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IMPACT is an economic and demographic research project conducted by Commonwealth Government agencies in association with the Faculty of Economics and Commerce at The University of Melbourne, the Faculty of Economics and Commerce and the Departments of Economics in the Research Schools at the Australian National University and the School of Economics at La Trobe University.

Paper presented to the Third Meeting of the Task Force on Applied General Equilibrium Modelling sponsored by the International Institute of Applied Systems Analysis, Laxenburg, Austria, 25th-29th August 1986

CALIBRATION OF COMPUTABLE GENERAL EQUILIBRIUM MODELS FROM SYNTHETIC BENCHMARK EQUILIBRIUM DATA SETS

by

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Preliminary Working Paper No. OP-57 Melbourne September 1986

The views expressed in this paper do not necessarily reflect the opinions of the participating agencies, nor of the Commonwealth Government

ISSN 0813 - 7986

ISBN 0 642 10064 0

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Pagan, A.R. and J.H. Shannon (1985) "Sensitivity Analysis for Linearized Computable General Equilibrium Models" in J. Piggott and J. Whalley (eds), New Developments in Applied General Equilibrium Analysis, pp. 104-118, Cambridge University Press, Cambridge.

Parmenter, B.R. (1985) "What Does Manufacturing Protection Cost Farmers? A Review of Some Recent Australian Contributions", IAESR Working Paper No. 7/1985, mimeo, 23 pp. Available from the Institute of Applied Economic and Social Research, University of Melbourne.

Quiggin, J.D. and A. Stoeckel (1982) "Protection, Income Distribution and the Rural Sector", Economic Papers, Vol. 1, No. 2, pp. 57-71.

Sutton, J. (1982) "Updating, Averaging and Balancing the ORANI78 Large Change Data Base", IMPACT Research Memorandum, mimeo, 23 pp. Available from IMPACT Research Centre, University of Melbourne, Melbourne.

Whalley, J. (1985) Trade Liberalization Among Major World Trading Areas, MIT Press, Cambridge, Massachusetts.

Hartley, M.J. (1985) "A Systems Approach to the Calibration of Economy-Wide Models with Incomplete Data", World Bank Report No. DRD140, mimeo, 85 pp. Available from Development Research Department, World Bank, Washington D.C.

Higgs, Peter J. (1985) "Implementation of Adams' Typical Year for the Agricultural Sector in the ORANI 1977-78 Data Base", IMPACT Preliminary Working Paper No. OP-49, mimeo, 180 pp. Available from Industries Assistance Commission, Canberra.

Higgs, Peter J. (1986) Adaptation and Survival in Australian Agriculture, Oxford University Press, Melbourne, forthcoming.

Hudson, E.A. and D.W. Jorgenson (1974) "U.S. Energy Policy and Economic Growth", Bell Journal of Economics and Management Science, Vol. 5, No.2, Autumn, pp. 461-514.

Industries Assistance Commission (1982) Approaches to General Reductions in Protection, Australian Government Publishing Service, Canberra.

Johansen, L. (1960) A Multi-Sectoral Study of Economic Growth, North-Holland Publishing Company, Amsterdam (2nd edition 1974).

Jorgenson, D.W. (1984) "Econometric Methods for Applied General Equilibrium Analysis", Chapter 4 in H.E. Scarf and J.B. Shoven (eds), Applied General Equilibrium Analysis, Cambridge University Press, Cambridge.

Jorgenson, D.W. and B.M. Fraumeni (1981) "Relative Prices and Technical Change", in E. Berndt and B. Field (eds), Modeling and Measuring Natural Resource Substitution, M.I.T. Press, Cambridge, Massachusetts.

Jorgenson, D.W., L.J. Lau, and T.M. Stocker (1980) "Welfare Comparison Under Exact Aggregation", American Economic Review, Vol. 70, No. 2, May, pp. 268-72.

Jorgenson, D.W., L.J. Lau, and T.M. Stocker (1981) "Aggregate Consumer Behaviour and Individual Welfare", in D. Currie, R. Nobay, and D. Peel (eds), Macroeconomic Analysis, London, Croom-Helm, pp. 35-61.

Jorgenson, D.W., L.J. Lau, and T.M. Stocker (1982) "The Transcendental Logarithmic Model of Aggregate Consumer Behaviour", in R.L. Basmann and G. Rhodes (eds), Advances in Econometrics, Vol. 1, Greenwich, JAI Press, pp. 97-238.

Lau, L.J. (1984) Comments on an article by Mansur, A. and J. Whalley "Numerical Specification of Applied General Equilibrium Models: Estimation, Calibration, and Data" in H.E. Scarf and J.B. Shoven (eds), Applied General Equilibrium Analysis, Cambridge University Press, Cambridge.

Mansur A. (1981) "On the Estimation of General Equilibrium Models", Department of Economics, University of Western Ontario, London, mimeo.

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1. INTRODUCTION

A computable general equilibrium (CGE) model can be thought of as a system of equations containing a set of parameters and coefficients, θ, such that a vector of exogenous variables, Z, produces a vector of endogenous variables, Y:

$$F(\theta, Z, Y) = 0 \quad . \qquad (1)$$

The absence of an error term on the right-hand-side of (1) indicates that we are interpreting CGE modelling as a non-stochastic approach, as opposed to the necessarily stochastic approach of econometrics. This does not mean that all (or any) CGE modellers view the world as deterministic. They do, however, see CGE modelling as being about the systematic, not the random, responses of economic variables to exogenous stimuli. Thus ideally a CGE model should contain the set of parameters θ that with a given Z produces the systematic part of the total response in Y; that is, the non-random part.

The most common approach for estimating θ is calibration from a benchmark data set that portrays the economy in a particular year-of-record.[1] To calibrate a CGE model means to choose values for its parameters and coefficients which guarantee that some selected benchmark data set is a solution to the model (i.e., an equilibrium). Parameters whose values cannot be inferred from the benchmark equilibrium data set (such as substitution elasticities in most cases) are then obtained from a search of the literature, or are set arbitrarily. The particular year-of-record selected is usually the most recent for which an input-output table is available. However, as a particular year-of-record clearly contains random components, the estimated θ combined with a given Z will produce the systematic plus the random response in Y. In the case of years of record in which realizations of one or more elements of Y reflect large random components, certain elements of the θ obtained by calibration will be very unsuitable for projecting GE responses.

Here we argue the case for the development of synthetic, typical-year benchmark equilibrium data sets. There are two alternative ways to construct such data sets, econometric estimation and calibration which involves pooling of data from more than one period-of-record. The relationship between econometrics and calibration can be illustrated as follows. Assume that an industry only requires labour (L) and capital (K) inputs which it chooses to minimize total costs, C:

$$C = WL + RK \quad ; \qquad (2)$$

subject to a CES production function:

Dixon, P.B. (1985b) "Prospects for Australian Industries: 1985 to 1990", paper presented to the Econometric Forecasting Project, Institute of Applied Economic and Social Research, University of Melbourne, mimeo, 31 pp.

Dixon, P.B. (1985c) "Forecasting Versus Policy Analysis with the ORANI Model", paper presented to the Bilateral Australia-China Working Party on the Role of Economic Modelling in National Economic Management, University of Melbourne, 25th-29th November, mimeo, 23 pp.

Dixon, P.B., S. Bowles, and D. Kenrick (1980) Notes and Problems in Microeconomic Theory, North-Holland Publishing Company, Amsterdam.

Dixon, P.B., B.R. Parmenter, and M. Horridge (1986) "Forecasting Versus Policy Analysis with the ORANI Model", IAESR Working Paper No. 4/1986, mimeo, 27 pp. Available from the Institute of Applied Economic and Social Research, University of Melbourne, Melbourne.

Dixon, P.B., B.R. Parmenter, A.A. Powell, and D.P. Vincent (1983) "The Agricultural Sector of ORANI 78: Theory, Data and Application", in A.C. Kelley, W.C. Sanderson, and J.G. Williamson (eds), Modeling Growing Economies in Equilibrium and Disequilibrium, Duke University Press Policy Studies, Durham, NC.

Dixon, P.B., B.R. Parmenter, J. Sutton, and D. Vincent (1982) ORANI: A Multi-Sectoral Model of the Australian Economy, North-Holland Publishing Company, Amsterdam.

Dixon, P.B., B.R. Parmenter, and R.J. Rimmer (1984) "ORANI Projections of the Short-Run Effects of a 50 per cent Across-the-Board Cut in Protection Using Alternative Data Bases", IMPACT Preliminary Working Paper No. OP-48, mimeo, 39 pp. Available from Industries Assistance Commission, Canberra.

Dixon, P.B., A.A. Powell, and B.R. Parmenter (1979) Structural Adaptation in an Ailing Macroeconomy, Melbourne University Press, Melbourne.

Freebairn, J.W. (1978) "Projections of Australia's World Trade Opportunities: Mid and Late Nineteen Eighties", IMPACT Working Paper No. I-07, mimeo, 88 pp. Available from Industries Assistance Commission, Canberra.

Harrison, G.W. (1986) "A General Equilibrium Analysis of Tariff Reductions" in T.N. Srinivasan and J. Whalley (eds), General Equilibrium Trade Policy Modelling, pp. 101-123, MIT Press, Cambridge, Massachusetts.

Harrison, G.W., R. Jones, L.J. Kimbell, and R. Wigle (1985) "How Robust is Applied General Equilibrium Analysis?" Working Paper No. 8501, Centre for the Study of International Economic Relations, University of Western Ontario.

Harrison, G.W. and L.J. Kimbell (1985) "Economic Interdependence in the Pacific Basin: A General Equilibrium Approach" in J. Piggott and J. Whalley (eds), New Developments in Applied General Equilibrium Analysis, pp. 143-174, Cambridge University Press, Cambridge.

References

Adams, Philip D. (1984) "The Typical Year Data Base for the Agricultural Sector of ORANI 78", IMPACT Preliminary Working Paper No. OP-45, mimeo, 113 pp. Available from Industries Assistance Commission, Canberra.

Adams, Philip D. (1985) "Agricultural Supply Response in ORANI", IMPACT Working Paper No. 0-44, mimeo, 29 pp. Available from Industries Assistance Commission, Canberra.

Australian Bureau of Statistics (1977) Australian National Accounts, Input-Output Tables 1968-69, Australian Government Publishing Service, Canberra.

Australian Bureau of Statistics (1981) Australian National Accounts, Input-Output Tables 1974-75, Australian Government Publishing Service, Canberra.

Australian Bureau of Statistics (1983) Australian National Accounts, Input-Output Tables 1977-78, Australian Government Publishing Service, Canberra.

Ballard, C.L., D. Fullerton, J.B. Shoven, and J. Whalley (1985) A General Equilibrium Model for Tax Policy Evaluation, University of Chicago Press, Chicago.

Berndt, E.R. and D.W. Jorgenson (1973) "Production Structure" in D.W. Jorgenson and H.S. Houthakker (eds), U.S. Energy Resources and Economic Growth, Washington D.C., Energy Policies Project, Chapter 3.

Bruce, I. (1985) "The Sensitivity of ORANI 78 Projections to the Database Used", IMPACT Preliminary Working Paper No. OP-53, mimeo, 45pp. Available from Industries Assistance Commission, Canberra.

Clements, K.W. (1980) "A General Equilibrium Econometric Model of the Open Economy", International Economic Review, Vol. 21, No. 2, June, pp. 469-88.

Crowley, P. and G. Martin (1982) "Manufacturing Industry Assistance and the Rural Sector", Quarterly Review of the Economy, Vol. 4, No. 4, November, pp. 288-94.

Deardorff, A.V. and R.M. Stern (1985) The Michigan Model of World Production and Trade, MIT Press, Cambridge, Massachusetts.

Dervis, K., J. De Melo, and S. Robinson (1982) General Equilibrium Models for Development Policy, Cambridge University Press, Cambridge.

Dixon, P.B. (1985a) "Agriculture in the Australian Economy, Unlocking Farm Potential", pp. 1-13 in Proceedings - Systems for Profit: Towards Integrated Crop-Stock Farming, The Farm Management Foundation of Australia (Inc.), Perth, W.A., April 1985.

$$Z = \gamma(\delta_L L^{-\rho} + \delta_K K^{-\rho})^{-1/\rho} \quad ; \qquad (3)$$

where W and R are the wage rate of labour and the rental rate of capital, respectively; Z is the output of the industry; γ, δ_L, and δ_K are positive parameters; and ρ is a parameter whose value is greater than -1 but not equal to zero. The input demand functions derived from the above problem are given by:[2]

$$\ell = z - \sigma[w - (S_L w + S_K r)] \quad ; \qquad (4)$$

$$k = z - \sigma[r - (S_L w + S_K r)] \quad ; \qquad (5)$$

where the lower case variables represent the percentage change in the respective upper case variables; σ is the elasticity of substitution between capital and labour, which is equal to $1/(1+\rho)$; and S_L and S_K are the cost shares of labour and capital, respectively. The cost shares are given by:[3]

$$S_L = \frac{\delta_L^{1/(1+\rho)} W^{\rho/(1+\rho)}}{\delta_L^{1/(1+\rho)} W^{\rho/(1+\rho)} + \delta_K^{1/(1+\rho)} R^{\rho/(1+\rho)}} \quad ; \qquad (6)$$

$$S_K = \frac{\delta_K^{1/(1+\rho)} R^{\rho/(1+\rho)}}{\delta_L^{1/(1+\rho)} W^{\rho/(1+\rho)} + \delta_K^{1/(1+\rho)} R^{\rho/(1+\rho)}} \quad . \qquad (7)$$

If econometric estimation is used then the cost shares are derived as a function of the econometrically estimated δ_L, δ_K, and ρ parameters; see equations (6) and (7). However, if calibration is used then the cost shares S_L and S_K are calculated from a benchmark equilibrium data set and the substitution parameter ρ is obtained from a literature search, or set arbitrarily.

The econometric approach to estimating θ has been largely developed by Dale Jorgenson. This approach typically involves estimating subsystems of a CGE model. For example, a subsystem of industry demand functions for inputs has been estimated econometrically by Berndt and Jorgenson (1973), Hudson and Jorgenson (1974), and Jorgenson and Fraumeni (1981). On the consumption side, the estimation of an econometric model of aggregate consumer behaviour based on the theory of exact aggregation has been carried out by Jorgenson, Lau, and Stoker (1980, 1981, 1982) and Jorgenson (1984). To our knowledge the econometric estimation of θ subject to cross-equation restrictions within the production and consumption subsystems of the model as well as the restrictions between these subsystems has only been attempted by Clements (1980) with a one product, one-consumer model and Mansur (1981) with a two-sector, one consumer model of the US economy.

The econometric approach has not, however, been used routinely by CGE model builders due to factors such as insufficient data,[4] computing resource constraints, etc.[5] If this is the case then less formal methods should be considered for extracting information from the pooled data. For example, sometimes a time series of, say, cost shares are available for a number of the industries of a CGE model. In general we can think of the share of input i in industry j's total costs (S_{ij}) as a function of prices, technical change, and other factors:

$$S_{ij} = f \text{ (prices, technical change, other).} \qquad (8)$$

13. Note that this is as would be expected since no changes were made to the data on the mining industries. Furthermore the CPI is projected to fall by approximately the same amount in each case. Thus the mining industries receive a comparable price-cost stimulus in each simulation.

14. Note that this result was anticipated by Adams (1985).

15. The greater the fall in the CPI the more competitive are domestic import-competing industries, and hence the smaller the expected increase in aggregate imports due to the tariff cut.

16. Note that a greater amount of goods are exported in the levels in the synthetic data base as compared with the 1977-78 data base. Thus even though the percentage increase in exports is significantly less for the synthetic data base as compared with the 1977-78 data base, the impact on the balance of trade is not significantly different (relative to what would be initially expected from a casual observation of the percentage-change aggregate export projections).

17. Note that real absorption is exogenous and set to zero change, i.e., it is assumed to be determined independent of the tariff cut.

18. Note that aggregate employment is demand determined.

19. The derivation of equations (14) and (15) is given in Higgs (1986, Appendix A.2).

20. Note that for one of the twenty-two largest sales the percentage change in output was the same computed with the synthetic data base as compared with the 1977-78 data base.

6. It should be noted that Hartley (1985) has proposed an ambitious multi-stage systems approach for calibrating CGE models. Hartley formulates a calibration procedure which involves the minimization of quadratic loss functions between the discrepancies of the solution (simulation) path of the endogenous variables (relative to any choice of the parameter vector) and the (observed) actual values, over the sample period. The advantage of Hartley's approach is that it is systematic (relative to a given model specification). However this approach is very computer intensive, it is sensitive to the particular closure of the CGE model assumed, and it would most probably require that the large CGE models currently used for policy analysis be less disaggregated and adopt more simple functional forms.

7. Note that in the above discussion we have assumed that the CGE model is to be used for policy analysis as opposed to forecasting. Preliminary work on using the ORANI model for forecasting has been done by Dixon (1985b, 1985c) and Dixon, Parmenter, and Horridge (1986).

8. Note that the approach of first imposing synthetic-year relationships between various elements in the data base and then to balance the data base was initially suggested by Sutton (1982).

9. There are 20 significant sales of agricultural commodities to domestic industries in the ORANI data base. The difference in the input shares between the synthetic and original data bases was less that 4 percentage points for 13 of these 20 sales. In only 2 cases was the difference greater than 10 percentage points. In the case of sales of milk cattle and pigs to the Milk Products industry the difference was 10.3 percentage points and in the case of sales of other farming (sugar cane, fruit and nuts) to the Other Food Products industry the difference was 16.6 percentage points.

10. See, for example, Dixon, Powell, and Parmenter (1979), Crowley and Martin (1982), Dixon, Parmenter, Sutton, and Vincent (1982), Industries Assistance Commission (1982), Quiggin and Stoeckel (1982), Vincent (1982), Dixon, Parmenter, Powell, and Vincent (1983), Dixon (1985a), Parmenter (1985), and Higgs (1986).

11. Note that the sensitivity of ORANI projections to the data base has been previously studied by Dixon, Parmenter, and Rimmer (1984) and Bruce (1985).

12. A complete list of the variables selected as exogenous and the values assigned to them and the indexation parameters for the ORANI simulations presented here can be found in Higgs (1986, Appendix A.1).

If the cost shares are all that are available then the strategy we suggest is to assume that the variables on the right-hand-side of equation (8) have trended with time and calculate the trend values of cost shares subject to the appropriate adding up restrictions. The most recent in-sample value of the trend could be used for construction of the synthetic data base where it is desired that the latter should represent 'a typical recent year'; alternatively, since data are never up to the moment, trends might, with caution, be used to project the configuration of the economy into the current year.[6] Note that if a strong trend is apparent, then the model builder should investigate why it has developed. For example, if a strong upward trend is evident in a particular export share it may be due to the development of new overseas markets. The goal is to construct a data base which abstracts from random influences (especially high frequency components).[7]

Some empirical evidence in support of the above approach was found by Mansur (1981). Mansur and Whalley (1984), commenting on Mansur's estimates of the coefficients for the model incorporating Cobb-Douglas production functions, find that the "benchmark equilibrium parameters show some degree of variation from year to year, but if we take the average of these yearly values, the mean is not very different from the values obtained by estimation" (Mansur and Whalley (1984, p.112)). They also report some results for the CES case. Using econometric methods, they obtain estimates both of the substitution elasticity (σ) and of the remaining coefficients. Given their estimated σ, they use calibration to derive a time series of these coefficients. Their arithmetic mean values are found not to differ greatly from the corresponding econometric estimates.

As a final point we will illustrate the sensitivity of the projections of a CGE model to the value assigned to the share of fixed factors in total costs. Recall from equation (5) that k is the percentage change in the industry's input of capital. A standard analytical device for generating a short-run solution is to assume fixed industry capital stocks, that is k = 0. If we substitute k = 0 into equation (5) we can solve for r:

$$r = w + z/(\sigma S_L) \quad . \qquad (9)$$

Equation (9) can be used to eliminate r from equation (4):

$$\ell = z/S_L \quad . \qquad (10)$$

Next We assume the following zero-pure-profits condition:

$$PZ = WL + RK \quad ; \qquad (11)$$

where P is the price of the good produced by the industry; and Z, W, L, R, and K are as defined above. Equation (11) can be written in percentage-change form:

$$p + z = (w + \ell)S_L + (r + k)S_K \quad ; \qquad (12)$$

where the lower case variables are the percentage changes in the respective upper case variables; and S_L and S_K are cost shares as defined above. The final step is to substitute equations (9) and (10) into equation (12) (note that the short-run assumption k = 0 is still made):

Notes

* We would like to thank Peter Dixon and Alan Powell for comments on an earlier version of this paper. The authors are also indebted to Mark Horridge for modifying his HAMMER computer program which balanced the data base while minimizing the inevitable distortions that occur between the synthetic and non-synthetic sections of the data base.

1. See, for example, Johansen (1960), Dervis, De Melo, and Robinson (1982), Ballard, Fullerton, Shoven, and Whalley (1985), Whalley (1985), and Deardorff and Stern (1986). Note also that prior to this study this was the approach used to calibrate the ORANI model of the Australian economy. The ORANI model was initially calibrated from 1968-69 input-output data tabulated by the Australian Bureau of Statistics, hereafter ABS, (1977). Subsequently it has been calibrated using the 1974-75 and 1977-78 input-output tables; see ABS (1981) and ABS (1983).

2. See Dixon, Bowles, and Kendrick (1980, pp.296-300).

3. See Dixon, Bowles, and Kendrick (1980, pp.296-300).

4. There are no hard rules concerning when there exists sufficient data to consider the use of econometric techniques. It depends on the particular functional form specified, the size of the system or subsystem being estimated, and the quality of the data. However, if one were forced to make an arbitrary rule on the basis of the studies by Clements (1980), Mansur (1981), and Jorgenson (1984), it would be that a time series of no shorter than about 20 years of suitable data sets would be required to successfully use econometric techniques to estimate the parameters and coefficients of a CGE model.

5. Note that, as pointed out by Lau (1984), one of the virtues of using econometric techniques is that it is possible to estimate the variance-covariance matrix of the estimator of the parameters and other within-sample goodness-of-fit estimators. On the other hand, if calibration is used then it is desirable to test the sensitivity of the model to the calibrated coefficients and parameter values; see, for example, Harrison, Jones, Kimbell, and Wigle (1985), Harrison and Kimbell (1985), Pagan and Shannon (1985), and Harrison (1986).

investment with the synthetic data base as compared with the 1977-78 data base.

4. CONCLUSION

It is not optimal to require that a CGE model replicate any particular year-of-record as a base period solution since a particular year-of-record contains systematic plus random components. Here we have argued the case for the development of synthetic benchmark equilibrium data sets which portray the economy in a notional typical year. A synthetic benchmark equilibrium data base is defined to be a benchmark equilibrium data set constructed from more than one particular year-of-record.

In this paper the development of a synthetic agricultural sector in the benchmark equilibrium data set of the ORANI model was described. The techniques developed here can be used to incorporate new data in a piecemeal fashion into a CGE model's data base. In the context of the ORANI model this could mean extending the synthetic portion of the data base to cover non-agricultural industries, or incorporating the properties of the synthetic agricultural sector in new particular year-of-record benchmark data sets as they become available.

$$z = \frac{\sigma(1 - S_K)}{S_K}(p - w) \quad . \tag{13}$$

According to equation (13) the output of the industry will increase as its selling price increases relative to the price of its variable inputs. The extent it will increase depends on <u>both</u> the elasticity of substitution between capital and labour and the <u>share of the fixed factor in total costs</u>.

From equation (13) it is clear that a CGE model calibrated with an atypical benchmark equilibrium data set will produce atypical projections. As the share of fixed factors, S_K, increases the output response of the industry decreases (given a constant non-zero change in its selling price relative to the price of its variable inputs). One potential problem therefore with calibrating from a benchmark equilibrium data set for a particular year-of-record is that a sector may have earned atypically low returns. If such a poor year were used as the benchmark equilibrium data set, the behaviour of the sector in projections would turn out to be much more volatile than is typical.

The remainder of the paper is organized as follows. In section 2 we describe the development of a synthetic agricultural sector in the benchmark equilibrium data set of the ORANI model (a large established CGE model of the Australian economy; see Dixon, Parmenter, Sutton, and Vincent (1982)). Next a comparison is made in section 3 of the results from ORANI of a 25 per cent across-the-board tariff cut simulation computed with both a synthetic benchmark equilibrium data set and a particular year-of-record data set. Finally, some concluding remarks are offered in section 4.

2. THE DEVELOPMENT OF A SYNTHETIC AGRICULTURAL SECTOR IN THE BENCHMARK EQUILIBRIUM DATA BASE OF THE ORANI MODEL

In 1977-78, the base year for the most recent Australian input-output table available at the time of this study, the performance of the agricultural sector was unusually poor. For the reasons outlined above, rather than calibrate the ORANI model from this atypical year-of-record it was decided to construct a synthetic agricultural data base. The synthetic data base has the advantage of being as up-to-date as possible for the non-agricultural economy, but does not imply atypical behaviour in the agricultural sector. To construct the synthetic data base 13 years of agricultural input-output data were collected by Adams (1984) covering the period 1967-68 through 1979-80. In this section we first describe how these data were used to augment the 1977-78 ORANI data base. We then highlight any differences between the augmented, synthetic data base and the original 1977-78 data base.

2.1 Strategy for Augmenting the Existing ORANI Data Base with the New Agricultural Data

The strategy used to augment the existing ORANI data base with the new agricultural data is depicted in Figure 2.1. The first task was to estimate the size of the agricultural sector with respect to the economy as a whole for the typical or synthetic year. This was done as follows. First the in-sample share for 1982-83 from a fitted linear trend of the share of Gross Farm Product (hereafter GFP) in Gross Domestic Product at current prices (hereafter GDP) from 1967-68 to 1982-83 was estimated. The trend showed a slight secular decline in agriculture over the period observed. The GFP that would give rise to

customer, move in general in the opposite direction. The explanation lies with changes in the composition of the sales shares of agricultural machinery. The Agricultural Machinery sells its output primarily to intermediate usage and investment in the agricultural industries. Of the twenty-two largest sales of agricultural machinery (which represents approximately 90 per cent of total sales of agricultural machinery) in only five cases is the percentage change in demand higher computed with the synthetic data base as compared with the 1977-78 data base. However for these five sales the sales share is larger in the synthetic data base as compared with the 1977-78 data base. Similarly for nine out of the sixteen sales where the percentage change in demand is lower computed with the synthetic data base, the sales shares are also lower in the synthetic data base as compared with the 1977-78 data base.[20]

The remaining non-agricultural industry to be discussed which exhibited a difference between its output projection computed with the two data bases of greater than 0.20 percentage points is Forestry and Logging (10). This industry is projected to experience a relatively larger reduction in output due to the tariff cut when computed with the synthetic data base as compared with the 1977-78 data base. This is due to a number of factors. Its relatively large sales to Pulp, Paper, and Paperboard (44) and Rail and Other Transport (94) are projected to increase less with the synthetic data base as compared with the 1977-78 data base. The Forestry and Logging industry is also particularly sensitive to reallocations of investment across industries as it sells approximately a quarter of its output to investment in itself. Due to compositional changes in the allocation of investment, the Forestry and Logging industry experiences a relatively larger contraction in due to the tariff cut computed with the synthetic data base as compared with the 1977-78 data base. Similar to Meat Products, the Cotton Ginning, Wool Scouring, and Top Making industry requires a significant amount of inputs from the zonal industries. The relatively low supply elasticities for the zonal industries in the synthetic data base restricts the supply to, and hence output of, the Cotton Ginning, Wool Scouring, and Top Making Industry.

The Other Food Products (25) industry also exports processed agricultural commodities. This industry is projected to experience a relatively greater increase in output due to the tariff cut computed with the synthetic data base as compared with the 1977-78 data base. Approximately 60 per cent of the total production of the commodity other farming (sugar cane, fruit, and nuts) is sold to this industry. Furthermore, in both the data bases virtually all production of the commodity is by the Other Farming (Sugar Cane, Fruit, and Nuts) industry. The supply elasticity for the Other Farming (Sugar Cane, Fruit, and Nuts) industry is relatively larger in the synthetic data base as compared with the 1977-78 data base; see Table 2.2. Thus the Other Food Products industry benefits by paying a relatively lower price for its purchases of other farming (sugar cane, fruit, and nuts) in the simulation computed with the synthetic data base as compared with the 1977-78 data base.

The Agricultural Machinery (76) industry is projected to experience a relatively larger increase in output due to the tariff cut computed with the synthetic data base as compared with the 1977-78 data base. This result is perhaps counter intuitive given that the differences in the output results for the agricultural sector, its main

(1) Estimate the synthetic-year size of the agricultural sector relative to the overall economy.

↓

(2) Estimate the synthetic-year agricultural product-mix matrix in the levels such that (1) is imposed.

↓

(3) Estimate the synthetic-year share parameters on sales of agricultural commodities and impose these shares in the ORANI data base without regard for balancing (i.e., without imposing for each industry that the value of sales equals the value of inputs). Adjust margins on sales in line with changes in sales.

↓

(4) Estimate the synthetic-year share parameters on inputs to agricultural industries and impose these shares in the ORANI data base without regard for balancing. (Note that only primary factors are adjusted, therefore there is no need to adjust margins on inputs.)

↓

(5) Balance the data base such that total agricultural commodity sales and industry inputs are consistent with (2) the synthetic-year agricultural product-mix matrix.

↓

(6) Evaluate distortions generated by augmentation.

FIGURE 2.1 STRATEGY FOR DEVELOPING THE SYNTHETIC AGRICULTURAL SECTOR IN THE BENCHMARK EQUILIBRIUM DATA BASE OF THE ORANI MODEL the 1982-83 trend share value of 0.0620 when combined with Non-Farm GDP from the existing 1977-78 ORANI data base was then calculated. This produced a GFP of $5287m (1977-78 prices) which was then converted into a value of current production of the agricultural sector as follows. A very stable relationship was observed over the period 1967-68 to 1979-80 of the ratio GFP to the Gross Value of Rural Production (hereafter GVRP). Using the average ratio of 0.68, the GFP of $5287m (1977-78 prices) was taken to imply a value of GVRP equal to $7749.9267m (1977-78 prices).

The second stage was to allocate the GVRP of $7749.9267m (1977-78 prices) across commodity production levels by agricultural industries such that the following proportions are imposed within the agricultural sector:

(i) the synthetic-year mix of total commodity production

(ii) the synthetic-year mix of total industry outputs;

and

(iii) the synthetic-year commodity mixes within agricultural industries.

The synthetic-year mixes (i) - (iii) were calculated by taking the arithmetic average from product-mix matrices for the agricultural sector over the period 1967-68 to 1979-80 as estimated by Adams (1984).

The third stage involved augmenting the ORANI input-output data base which is depicted in Figure 2.2. This involved modifications to both the sales of agricultural commodities (i.e., the row of matrices A, B, C, D, and E) and the margins associated with these sales

above, less when computed with the synthetic data base as compared with the 1977-78 data base. Thus the demand for poultry by this industry is also less when computed with the synthetic data base as compared with the 1977-78 data base.

For the non-agricultural industries the output response to a tariff cut computed with the 1977-78 data base and the synthetic agricultural data base is in general very similar. Out of 104 non-agricultural industries only 8 exhibit differences between their output projections computed with the two data bases of greater than 0.20 percentage points. The relatively large differences occur in industries 9, 10, 18, 25, 30, 49, 76, and 94. Not surprisingly these are nearly all agricultural related industries.

The Services to Agriculture (industry 9), Chemical Fertilizers (49), and Rail and Other Transport (94) industries all experience a relatively smaller increase in output due to the tariff cut computed with the synthetic data base as compared with the 1977-78 data base. The three zonal industries are significant purchasers of agricultural services and fertilizers. They also use the services of the Rail and Other Transport industry to shift a large percentage of their produce. The relatively smaller increase in the output of the zonal industries when the simulation is computed with the synthetic data base translates into a relatively smaller demand for agricultural services, fertilizer, and rail and other transport services.

The Meat Products (18) and Cotton Ginning, Wool Scouring, and Top Making (30) industries both export processed agricultural commodities. These industries experience a smaller increase in output

The three zonal industries are all projected to expand less due to a tariff cut when computed with the synthetic data base as compared with the 1977-78 data base; see Table 3.2. A similar result is obtained for the Northern Beef industry. Thus for these industries the differences in their projections between the two data bases is in the direction that would be expected given their respective λ_j's.

The Other Farming (Sugar Cane, Fruit, and Nuts) and Other Farming (Vegetables, Cotton, Oilseeds, and Tobacco) industries are relatively more responsive with the synthetic data base as compared with the 1977-78 data base. These results also confirm our expectations given the respective λ_j's for these industries in the two data bases; see Table 2.2.

The differences in the projections of the Milk Cattle and Pigs and the Poultry industries would not be expected given their supply elasticities in the two data bases. The explanation for the Milk Cattle and Pigs industry's projection lies with the multiproduct zonal industries. The production of the commodity milk cattle and pigs by the zonal industries is projected to increase significantly less with the synthetic data base. This induces an increase in the market share of the Milk Cattle and Pigs industry in the simulation with the synthetic data base as compared with the 1977-78 data base.

The explanation for the unexpected difference in the Poultry industry's projections involves demand side effects. Approximately half of the Poultry industry's output is sold to the Meat Products industry. The output response of the Meat Products industry is, as discussed

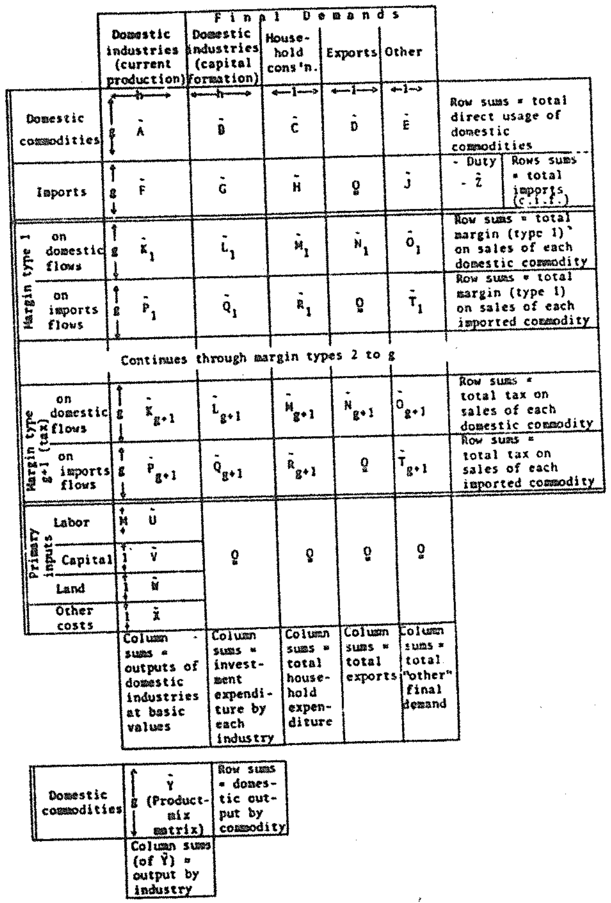

FIGURE 2.2 THE ORANI INPUT-OUTPUT DATA BASE*

*Source: Dixon, Parmenter, Sutton, and Vincent (1982, Figure 25.1).

(i.e., the rows of matrices $K_1,\ldots,K_{g+1}$, $L_1,\ldots,L_{g+1}$, $M_1,\ldots,M_{g+1}$, $N_1,\ldots,N_{g+1}$ and $O_1,\ldots,O_{g+1}$). The sales pattern of agricultural commodities was left as it was in the 1977-78 ORANI input-output data file, except for exports. Data were collected on the export shares of agricultural commodities from 1967-68 to 1982-83. Synthetic-year export shares were then calculated from these data. For most commodities the average export share over the period observed seemed appropriate as the synthetic-year export share. However, for the commodities sheep and barley a significant upward trend was observed in their export share. For these commodities the 1982-83 trend values were declared to be the synthetic-year share values. New export levels were imposed that preserved the synthetic-year export shares.

At the fourth stage the inputs to current production in the agricultural industries (i.e., the columns of matrices A, F, $K_1,\ldots,K_{g+1}$, $P_1,\ldots,P_{g+1}$, U, V, W, and X) were adjusted. Adams (1984) collected a time series of data (1967-68 through 1979-78) on payments to labour, returns to owner-operators' labour, fixed capital, working capital and land and other inputs to current production. A time-series of the shares of these six inputs to current production was calculated; see Higgs (1985). The synthetic-year shares were declared to be their arithmetic means over the period observed. New levels of inputs were then imposed that preserved the synthetic-year input shares.

Once the synthetic-year relationships between various elements of the data base were imposed the next task was to balance the data base such that inputs to current production equal total sales in each industry.[8] Finally an analysis was made of the inevitable distortions

(this is an appropriately weighted index for the multiproduct industries); ξ is the percentage change in the CPI; σ is the elasticity of substitution between primary factors (assumed to be 0.5 for all industries in the short run); S_{Fj} is the share of fixed factors (capital and agricultural land) in industry j's primary-factor inputs; and H_{Xj} is the share of primary-factor inputs in industry j's total costs.

The significance of the input shares S_{Fj} and H_{Xj} in determining the value of the short-run supply elasticity λ_j is clear from equation (15). It turns out that the H_{Xj}'s are in general larger in the synthetic data base as compared with the 1977-78 data base, this would tend to cause lower short-run agricultural supply elasticities. The S_{Fj}'s are larger for the Pastoral, Wheat-Sheep, and High Rainfall industries in the synthetic data base as compared with the 1977-78 data base; see Table 2.2. The larger S_{Fj}'s would also tend to cause lower λ_j's. However, the situation is the reverse for the two Other Farming industries; see Table 2.2. In this case the lower S_{Fj}'s tend to generate higher λ_j's in the synthetic data base as compared with the 1977-78 data base.

The short-run supply elasticities (i.e., the λ_j's) for the agricultural industries in the 1977-78 data base and the synthetic agricultural 1977-78 data base are listed in Table 2.2. On the basis of the short-run supply elasticities we would expect the first five agricultural industries to be less responsive with the synthetic data base as compared with the 1977-78 data base. Our expectations are the opposite for the last three industries, where the λ_j's are larger in the synthetic data base as compared with the 1977-78 data base.

TABLE 3.2 (Continued)

ORANI Industry	25 per cent Across-the-Board Tariff Cut: 1977-78 ORANI Data Base [I]	Synthetic Agricultural 1977-78 ORANI Data Base [II]	[II]-[I]
76 Agricultural Machinery	9.64	9.99	0.35
77 Construction Machinery	-0.54	-0.70	-0.16
78 Other Machinery	-0.55	-0.64	-0.11
79 Leather Products	-4.35	-4.34	0.01
80 Rubber Products	-1.55	-1.57	-0.02
81 Plastic Products	-0.70	-0.77	-0.07
82 Signs and Writing Equipment	-0.41	-0.47	-0.06
83 Other Manufacturing	-0.48	-0.50	-0.02
84 Electricity	0.16	0.11	-0.05
85 Gas	-0.21	-0.23	-0.02
86 Water, Sewerage, and Drainage	0.25	0.16	-0.09
87 Residential Building	-0.00	-0.00	0.00
88 Other Construction	-0.06	0.01	0.07
89 Wholesale Trade	0.49	0.35	-0.14
90 Retail Trade	0.07	0.07	0.00
91 Mechanical Repairs	0.38	0.30	-0.08
92 Other Repairs	0.34	0.23	-0.11
93 Road Transport	0.58	0.44	-0.14
94 Rail and Other Transport	1.03	0.76	-0.27
95 Water Transport	0.63	0.61	-0.02
96 Air Transport	0.45	0.43	-0.02
97 Communication	0.10	0.05	-0.05
98 Banking	0.08	0.03	-0.05
99 Non-Bank Finance	0.14	0.08	-0.06
100 Investment Services	-0.06	-0.08	-0.02
101 Insurance	0.14	0.10	-0.04
102 Other Business Services	0.10	0.05	-0.05
103 Ownership of Dwellings	-0.00	0.00	0.00
104 Public Administration	0.02	0.01	-0.01
105 Defence	-0.00	-0.00	0.00
106 Health	0.01	0.00	-0.01
107 Education and Libraries	0.00	0.00	0.00
108 Welfare Services	0.08	0.04	-0.04
109 Entertainment and Leisure	0.01	-0.02	-0.03
110 Restaurants and Hotels	0.04	0.02	-0.02
111 Personal Services	0.00	-0.00	-0.00
112 Non-Competing Imports	-0.03	-0.08	-0.05

* All projections are percentage deviations from what the output of the industry would have been in the absence of the tariff cuts.

which occurred between the synthetic and non-synthetic sections of the data base. Fortunately these did not appear to be too severe.[9]

2.2 Key Differences Between the 1977-78 ORANI Data Base and the Synthetic Agricultural 1977-78 ORANI Data Base

Before we analyze the results from the ORANI model calibrated with the 1977-78 data base and the synthetic agricultural data base it is helpful to summarize the four potential areas of major differences between these data bases:

(1) The size of the agricultural sector is larger in the synthetic data base as compared with the 1977-78 data base. Specifically, the gross value of rural production is $7,750m (1977-78 prices) in the synthetic data base as compared with $6,258m (1977-78 prices) in the 1977-78 data base, i.e., an increase of about 25 per cent.

(2) The product-mix in the agricultural sector of the synthetic data base represents a recent average of the product-mixes exhibited in the agricultural sector. It turned out that the differences in the product-mix and industry-mix shares between the two data bases were relatively minor.

(3) The export shares of the agricultural commodities differs between the 1977-78 data base and the synthetic data base; see Table 2.1. In general a greater proportion of agricultural commodities are exported as

TABLE 2.1 : EXPORT SHARES OF THE AGRICULTURAL COMMODITIES IN THE 1977-78 ORANI DATA BASE AND THE SYNTHETIC AGRICULTURAL 1977-78 ORANI DATA BASE

Commodity		Share of Exports in Total Output: 1977-78 ORANI Data Base [I]	Share of Exports in Total Output: Synthetic Agricultural 1977-78 ORANI Data Base [II]	Basis of Decision for the Selection of the Synthetic Export Share Using Annual Data from 1967-68 to 1982-83[a]
A1.	Wool[b]	0.83	0.88	The arithmetic mean share
A2.	Sheep	0.17	0.40	The in-sample share for 1982-83 of a fitted logistic trend with a ceiling parameter of 1.0
A3.	Wheat[b]	0.84	0.76	The arithmetic mean share
A4.	Barley[b]	0.57	0.83	The in-sample share for 1982-83 of a fitted linear trend
A5.	Other Cereal Grains[b]	0.22	0.39	The arithmetic mean share
A6.	Meat Cattle	0.01	0.01	The arithmetic mean share
A7.	Milk Cattle and Pigs	0.00	0.00	The arithmetic mean share
A8.	Other Farming (Sugar Cane, Fruit, and Nuts)	0.09	0.09	The arithmetic mean share
A9.	Other Farming (Vegetables, Cotton, Oilseeds, and Tobacco)	0.02	0.08	The arithmetic mean share
A10.	Poultry	0.03	0.01	The arithmetic mean share
	All Agriculture	0.32	0.34	
	Endogenous Agricultural Export Commodities	0.75	0.81	

a For more details see Higgs (1985).
b Exports of this commodity are determined endogenously by the ORANI model.

TABLE 3.2 (Continued)

	ORANI Industry	25 per cent Across-the-Board Tariff Cut: 1977-78 ORANI Data Base [I]	Synthetic Agricultural 1977-78 ORANI Data Base [II]	[II]-[I]
34	Textile Finishing	-1.47	-1.53	-0.06
35	Textile Floor Coverings	-1.00	-1.09	-0.09
36	Other Textile Products	0.25	0.16	-0.09
37	Knitting Mills	-2.04	-2.05	-0.01
38	Clothing	-2.54	-2.58	-0.04
39	Footwear	-10.79	-10.73	0.06
40	Sawmill Products	0.21	0.21	0.00
41	Veneers and Wood Boards	-0.43	-0.43	0.00
42	Joinery and Wood Products nec	-0.18	-0.18	0.00
43	Furniture and Mattresses	-0.28	-0.30	-0.02
44	Pulp Paper and Paperboard	0.39	0.32	-0.07
45	Bags and Containers	0.48	0.37	-0.11
46	Paper Products nec	-0.07	-0.11	-0.04
47	Newspapers and Books	0.25	0.21	-0.04
48	Commercial Printing	0.05	-0.01	-0.06
49	Chemical Fertilizers	2.58	1.51	-1.07
50	Other Basic Chemicals	-0.53	-0.61	-0.08
51	Paints and Varnishes	-1.11	-1.11	0.00
52	Pharmaceutical Goods	0.55	0.41	-0.14
53	Soaps and Detergents	0.19	0.14	-0.05
54	Cosmetics and Toiletries	-0.07	-0.07	0.00
55	Other Chemical Goods	0.01	-0.02	-0.03
56	Petrol and Coal Products	0.27	0.13	-0.14
57	Glass and Glass Products	-0.26	-0.28	-0.02
58	Clay Products and Refractories	0.28	0.28	0.00
59	Cement	0.04	0.07	0.03
60	Ready Mixed Concrete	-0.04	0.01	0.05
61	Concrete Products	-0.04	0.01	0.05
62	Non-Metallic Mineral Products	-0.01	0.00	0.01
63	Basic Iron and Steel	-0.56	-0.57	-0.01
64	Non-Ferrous Metals	2.73	2.73	0.00
65	Structural Metal Products	-0.18	-0.15	0.03
66	Sheet Metal Products	-0.06	-0.16	-0.10
67	Other Metal Products	-1.16	-1.19	-0.03
68	Motor Vehicles and Parts	-7.23	-7.16	0.07
69	Ships and Boats	-0.52	-0.70	-0.18
70	Railway Rolling Stock	0.55	0.41	-0.14
71	Aircraft	-0.08	-0.20	-0.12
72	Scientific Equipment	-0.04	-0.06	-0.02
73	Electronic Equipment	-1.29	-1.32	-0.03
74	Household Appliances	-0.53	-0.46	0.07
75	Other Electrical Goods	-0.54	-0.61	-0.07

TABLE 3.2: A COMPARISON OF THE SECTORAL EFFECTS OF A 25 PER CENT ACROSS-THE-BOARD TARIFF CUT COMPUTED WITH THE 1977-78 ORANI DATA BASE AND THE SYNTHETIC AGRICULTURAL 1977-78 ORANI DATA BASE*

	ORANI Industry	25 per cent Across-the-Board Tariff Cut: 1977-78 ORANI Data Base [I]	Synthetic Agricultural 1977-78 ORANI Data Base [II]	[II]-[I]
1	Pastoral Zone	2.96	1.50	-1.46
2	Wheat-Sheep Zone	3.32	1.29	-2.03
3	High Rainfall Zone	2.58	1.85	-0.73
4	Northern Beef	5.36	2.98	-2.38
5	Milk Cattle and Pigs	0.93	1.00	0.07
6	Other Farming (Sugar Cane, Fruit, and Nuts)	2.75	2.96	0.21
7	Other Farming (Vegetables, Cotton, Oilseeds, and Tobacco)	0.49	0.52	0.03
8	Poultry	1.87	1.49	-0.38
9	Services to Agriculture	2.03	1.25	-0.78
10	Forestry and Logging	-0.79	-1.11	-0.32
11	Fishing and Hunting	0.70	0.61	-0.09
12	Ferrous Metal Ores	1.75	1.75	0.00
13	Non-Ferrous Metal Ores	2.31	2.32	0.01
14	Black Coal	2.88	2.88	0.00
15	Oil, Gas, and Brown Coal	0.21	0.21	0.00
16	Other Minerals	0.32	0.33	0.01
17	Services to Mining nec	0.83	0.69	-0.14
18	Meat Products	3.71	2.82	-0.89
19	Milk Products	0.06	0.04	-0.02
20	Fruit and Vegetable Products	-0.04	-0.04	0.00
21	Margarine, Oils, and Fats nec	0.19	0.15	-0.04
22	Flour and Cereal Products	0.44	0.33	-0.11
23	Bread, Cakes, and Bicuits	0.04	0.03	-0.01
24	Confectionery and Cocoa	-0.17	-0.18	-0.01
25	Other Food Products	4.82	5.36	0.54
26	Soft Drinks and Cordials	-0.11	-0.12	-0.01
27	Beer and Malt	0.01	0.01	0.00
28	Other Alcholic Beverages	-1.26	-1.23	0.03
29	Tobacco Products	0.00	0.01	0.01
30	Cotton Ginning, Wool Scouring and Top Making	2.51	1.72	-0.79
31	Man-Made Fibres and Yarns	-9.44	-9.57	-0.13
32	Cotton Yarns and Fabrics	-4.53	-4.51	0.02
33	Wool and Worsted Fabrics	-1.73	-1.84	-0.11

reported in the synthetic data base as compared with the 1977-78 data base.

(4) The shares of inputs to current production in the agricultural industries differs between the two data bases; see Table 2.2. The share of returns to capital and agricultural land in primary-factor costs are larger for the Pastoral, Wheat-Sheep, and High Rainfall Zone industries in the synthetic data base as compared with the 1977-78 data base. However, the reverse is the case for the two Other Farming industries. In general the share of primary-factor inputs in total costs is greater in the synthetic data base as compared with the 1977-78 data base. (Note that the significance of these input shares is discussed in section 3.2.)

3. A COMPARISON OF THE RESULTS FROM THE ORANI MODEL CALIBRATED FROM A PARTICULAR YEAR-OF-RECORD BENCHMARK EQUILIBRIUM DATA BASE AND A SYNTHETIC AGRICULTURAL BENCHMARK EQUILIBRIUM DATA BASE

In this section we compare the results from the ORANI model calibrated from the 1977-78 data base and the synthetic agricultural 1977-78 data base. A 25 per cent across-the-board tariff cut was selected as the simulation to use for comparative purposes as its results have been documented in a large number of papers.[10] Given that the results are fairly well known, we will concentrate here on the differences between the two set of projections.[11]

TABLE 2.2 : THE SHORT-RUN SHARES OF FIXED FACTORS IN PRIMARY FACTORS AND BACK-OF-THE-ENVELOPE INDUSTRY OUTPUT PARAMETERS FOR THE AGRICULTURAL SECTOR IN THE 1977-78 ORANI DATA BASE AND THE SYNTHETIC AGRICULTURAL 1977-78 ORANI DATA BASE

Industry	Share of Returns to Capital and Agricultural Land in Primary-Factor Costs S_{Fj}		Short-Run Back-of-the-Envelope Industry Output Parameter[a] λ_j	
	1977-78 ORANI Data Base [I]	Synthetic Agricultural 1977-78 ORANI Data Base [II]	1977-78 ORANI Data Base [III]	Synthetic Agricultural 1977-78 ORANI Data Base [IV]
1. Pastoral Zone	0.25	0.46	2.83	0.75
2. Wheat-Sheep Zone	0.30	0.56	2.20	0.57
3. High Rainfall Zone	0.28	0.46	2.38	0.91
4. Northern Beef	0.54	0.51	1.01	0.67
5. Milk Cattle and Pigs	0.38	0.40	1.70	1.11
6. Other Farming (Sugar Cane, Fruit, and Nuts)	0.45	0.32	1.04	1.65
7. Other Farming (Vegetables, Cotton, Oilseeds, and Tobacco)	0.46	0.23	0.96	3.00
8. Poultry	0.39	0.40	2.37	2.97

a Note that λ_j is defined in equation (15).

3.2 The Industry Results

The sectoral effects of a 25 per cent across-the-board tariff cut computed by the ORANI model calibrated with the 1977-78 data base and the synthetic agricultural data base are given in Table 3.2. Again the main conclusions from an ORANI simulation of an across-the-board tariff cut can be drawn from either columns [I] or [II] of Table 3.2. The major winners from an across-the-board tariff cut are the export-oriented industries such as the agricultural, food processing, and mining industries. The main losers are the protected import-competing industries such as the textile, clothing, footwear, and motor vehicle industries.

To explain the differences in the agricultural industry output projections it is helpful to make use of an equation which summarizes the factors in ORANI which influence the supply behaviour of industries. Similar to the derivation of equation (13), it is possible to derive a short-run industry supply function for industries in the ORANI model. If it is assumed that wages are 100 per cent indexed to the CPI, and we make the approximation that the costs of intermediate inputs move in line with the CPI, the ORANI short-run industry supply function can be written:[19]

$$z_j = \lambda_j(p_{0j} - \xi) \quad ; \qquad (14)$$

where

$$\lambda_j = \sigma(1 - S_{Fj})/(S_{Fj}H_{Xj}) \quad . \qquad (15)$$

The percentage change in industry j's output is represented by z_j; p_{0j} is the percentage change in the farm-gate price of industry j's output industries with the synthetic data base. The smaller projected increase in exports dominates the smaller projected increase in imports and as a result the balance of trade is projected to move relatively less towards surplus with the synthetic data base as compared with the 1977-78 data base.[16] As the balance of trade is projected to increase less with the synthetic data base, real GDP is projected to increase less,[17] and hence aggregate employment is also projected to increase less.[18]

Since aggregate employment is projected to increase less with the synthetic data base as compared with the 1977-78 data base we would expect a similar overall result for the employment by occupation projections. There are two significant exceptions to this result, the employment projections for rural workers and skilled blue collar (other) workers; see Table 3.1.

Employment of rural workers increases by a smaller amount with the synthetic data base as the output response of the agricultural sector is relatively smaller when computed with the synthetic data base; this is discussed in section 3.2. Approximately 20 per cent of skilled blue collar (other) workers are employed in the export-oriented Meat Products industry. The response of the Meat Products industry is linked to the supply of sheep, cattle, pigs, and poultry from the agricultural sector. As the agricultural sector's ability to supply these commodities is somewhat less with the synthetic data base (due to the higher fixed-factor shares) the response of the Meat Products industry is also less (see Table 3.2). Hence the increase in employment in skilled blue collar (other) workers is also less with the synthetic data base as compared with the 1977-78 data base.

The simulations to be discussed in this section were computed assuming that the nominal exchange rate is the numeraire. Hence, changes in domestic price indexes can be interpreted as changes in domestic relative to world prices. There are also assumed to be no shortages of labour at the going real wage rates. Thus, changes in the labour market show up as changes in employment (which is demand-determined in this closure). Real domestic absorption and the shares in it of aggregate consumption, investment, and government spending are exogenous and set to zero change. Under this assumption changes in real GDP show up as changes in the balance of trade rather than in real absorption. The final feature is that plant, equipment, and agricultural land in use in every industry are assumed not to change (from the levels they otherwise would have reached) due to the shock under analysis (i.e., fixed industry capital stocks). This is a standard analytical device for defining the short run.[12]

3.1 The Macroeconomic Results

The macro impacts of a 25 per cent across-the-board tariff cut computed by the ORANI model calibrated with the 1977-78 data base and the synthetic agricultural 1977-78 data base are given in Table 3.1. The main conclusions from an ORANI simulation of an across-the-board tariff cut can be drawn from either columns [I] or [II] of Table 3.1. An across-the-board tariff cut generates a decrease in the consumer price index, hereafter CPI, and stimulates both exports and imports. Exports expand at a faster rate than imports causing a small improvement in the balance of trade. Real GDP is projected to increase slightly with a similar increase in aggregate employment.

TABLE 3.1 : A COMPARISON OF THE MACROECONOMIC IMPACT OF A 25 PER CENT ACROSS-THE-BOARD TARIFF CUT COMPUTED WITH THE 1977-78 ORANI DATA BASE AND THE SYNTHETIC AGRICULTURAL 1977-78 ORANI DATA BASE*

Variable	25 per cent Across-the-Board Tariff Cut		
	1977-78 ORANI Data Base [I]	Synthetic Agricultural 1977-78 ORANI Data Base [II]	[II]-[I]
Consumer Price Index	-2.34	-2.33	0.01
Aggregate Exports (foreign currency value)	3.19	2.61	-0.55
Aggregate Imports (foreign currency value)	1.60	1.54	-0.06
Balance of Trade	0.20	0.16	-0.04
Real Gross Domestic Product	0.22	0.17	-0.05
Aggregate Employment	0.34	0.28	-0.06
Employment by Occupation			
Professional White Collar	0.13	0.11	-0.02
Para Professional White Collar	0.07	0.05	-0.02
Skilled White Collar	0.14	0.06	-0.08
Semi & Unskilled White Collar	0.17	0.11	-0.06
Skilled Blue Collar			
Metal & Electrical	0.04	-0.01	-0.05
Building	-0.04	-0.05	-0.01
Other	0.78	0.56	-0.22
Semi and Unskilled Blue Collar	0.14	0.08	-0.06
Rural Workers	3.03	2.38	-0.65
Armed Services	0.00	0.00	0.00

* All projections, with the exception of the balance of trade, are percentage deviations from the value the variable in question would have taken if there had been no change in the tariffs. The balance of trade, while also a deviation from control, has the units billions of 1977-78 Australian dollars.

Column [III] of Table 3.1 shows the differences between the projections listed in columns [I] and [II]. For example, the CPI (with a base of 100) is projected to decrease by 0.01 percentage points less according to ORANI when it is calibrated with the synthetic agricultural 1977-78 data base as compared with the standard 1977-78 data base.

The difference between the aggregate export projections is the key result in Table 3.1. The two principal export sectors in the Australian economy are agriculture and mining. It will be shown in Table 3.2 that the response of the mining industries to the tariff cut is approximately the same for both simulations.[13] However, the response of the agricultural sector is significantly less when calculated using the synthetic agricultural data base. This is discussed in more detail in section 3.2, but briefly the short-run supply elasticities for the agricultural industries are in general lower due to the higher shares of fixed factors in the synthetic agricultural data base as compared with the 1977-78 data base;[14] see Table 2.2. Thus the aggregate export result is dominated by the change in the fixed-factor shares between the two data bases even though the agricultural sector is somewhat larger and in general a greater proportion of agricultural commodities are exported (see Table 2.1) in the synthetic agricultural data base as compared with the 1977-78 data base.

The other results in Table 3.1 follow from the aggregate export result. Aggregate imports are projected to increase slightly less with the synthetic data base even though the CPI is projected to fall slightly more with the 1977-78 data base.[15] The smaller increase in aggregate imports is due to the relatively lower projected change in demand for imports by the agricultural and agricultural related