1 \ldots n$

(4) $\pi' \leqslant p'KR$
$(\pi' - p'KR)J = 0$

(5) $T = \sum_{i \epsilon \Gamma} t_i(\theta p^m{}_i) m_i$

[7] Confusions about timing in the Evans model may be avoided by reference to the diagram below.

	Base point ↓					Snapshot Year ↓		
Time	0 ——	1 ——	2 — . . . —	9 ——	10 ——		11 ——	12 — . . . . .
Capital Stocks	$k(0)$	$k(1)$	$k(2)$		$k(10)$		$k(11)$	

[8] For simplicity, we omit indirect taxes, home-price schemes and production and export subsidies. These are included in the Evans model and we take account of them in our computations in Section IV.

[9] J_i, t_i, p_i, etc., are the ith components of the vectors J, t, p, etc.

(6) $p_i \leqslant \theta p^m_i(1+t_i)$ and $(p_i - \theta p^m_i(1+t_i))m_i = 0$ A $i \epsilon \Gamma$
$p_i \geqslant \theta p^e_i$ and $(p_i - \theta p^e_i)e_i = 0 \ \forall i \epsilon \Gamma$
(7) $(p^m)'m - (p^e)'e \leqslant F$
$\theta((p^m)'m - (p^e)'e - F) = 0$
(8) $l^e x \leqslant L$
$w(l'x - L) = 0$
(9) $x \leqslant k(10)$
$\pi'(x - k(10)) = 0$
(10) $(1 - A)x + Nm \geqslant Ne + c + KJ$
$p'((1 - A)x + Nm - Ne - c - KJ) = 0$

where each of the vectors and scalars in Ξ refers to the levels of endogenous variables (i.e. variables whose values are to be explained by the Evans model) for the snapshot year (see footnote 7). In particular,

c is the $n \times 1$ vector of aggregate consumption levels,
Y is the aggregate consumption expenditure,
x is the $n \times 1$ vector of output levels,
m and e are the $v \times 1$ vectors of import and export levels for the traded goods, $v < n$,
J is the $n \times 1$ vector of net investment levels for each of the n industries,
$k(10)$ is the $n \times 1$ vector of industry capital levels,
T is the value of tariff revenue collection,
θ is the exchange rate (domestic currency per unit of foreign currency),
w is the wage rate,
π is the $n \times 1$ vector of annual net[10] rentals payable on units of capital in each industry, and
p is the $n \times 1$ vector of commodity prices.

The exogenous variables are
L, the number of labour units available in the snapshot year,
$k(0)$, the $n \times 1$ vector of industry capital levels at the *base* point (i.e. the time of the tariff reform).
r_i, the minimum net rate of return required in industry i to induce investment (R is a diagonal matrix with the r_i on the diagonal).
t, the $v \times 1$ vector of *ad valorem* tariff rates applicable in the snapshot year,
p^m, p^e, the $v \times 1$ vectors of foreign exchange cost and foreign exchange earning per unit of import and export of each of the v traded goods,
F, the balance of trade deficit in foreign exchange units,
A, the $n \times n$ input-output coefficient matrix,[11]

[10] π does not include the cost of repairing and replacing capital stock. Depreciation is handled via the A matrix (footnote 11).

[11] Evans' A matrix includes inputs for the maintenance of capital: he assumes that capital deteriorates with use, not time. $A_{ij} = a_{ij} + d_{ij}$ where a_{ij} is the input of good i absorbed by the production of a unit of good j and d_{ij} is the input of i required to maintain a unit of capital, type j, while it is being used to produce one unit of output.

l, the $n \times 1$ vector of labour requirements per unit of output in each industry, and

K, the $n \times n$ capital matrix — K_{ij} is the input of good i required to create a unit of capital stock for industry j.

U is a quasi-concave aggregate utility function with positive first derivatives combining the preferences of all households and the government.[12] N is a $n \times v$ matrix of ones and zeros which arranges the imports and exports in their appropriate positions in the market-clearing equations (10), and Γ is the set of subscripts of the v traded commodities.

Perhaps the least familiar features of an EE are conditions (3) and (4). Condition (4) defines the net rate of return on capital in each industry. It can be rewritten as

$$\frac{\text{Rental per unit of capital in industry } i}{\text{Cost per unit of capital in industry } i} \leqslant r_i \; i = 1 \ldots n,$$

with the strict inequality implying that there is no investment in industry i. Intuitively, condition (4) can be thought of as having the role of determining the capital stock vector, $k(10)$, for the snapshot year. For example, assume that we compute an EE where the rate of return in industry i is set at 10 per cent. Now we reset r_i to 20 per cent and recompute. We would expect the new computation to reveal a smaller value for $k(10)$. For capital in industry i in the snapshot year to earn 20 per cent, rather than 10 per cent, it must be relatively scarce.

Condition (3) describes investment in the snapshot year. It implies that for each industry, the rate of growth in the incremental (i.e., installed since the base year) capital stock equals the rate of return. Evans attempted to justify this assumption by appeals to the literature on golden-rules (see [7, Appendix 8]). In our opinion he was unsuccessful. The difficulty with (3) is apparent if we ask what happens when we change the snapshot period. For example, we would expect the ratio of the sixteenth year's increase in capital to the total expansion of the previous fifteen years to be less than the eleventh year's share in the previous ten years. However, the rate of return in year eleven might well be the same as in year sixteen. Perhaps a more plausible specification for the snapshot year investment is

$$(11) \qquad \begin{cases} J_i = h_i k_i(10), i = 1 \ldots n, \\ h_i = (k_i(10)/k_i(0))^{\cdot 1} - 1, i = 1 \ldots \mathrm{n}, \\ k_i(10) \geqslant k_i(0), i = \ldots n. \end{cases}$$

(11) implies that by the snapshot year, the rate of growth of capital in industry i, h_i, will have settled at the average rate of growth of the previous ten years.

Another novel feature of the Evans treatment of investment concerns the savings constraint. The reader will notice that there is no

12 [3, ch. 2] is an applied analysis of the conditions under which it is permissible to treat the aggregate consumption vector as though it arises from the constrained maximization of a *single* function.

savings function (explicit relationship between savings and GDP) as part of the definition of an EE. Consequently, there is no guarantee that an EE will imply a realistic level of aggregate savings for the snapshot year. However, in Evans' actual computations, plausible values for the average propensity to save, s, were obtained. Also, if we wished, we could impose a particular value for s by varying the *absolute* size of the r_is, while maintaining their relative values, see [1].

The remaining conditions for an EE are quite conventional. (1) describes consumer behaviour and defines the consumer budget. Where data is available, it would be desirable to distinguish between public and private consumers, and even to disaggregate the private household sector. For this to be possible, we need information on the consumption behaviour of different household groups (to allow the identification of separate utility functions) and on their factor endowments (so as to obtain the separate budget constraints). Condition (2) is the zero pure profits or competition assumption. (3) and (4) have already been discussed. (5) defines the tariff revenue collection. (6) is a series of pricing inequalities for traded goods. Import prices plus tariffs set ceilings for domestic prices while export prices set floors. (7) defines the balance of trade. (8) is the market-clearing equation for labour. Labour is treated as though it is a single homogeneous input and disaggregation into skill types would be an obvious and desirable model modification.[13] (9) provides the market-clearing equations for capital. Unlike labour, capital is assumed to be industry specific or non-malleable. The units for measuring capital stocks are chosen so that for all i, a unit of output of good i requires the use of one unit of capital of type i. (10) is the set of market-clearing equations for goods. Notice that (6) and (10) imply that for all $i \in \Gamma$, imports of good i are perfect substitutes for domestically produced i.

There are a number of questions which could be asked about an EE. They could be grouped under two headings (i) technical and theoretical and (ii) applications. Under the first heading, general equilibrium theorists will want to know about existence and uniqueness. Under the second, policy makers will be concerned with the reliability of the model projections of the effects of tariff reforms on the industrial composition and rate of growth of GDP, on the standard of living and on the distribution of income. In the remainder of this section, we will briefly consider the theoretical questions and in following sections we will move to the applications.

For the present context, the question of existence is less important than that of uniqueness. Our computations in Section IV, and Evans' own computations suggest that for plausible data (values for the exogenous variables), EEs are easily computed, and therefore obviously exist. On the other hand, no evidence has been produced on unique-

[13] See [1]. Evans contains some material on labour force disaggregation [7, ch. 7].

ness.[14] Non-uniqueness would seriously impair the usefulness of the Evans model as a tool for economic analysis: if there were two or more distinct vector lists, Ξ, satisfying (1)-(10), then the assumption that the economy achieves an EE would not be sufficient to enable us to forecast the effects of tariff reforms. Unfortunately, no general proposition on uniqueness which is immediately applicable to an EE is available. Also, the Evans model would appear to be too 'special' to make a theoretical investigation worthwhile. However, as a second best, one can compute EEs using a variety of starting points in the relevant algorithm. Convergence to a common solution is evidence (certainly not conclusive) of uniqueness. Our Brisbane paper [2] contains a computer analysis which led us to conclude that the assumption of uniqueness is likely to be valid.

III The Limitations of an Evans Equilibrium

As an instrument for projecting the effects of tariff reforms, the EE has some obvious limitations. For example, the comparison of EEs under alternative tariff regimes does not allow us to study the potentially interesting relationship between rates of return and tariffs, or the effects of tariff reforms on technology. The production technology matrices, A, K, and l, are assumed to be independent of the price and output vectors p and x. Thus the possibility of analyzing the technology substitution and scale economy effects of tariff reforms is ruled out. On the other hand, at first glance, the EE is a potentially attractive alternative to its main rival, the Barber, Balassa, Johnson, Corden theory of 'effective protection'. Evans [5 and 7, Ch. 8] has shown that for a complete analysis of the resource reallocation effects of a tariff reform, one needs a general equilibrium model which is capable of explaining factor prices, industry investment behaviour and exchange rates. Also, the Evans study demonstrates that although the data requirements for the general equilibrium approach are much heavier than those for an application of the 'effective protection' concept, they are not overwhelming. Nevertheless, it seems to us that while Evans' work has made a good case for the general equilibrium approach, his particular model is not very appropriate for the study of international trade.

The problem is that an EE tends to imply unrealistic levels of industrial specialization. Typical computations give very high growth and exports in one industry, while all other industries are stagnant or decline. Too few of the real-world phenomena which explain industrial diversification are modelled. Among the left-out diversifying factors are (a) terms of trade effects. (p^e and p^m are exogenous.) In particular, exports of any commodity can be expanded to any extent without lowering prices. (b) The regional, sex, age, skill, etc., composition of the

[14] For our discussion of uniqueness, two EEs which differ only in the absolute (and not relative) values of monetary variables (p, π, Y, w, T, θ) and which have identical values for the real variables (x, $k(10)$, J, c, m, e) are considered indistinct.

labour force. In the Evans world, there is no limit on the growth of any industry arising from shortages of appropriately skilled labour. Similarly, rates of decline are not restricted by labour immobilities between occupations and locations. (c) Diminishing returns to scale. All production in the Evans model is with constant returns to scale. There are no industries in which growth is restricted by non-producible factors such as land and scarce mineral resoures. (d) Uncertainty. There is no mechanism in the model to capture risk adverse behaviour in the capital market; there is no tendency in an EE for investment and growth to be spread across industries. The variance of expected returns is not a recognized argument in the investors' objective functions. (e) Differences in the properties of imports and domestically produced goods of the same name. In the model, imported and domestic cars, say, are perfect substitutes in all uses. Consequently, the model has a tendency to imply that the economy will either rely completely on imports for a particular commodity or completely on domestic production. In particular, there is no possibility of an EE reflecting the important real-world fact of intra-industry trade.

The diversifying factors which *are* included in the model are (a) transport costs and (b) industry-specific capital. Transport costs are recognized by setting $p^m_i > p^e_i$ and by declaring various commodities non-traded. This allows some industries to survive in an EE, supplying the domestic market only. Capital immobility is imposed via condition (3). Under (3), the base-year capital stocks cannot be transferred between industries.[15] Consequently, EEs typically show several industries surviving at their base-year size.

Not surprisingly, Evans found that transport costs and industry-specific capital are insufficient to induce an EE to exhibit a believable pattern of industrial specialization. He was forced to make a pair of seemingly arbitrary additions to the basic model (1)-(10). In most computations, he included the conditions

(12) $x \geqslant X,$

where X is an exogenously given vector of minimum output levels for the snapshot year. For all industries, he set $X_i \geqslant k_i(0)$, i.e., he allowed no industry to decline.[16] Also, throughout his computations he used the constraint

(13) $e \leqslant E,$

where E is a vector of maximum levels for exports in the snapshot year.

Both (12) and (13) could be included in our formal definition of an EE by the addition of production subsidies and export taxes. The use of (12) and (13) is equivalent to the assumption that production in each industry is subsidized to an extent sufficient to ensure (12), and exports are taxed to an extent sufficient to ensure (13). However, the

[15] Notice that (3) implies $k_i(10) \geqslant k_i(0)$ since $J_i \geqslant 0$.

[16] The minimum growth constraints (12) and the export limits (13) are listed in [7, p. 73].

key role of restrictions such as (12) and (13) is to impose realism by forcing an EE to imply a more diversified industrial structure.

IV Some Examples of Evans Equilibria

In this section we will illustrate the decisive role of the export limits (13) by comparing some computations in which (13) was applied with some in which it was relaxed.[17] Our second objective is to investigate the implications of replacing (3) with the intuitively more appealing (11). The computations also served a third purpose—to check the feasibility of a particular algorithm. This is discussed in [2].

Table 1 shows some results from our computations of EEs for six versions of the Evans model. We attempted, as far as possible, to use the Evans data base. Also, we included indirect taxes, inventory accumulation and various other complications which are part of the Evans model, but which, for simplicity, were omitted from our previous discussion.[18]

The six versions of the model were generated as follows. In versions (1), (2), (4), and (5), i.e., those marked 'MAXEX', constraint (13) was included. In versions (3) and (6) it was excluded. In the versions marked 'TARIFFS', the *ad valorem* rates, t_i, $i \in \Gamma$, were set at actual 1958 levels, while under 'FT', free trade, the t_is were zero. It should also be noted that the TARIFFS solutions reflect the influence of *minimum* export constraints,

(14) $e_i \geqslant b_i x_i$, $i = 13, 15, 16, 17$,

where the b_is are parameters. Evans included (14) in the protection model to simulate the effect of home-price schemes [7, p. 73]. He argues that home-price schemes had the effect of raising export shares in the output of the processed food industries (13, 15, 16 and 17, our numbering system) to 0·27, 0·23, 0·43 and 0·21 respectively. Finally, versions marked EIS, Evans investment specification, were computed under (3), whereas in versions marked OIS, our investment specification, (11) was used. Hence, column 2 is our attempt to reproduce Evans' projection of Australian industrial development under unchanged tariff policy, while column 5 is our version of his free trade simulation.[19] The remaining four solutions contain variations from the Evans specification—either (13) is deleted or the alternative investment behaviour (11) is assumed.

For each of the six solutions, the upper part of Table 1 shows the annual percentage industry growth rates (the industries are listed in the Appendix) over the ten years from the base year to the snapshot year, i.e.,

[17] We also investigated the role of (12) and found it less crucial than (13) in determining model solutions. In all the solutions in Table 1, (12) is operative. However, the non-shiftability of the base-year capital stocks was sufficient to keep outputs in most industries up to their base-year capacities without imposing (12).

[18] We attempted to reproduce the complete model set out in [7, p. 82].

[19] Difficulties in obtaining Evans' precise data prevented us from exactly reproducing his results. For example, Evans split industry 1 from the 1958 input-output table into three parts. Insufficient information was given to enable us to make this adjustment.

TABLE 1

Examples of Evans Equilibria

Industry*	(1) MAXEX TARIFFS OIS	(2) MAXEX TARIFFS EIS	(3) TARIFFS EIS	(4) MAXEX FT OIS	(5) MAXEX FT EIS	(6) FT EIS
	Percentage Growth Rates (h_i)					
1	5·87	5·89	3·04	9·27	8·76	3·04
2	4·83	4·83	5·35	1·84	2·16	2·32
3	1·41	1·41	1·41	1·41	1·41	1·41
4	5·14	5·17	0·0	0·0	0·0	0·0
5	0·71	0·73	0·0	1·16	1·21	0·0
6	13·16	13·11	30·33	12·15	12·02	31·57
7	0·0	0·0	0·0	0·0	0·0	0·0
8	0·0	0·0	0·0	0·0	0·0	0·0
9	5·11	5·16	5·45	5·65	5·77	5·45
10	7·42	7·30	0·0	0·0	0·0	0·0
11	0·0	0·0	0·0	0·0	0·0	0·0
12	0·0	0·0	0·0	0·0	0·0	0·0
13	4·10	4·22	4·55	3·88	3·63	0·0
14	4·11	4·22	0·0	3·84	4·56	0·0
15	3·50	3·61	4·12	38·56	36·10	1·41
16	4·71	4·83	5·32	0·0	0·0	0·0
17	4·32	4·43	4·87	5·26	5·20	2·39
18	0·0	0·0	0·0	0·0	0·0	0·0
19	0·0	0·0	0·0	0·0	0·0	0·0
20	0·0	0·0	0·0	0·0	0·0	0·0
21	0·0	0·0	0·0	0·0	0·0	0·0
22	0·0	0·0	0·0	0·0	0·0	0·0
23	4·35	4·41	0·0	9·24	8·68	0·0
24	11·91	11·93	0·0	18·54	17·61	0·0
25	0·0	0·0	0·0	0·0	0·0	0·0
26	5·07	4·90	5·32	6·41	5·48	5·36
27	4·67	4·73	4·61	3·92	4·48	4·63

TABLE 1 (*Continued*)

28	4·86	4·90	5·86	5·42	5·59	6·01
29	4·58	4·60	6·52	4·33	4·54	6·75
30	2·68	2·72	2·96	3·27	3·46	2·97
31	4·67	4·75	5·24	4·41	5·05	5·34
32	4·30	4·36	4·72	4·26	4·65	4·81
33	4·36	4·43	4·89	4·19	4·76	4·98
34	3·77	3·78	3·91	4·00	3·99	3·96
Exports as a Share of Domestic Output ($p_i e_i / p_i x_i$)						
1	0·40	0·39	0·19	0·29	0·30	0·28
3	0·44	0·44	0·42	0·36	0·35	0·42
6	0·65	0·66	0·93	0·72	0·72	0·94
13	0·27	0·27	0·27	0·0	0·0	0·0
15	0·23	0·23	0·23	0·89	0·92	0·0
16	0·43	0·43	0·43	0·12	0·07	0·05
17	0·21	0·21	0·21	0·0	0·0	0·0
Macro Variables						
Wage Rate (w)	1·240	1·240	1·440	1·390	1·380	1·600
Exchange Rate (θ)	0·840	0·830	0·680	0·870	0·860	0·700
GDP	10526	10463	10750	10813	10776	10743
Consumption	8093	8156	8549	7897	8397	8629
Consumption/GDP	0·769	0·779	0·795	0·730	0·779	0·803
Imports/GDP	0·110	0·110	0·175	0·229	0·211	0·182

* Industry names are listed in the Appendix.
Industries 2 and 26-34 are non traded.

$$h_i = (k_i(10)/k_i(0))^{\cdot 1} - 1, i = 1 \ldots n.$$

The middle part of the table shows the export share in total output for those industries which have exports in any of the solutions. The lower part gives model solutions for various macro variables. These are expressed in terms of consumption bundles. For example, in solution 1, the wage rate, w, will buy 1·24 standard consumption bundles; 0·84 standard consumption bundles exchange for 1 unit of foreign exchange, etc. The same consumption bundle is used in all solutions so that cross solution comparisons are legitimate.

The most notable feature of Table 1 is the similarity between the solutions in columns (1) and (2) and between those in columns (4) and (5). This implies that the replacement of (3) with (11) has had only a minor impact. The growth rates (h_i) implied by the Evans model for the ten-year period following the base point are not sensitive to the introduction of the unjustified Evans assumption that the rate of return (r_i) in each industry is the same as the ratio of the eleventh year's increase in capital stock to the increase of the previous ten years. On the other hand, there are some interesting differences between the OIS and the EIS solutions in the macro variables. For the free-trade model, the consumption share in the GDP is much higher in the EIS version (column (5)) than in the OIS version (column (4)). In fact, the consumption share in column (4) is so low that the comparison of columns (1) and (4) reveals that with the removal of tariffs, consumption in the snapshot year is *lower* than it would have been had the tariffs been maintained. If we follow Evans and compare columns (2) and (5) we obtain the more conventional result that the shift to free trade is associated with an increase in consumption. The explanation for our rather strange result appears to be as follows. In the free-trade solutions, there are some extremely fast-growing industries. For these industries, our assumption that investment in the snapshot year is sufficient to maintain the growth rate of the past ten years implies very large investments compared with the Evans assumption (3). Obviously, on the basis of our result, we cannot jump to any conclusions about the welfare effects of moving to free trade. Evans gives a long list of reasons as to why his model is inadequate for measuring the costs of protection [7, p. 111]. However, it seems that we can add one more. The gains from free trade, as measured by the change in consumption between the TARIFFS and FT solutions, depend on the specification of the snapshot year investment; both Evans' (3) and our (11) are without theoretical or empirical justification.[20]

Columns (3) and (6) are included in Table 1 to illustrate the problem of over-specialization, discussed in the last section. The dominant role of the export constraints (13) can be seen by comparing column (2) with (3) and (5) with (6). In our solutions, and Evans'

[20] The empirical and theoretical investigation of the implications of alternative snapshot year investment specifications is part of G. A. Meagher's current Monash Ph.D. project.

own computations, exports are confined to at most seven industries, and even this limited diversification is imposed on the model via 'special' restrictions. In all the TARIFFS solutions, the home-price schemes (14) combined with the minimum growth constraints (12) force exports to be positive in industries 13, 15, 16 and seventeen. Minimum growth constraints explain exports in industries 1 and three. These two industries were constrained to grow at no less than 3·04 and 1·41 per cent per annum respectively and since they were major export industries in the base year, the imposed growth rates ensure that they must be export industries in the snapshot year. Minimum growth constraints also explain the free-trade exports in industry sixteen. Output in industry 16 was set to a level beyond domestic requirements. Industry 6 (other mining) is the only industry for which the Evans model implies exports without coercive restrictions. Notice that in the TARIFFS model the removal of the exports limits (13) increases exports in industry 6 primarily at the expense of industry 1 (grains), while in the free-trade solutions industry 6 takes over from industry 15 (jam and fruit canning) as the major exporter.

V Conclusion

The Evans model is an important methodological contribution to the study of protection. As such, it warrants detailed and critical examination. In this paper we have reviewed the Evans theory and illustrated our arguments with various recomputations of the Evans model.

For our discussion of the theory, we found it helpful to introduce the concept of an Evans equilibrium. This enabled us to make explicit the Evans behavioural assumptions concerning consumers, producers and investors. In particular, by defining an EE we were able to pinpoint an apparent misconception in Evans' treatment of investment.

Our work in Section IV indicates that there is little difficulty in computing EEs. Also the computations highlighted the main weakness of the Evans model—its tendency to imply unrealistic specialization. Evans [8] has outlined various modifications of the model, including the introduction of imperfect substitution between imports and domestic sources. In Section III, we mentioned several others. Empirical implementation of those modifications is essential before EEs can be used for policy purposes.

To conclude our review, we will reiterate some of the more interesting aspects of the Evans model. First, there is the snapshot idea. Following the lead of Sandee [13], Manne [11] and others, Evans neatly avoids problems of specifying and implementing a fully intertemporal model by simply asking what the economy will look like at a given point of time in the future. Second, there is his treatment of 'unexplainable' variables. Throughout his work, Evans is acutely aware of current weaknesses in received economic theory. For example, rather than burden his model with a weak theory of the determinants of rates of return in various industries, Evans sets the rates of return at realistic levels. With this approach, he frankly reveals that questions whose answers depend crucially on risk differentials across industries are unanswerable with the present model. Finally, Evans' achievements with the Australian data base of the mid-sixties will be an inspiration for the comparatively data wealthy Australian economists of the mid-seventies.

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APPENDIX

Industry Identifications

1 Crops. 2 Dairying. 3 Pastoral. 4 Forestry. 5 Coal mining. 6 Other mining. 7 Non-metal mine products. 8 Chemicals. 9 Mineral oil. 10 Metals, engineering and vehicles. 11 Textiles. 12 Clothing. 13 Grain products. 14 Confectionery. 15 Jam and fruit canning. 16 Dairy products. 17 Other food products. 18 Alcoholic drink. 19 Tobacco products. 20 Wood products. 21 Rubber products. 22 Leather products. 23 Paper products and printing. 24 Paper making. 25 Other manufacturing. 26 Building and construction. 27 Gas. 28 Water. 29 Electricity. 30 Trade and transport. 31 Dwelling. 32 Finance. 33 Personal and government services. 34 Business services.

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