The Economic Effects of the Sugar Tariff

by

Philip D. Adams and Peter B. Dixon

Centre of Policy Studies, Monash University

January 1997

EXECUTIVE SUMMARY

- The main part of the report presents simulation results from the MONASH-Sugar model on the effects of removing the tariff on raw and refined sugar in 1997-98. This: :
  - reduces the price of sugar to users in the Australian market by about 10 per cent or $37 per tonne; and
  - reduces the prices received per unit of output by canegrowers and millers by about 1.7 per cent.
- It is found that by 2007-08 this would
  - reduce the real value of output of cane growers and millers by about 4.5 per cent (or $215m in 1994-95 prices) from what it otherwise would have been;
  - reduce the real value of raw sugar exports by 6.0 per cent ($132m in 1994-95 prices) from what it otherwise would have been;
  - increase economic welfare annually by about $1m in constant 1994-95 prices;
  - increase annual output in sugar refining by about 0.4 per cent ($4m in 1994-95 prices) from what it otherwise would have been;
  - increase annual output in Australia's soft drink, confectionery and beer industries by small amounts (between 0.03 and 0.05 per cent); and
  - reduce Australia's real exchange rate from what it otherwise would have been, allowing expansion of exports in mining, agriculture and non-sugar manufacturing to replace lost sugar exports;

1. INTRODUCTION

Australia is the world's largest exporter of raw sugar. All of Australia's sugar exports come from Queensland, which supplies over 90 per cent of Australia's raw sugar output. The rest is produced in New South Wales and Western Australia.

Queensland sugar producers are subject to significant regulation by the state Government (see Industry Commission, 1992, chapter 4). Part of this legislation bestows to the Queensland Sugar Corporation (QSC) sole acquisition and marketing rights over all raw sugar produced in Queensland. The legislation also gives the QSC responsibility for storage and shipment and for the distribution of proceeds from sugar sales to millers and growers.

The Commonwealth Government's involvement in the sugar industry is limited to the provision of an import tariff on raw and refined sugar. The current rate is $55 per tonne (equivalent, currently, to an *ad valorem* rate of around 15 per cent). For imports from developing countries, such as Thailand, the tariff is reduced by 5 per cent of the fob price.

State and Commonwealth regulation of the Queensland sugar industry is currently under review.[1] This paper seeks to assist the review by shedding light on some of the economy-wide effects of the sugar tariff. In so doing, we extend work done by the Industry Commission (Industry Commission, 1992) on the effects of all regulatory arrangements, including sole acquisition rights and single-desk marketing. Other papers examining aspects of sugar regulation include Edwards (1993), Australian Bureau of Agricultural and Resource Economics (ABARE) (1991), Dixon and Johnson (1988), Borrell and Wong (1986), and Borrell and Lawrence (1984).

Our modeling framework is described in section 2. The projections are discussed in section 3. Concluding remarks are is section 4

---

[1]Current Queensland government regulation was established under the Sugar Industry Act of 1991. At the time of the Act's introduction, it was agreed that the legislation would be reviewed in 1996. This review is being conducted by a Working Party comprising industry representatives, representatives of sugar users and representatives from the Commonwealth and Queensland Governments. The Boston Consulting Group (BCG) has been commissioned to undertake any analyses required by the Working Party. An earlier version of this paper was commissioned by the BCG.

2. MONASH-SUGAR

Our analysis is based on projections from a specially built version of the MONASH model, called MONASH-Sugar.

MONASH is a 114 commodity/112 industry model of Australia (Adams et al., 1994). It is a descendant of ORANI (Dixon et al., 1982) which has been applied in Australian policy debates since the 1970s.[2] ORANI is a Computable General Equilibrium (CGE) model. Its equations capture the direct and indirect relationships between industries and final users (consumers, exporters, etc.) arising from the flows of goods and services, and the economy-wide constraints on resources such as capital and foreign exchange. Markets are modeled as being perfectly competitive. Consumers are assumed to be always maximizing utility, while producers are assumed to be minimizing costs subject to constant returns to scale production technologies.[3]

The main theoretical extension in MONASH relative to ORANI is dynamics. MONASH produces sequences of annual solutions connected by accumulation relationships for capital stocks. ORANI, on the other hand, is a comparative static model. It shows for a single year the differences produced in the economy by changes in taxes, tariffs and other exogenous variables.

The building of MONASH-Sugar involved two main tasks.

(1) *Development of a special-purpose database.* The standard version of MONASH and its database includes canegrowing, sugar refining and milling in two miscellaneous industries, 6 *Other export-related farming* and 25 *Other food products*. Industry 6 includes sugar cane farming, while industry 25 includes sugar milling and refining. Our first task was to disaggregate the database to create five new industries: *Sugar cane farming, Other export-related farming nec., Sugar milling, Sugar refining, and Other food products nec.*

(2) *Addition of equations capturing the unique features of the sugar industry.* The standard version of MONASH makes no allowance for the sugar tariff nor for the arrangement by which Queensland millers make delivery payments to growers.

---

[2] For an overview of ORANI applications, see Powell and Snape (1993).

[3] There are several CGE models incorporating imperfect competition in commodity markets (see Dixon and Parmenter, 1996). However, at this stage the literature does not provide an alternative to the competitive paradigm which generates superior results on either formal statistical criteria or on an informal plausibility basis.

Our second task was to incorporate into the theory of the model these special arrangements.

2.1 Database

The MONASH-Sugar database relates to the year 1994-95; the base year for our projections. It is organized in two separate files. The first contains input-output data for 1994-95. These data provide the basis for computing initial cost and sales shares for industries and their products. The second stores elasticity parameters which are invariant to time.

The starting point in the construction of the MONASH-Sugar database was the MONASH database for 1990-91.[4] The construction involved disaggregating the existing data, to separate out cane growing, raw sugar milling and sugar refining from their parent activities. The disaggregated database was then updated from 1990-91 to 1994-95 by model simulation. Table 1 matches the parent industries identified in MONASH with the disaggregated commodities identified in MONASH-Sugar.

Table 1: Sugar Industries in MONASH and MONASH-Sugar

MONASH	MONASH-Sugar
Other export-related farming (MONASH industry 6)	Sugar cane growing (MONASH-Sugar industry 6) Other export-related farming (nec) (MONASH-Sugar industry 7)
Other food products (MONASH industry 25)	Raw sugar manufacturing (MONASH-Sugar industry 26) Refined sugar manufacturing (MONASH-Sugar industry 27) Other food products (nec) (MONASH-Sugar industry 28)

Note that the newly defined industries are national industries. That is they cover all growing, milling and refining establishments in Australia, not just establishments in Queensland.

The disaggregation of the 1990-91 input/output file proceeded as follows.

[4] Details of the construction of the 1990-91 MONASH input-output file is given in Dixon and McDonald (1992).

For sales, the primary source was the input/output section of the Australian Bureau of Statistics (ABS) who provided unpublished sales data at a very detailed commodity level for 1989-90 and previous years. These data were used to make the initial split of the sales of MONASH industries 6 and 25. Adjustments were then made in light of supplementary information from ABARE (various issues of *Australian Quarterly* and unpublished data supplied on a personal basis), from Warren Males of the QSC and from the Industry Commission (IC). These changes related primarily to sales to final users (consumption and exports). The most significant adjustment was to consumption sales of refined sugar. The initial split suggested that consumption's share in total sales was 46.3 per cent. Subsequent changes reduced this to 23.4 per cent.

Data for splitting costs were more difficult to obtain. Initial splits were done by a simple pro-rating procedure using the total sales of each disaggregated industry. This leaves the disaggregated industries with the same cost structures as their parent industries. Adjustments were then made using information (often qualitative) from published ABARE and IC reports, and from the annual report of the QSC. Further refinements were enabled using confidential data supplied by the CANEGROWERS and the Australian Sugar Milling Council. Data from the latter came partially from a specially commissioned survey.

In contrast to our work on the input/output data, the task of disaggregating the 1990-91 elasticities file was straightforward. The key elasticity underlying our projections is the export demand elasticity for raw sugar. The export demand elasticity for the parent commodity, other food products, is -20. However, this is too high for raw sugar. In our simulations we use a value of -5. ABARE (1990) found estimates for sugar demand elasticities ranging from -5 to -50. The value adopted here is that preferred by ABARE for their sugar model, SUGABARE. It is also the value adopted by the IC in its modeling of sugar industry policies [5].

Our 1994-95 database was generated by updating the 1990-91 data via simulation with MONASH-Sugar. For as many of the model's variables as possible, growth rates over the period 1990-91 to 1994-95 were observed. The variables for which the required growth rates were available included employment by industry, rates of protection against imports, exports and production of major agricultural and mining commodities (including sugar cane, raw sugar and refined sugar), the real wage rate, aggregate household consumption and the trade-weighted exchange rate. In the updating

[5] See Appendix G of IC (1992).

simulations all these variables were *exogenous*. The results of the simulations give growth rates for all the *endogenous* variables. Together with the observed growth rates for the exogenous variables, these are enough to update all the commodity, factor and tax flows in the input-output database.

Table 2 summarizes the 1994-95 sales patterns for the products of the disaggregated sugar industries in the MONASH-Sugar data base.

Table 2 : Sales shares in 1994-95 from the MONASH-Sugar data base

Product	Sales shares (%)					
	Industries			Final demand:		
	sugar milling	sugar refining	other	Private consumption	Exports	Total
Sugar cane	100.0	0.0	0.0	0.0	0.0	100.0
Raw sugar[a]	0.0	17.5	0.4	0.0	82.1	100.0
Refined sugar	0.0	0.0	73.6	18.9	7.5	100.0

(a) Includes molasses.

2.2 Theory

In this sub-section we describe the enhancements to the theory of MONASH to take account of: (a) the arrangement by which Queensland millers make delivery payments to growers; and (b) the sugar tariff.

2.2.1 The distribution of sugar proceeds in the Queensland sugar industry

The present distribution formula in each mill area takes into account the price of raw sugar and the sugar content of the cane delivered to the mill. It can be written as:

$$P^c = P^s \times \frac{90}{100} \times \frac{(CCS-4)}{100} + 0.578 \qquad (1),$$

where:

- P^c is the average price of green cane ($ per tonne) paid to farmers over the season in the mill area;
- P^s is the price of raw sugar ($ per tonne of 94nt sugar)[6]; and
- CCS is the average yield of *commercial cane sugar* from a tonne of cane[7].

[6] Net titre (nt) is a raw sugar quality measure (100nt is pure white sugar). In Queensland sugars of various qualities are reduced to a common basis of 94nt for payment purposes.

The sugar price, P^s, in equation (1) is mill specific, reflecting the share of the mill's output allocated to the No. 1 and 2 pools. The price differential between the two pools is set to a fixed percentage difference, currently 6 per cent. The cane price received by individual farmers will vary from P^s according to the CCS of their cane.

The average quantity of 94nt raw sugar produced from a tonne of cane over the season in the mill area is given as:

$$\frac{X^s}{X^c} = \frac{CCS}{100} \times \frac{COW}{100} \qquad (2)$$

where:

X^s is the quantity (tonnes) of 94nt raw sugar produced over the season in the mill area,

X^c is the quantity (tonnes) of cane delivered, and

COW, the coefficient of work, is the percentage ratio of the weight of 94nt sugar produced to the weight of commercial cane sugar in the cane.

COW is a partial measure of mill productivity. It measurers tonnes of sucrose "in" (CCS nominally at 100nt) relative to tonnes of sucrose "out" (94nt).[8]

From now on, we treat (1) and (2) as applying to the Queensland sugar industry as a whole, with COW and CCS interpreted as average ratios across all mills and growers, and P^s as the average return from both pools.

Combining (1) and (2) yields the average share of grower revenue from sugar sales in a mill year:

$$\frac{P^c X^c}{P^s X^s} = \frac{90(CCS-4)}{CCS \times COW} + \frac{5780}{P^s(CCS \times COW)} \qquad (3).$$

Over the last five years, CCS has averaged 13.8 per cent, COW approximately 102 per cent, and the raw price of sugar $340.8 per tonne. Thus, according to (3) the revenue per tonne of raw sugar has been distributed between growers and millers in the ratio 0.638 to 0.361.

---

[7] CCS is normally expressed in units. Here it is expressed as a percentage.

[8] COW is normally referred to as a ratio. Here it is expressed as a per cent.

MONASH-Sugar takes account of both (1) and (3). For simplicity they are assumed to relate to all cane grown and sugar milled in Australia. Equation (1) is included to explain changes in the basic price of sugar cane as a function of changes in the basic price of raw sugar.[9] To accommodate equation (1) the supply schedule for cane growing is endogenised to ensure that demand equals supply at the extraneously given price. This is done by allowing shifts in cane growing profitability beyond that attributable to changes in the scarcity of cane growing land and capital.

Equation (3) is used to check that in each year of the projection period total revenue in cane-farming is the correct proportion of total revenue available for distribution. The default values for CCS and COW are 13.8 and 102. These settings are maintained throughout the projection period and across all projections.

2.2.2 *The sugar tariff*

The Commonwealth Government provides assistance to the sugar industry in the form of a specific tariff on imports of raw and refined sugar. In the March 1991 Economic Statement, the Government announced that as from 1 July 1992 the tariff would be $55 per tonne less 5 per cent of the fob export price for imports from developing countries (leading to an effective tariff of approximately $36 per tonne).[10]

Because of the monopoly power of the QSC, domestic raw sugar prices are set at import parity rather than export parity. In contrast, competition among refiners generally leads to domestic refined sugar prices being set at export parity.

The import parity price for raw sugar has three basic components:

- the world fob price of raw sugar in Australian dollars;
- shipment costs from the supplier's to the refiner's port (referred to as the freight differential); and
- the effective rate of tariff (taking account of discounts for developing country preference).

In modeling the sugar tariff we assume that the price for raw sugar paid by domestic customers is the world fob price plus shipment costs plus the effective tariff.

---

[9]The basic price of a commodity is the price received by the producer of the commodity. It is equal to the price paid by the purchaser less margins (e.g. freight) and sales taxes.

[10]Most imports are likely to come from developing countries such as Thailand. Thus the full 5 per cent developing country discount is generally passed on fully to domestic customers.

By contrast, we assume that the domestic purchasers' price for refined sugar is the world fob price only.

Figure 1 shows diagrammatically the effects of the tariff on participants in the raw sugar market. DD is domestic demand, WD is world demand and DS is long run domestic supply.[11] Note that DD is drawn as being highly inelastic and DS as being elastic. This broadly agrees with the elasticities implied by the MONASH-Sugar database. Although WD is drawn as having infinite elasticity, in the simulations reported in section 4.2 it has an elasticity of -5 (see above). Pw is the export parity price including the freight differential, t is the effective rate of the specific tariff, and Ps is the price received by domestic producers.

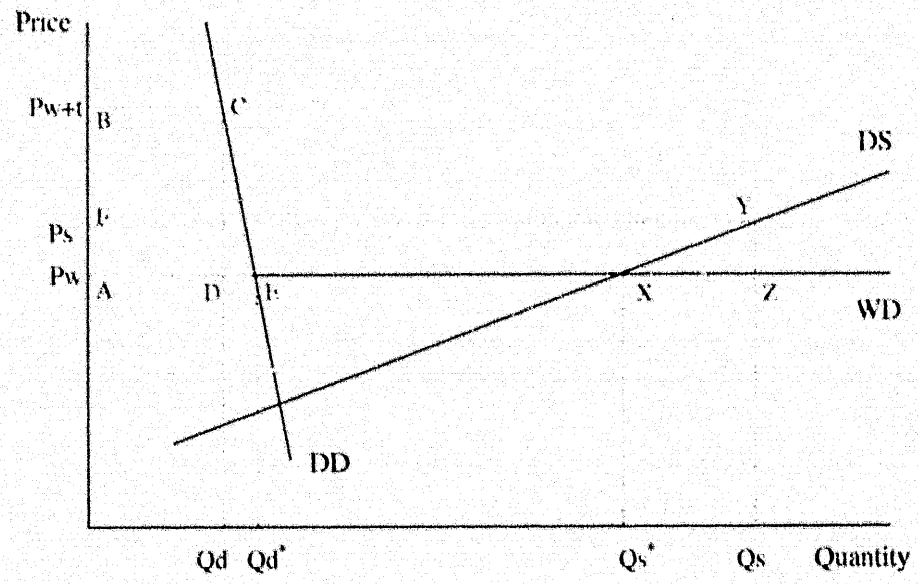

Figure 1: Domestic Demand and Production in the Raw Sugar Market

In the absence of a tariff, Pw and Ps are equal. Domestic demand is Qd^* and domestic supply Qs^*, implying exports of $Qs^* - Qd^*$. The introduction of a tariff causes the price faced by domestic customers to rise. We assume that the full amount of the tariff is passed on. Thus the new price faced by domestic refiners is Pw + t. As a result, domestic demand contracts to Qd. Under the system of price pooling currently in place, the price received by producers rises to Ps, the average unit revenue from both export and domestic sales. At that price, production expands to Qs and exports to Qs - Qd.

[11] Movements along the long-run supply curve (DS) show how much supply changes in the long run in response to a *permanent* change in price. The long run is defined here as a period sufficiently long to allow industry capital stocks to fully adjust to the cut in tariff.

Note that the impost on consumers is given by the area of the rectangle ABCD. This must equal the transfer to producers given by the area of AFYZ.

Assuming that the full amount of the tariff is passed on to consumers, the tariff generates a loss of consumer surplus given by the area in triangle CDE. For the producer, the loss in surplus is given by the area in triangle XYZ. Adding together the two areas gives the total deadweight loss due to the imposition of the tariff. In other words,

$$\text{DW loss} = \tfrac{1}{2}\{(Qd^* - Qd)\,t\} + \tfrac{1}{2}\{(Qs - Qs^*)(Ps - Pw)\} \qquad (4)$$

where the first term is the loss of consumer surplus and the second is the loss in producer surplus.

We model the tariff in the way suggested by Figure 1, that is, as a two-price domestic support scheme. To capture the price discrimination between the domestic and export markets we impose a *tax* on domestic sales of raw sugar which elevates the price paid by domestic customers by the amount of the effective sugar tariff plus the notional freight differential. The revenue from this tax is passed back to producers as a production subsidy.

3. PROJECTIONS

Having constructed MONASH-Sugar, our remaining tasks were to:

(1) *Project the development of the economy between 1995-96 and 2007-08, with current sugar industry arrangements in place.* In this projection (the *base case* projection) it is assumed that there are no changes to the special sugar industry regulatory arrangements (the tariff and other arrangements primarily relating to the Queensland sugar industry) currently in place. The *base case* projection gives us a starting point for the economy in 1996-97 for all our subsequent projections.[12] It also serves as a control path from which deviations are measured in assessing the effects of removing the tariff.

(2) *Project deviations from base arising from removal of the sugar tariff in 1997-98 and from any other policy options under consideration.* Using MONASH-Sugar,

[12] 1996-97 is the final year of current sugar industry arrangements in QLD.

we assess how the development of the economy would have differed from the *base case* under policy options being considered.

3.1 The base case

Projections for the base case are given in columns (I) to (III) of Table 3. Column (I) shows average annual percentage growth rates between 1994-95 and 2006-07. Columns (II) and (III) show starting and end values for each variable. Projections for macroeconomic variables are shown in part 1 of the table. The remaining parts cover projections for: production of aggregated industry sectors (part 2); production of sugar and sugar-related industries (part 3); and export volumes of raw and refined sugar (part 4).

3.1.1 Macroeconomic projections

The base case macroeconomic scenario for the first half of the projection period follows assumptions supplied by Syntec Economic Services for use in the January 1996 edition of the CoPS/Syntec publication *Guide to Growth*. The macroeconomic scenario for the second half of the period is based on extrapolation of first-half trends.

Overall, the scenario shows moderate growth of GDP (row 1.1) and employment (row 1.8) over the period and a slight improvement in net trade volumes (row 1.5 *cf* row 1.6). An outstanding feature of the scenario is the rapid growth of international trade flows (exports and imports) relative to GDP. As explained in Adams and Dixon (1995), Australia's international trade is growing rapidly, reflecting several trends which are expected to continue into the next century. Among these trade-enhancing trends are:

- falling tariffs and other barriers to trade imposed by Australia and by our trading partners;
- declining real transport and communication costs associated with international trade;
- increasing usage in Australia of computing, communications and other high-technology equipment. These products are largely imported and this will create a demand for imports and simultaneously a need for exports; and
- a rising share of Australia in the world tourism market, reflecting Australia's growing reputation as a safe destination and special events such as the Sydney Olympics.

Table 3: Projections (1994-95 to 2006-07): Effects of Removing Tariff in 1997-98*

	(I)	(II)	(III)	(IV)	(V)
	Base case			Difference in 2006-07 due to removal of tariff	
	Average annual %Δ	Level in 1994-95[a]	Level in 2006-07[a]	Absolute[a,b]	per cent
1 Macroeconomic Variables[a]					
1.1 Real GDP	2.68	455675	625687	2	0.00
1.2 Real private consumption	3.05	284255	407746	3	0.00
1.3 Real public consumption	1.45	80071	95170	0	0.00
1.4 Real private investment	2.63	96732	132087	8	0.01
1.5 Real exports	7.24	86371	199825	13	0.01
1.6 Real imports	6.29	96085	199786	22	0.01
1.7 Real exchange rate deval.	-1.26	100	86	+	0.01
1.8 Real labour input	2.11	223110	286743	0	0.00
1.9 Real capital input	3.15	169818	246311	13	0.01
1.10 Real wage rate	0.71	100	109	+	0.00
1.11 GDP deflator	2.69	100	138	+	0.00
1.12 Terms of trade	0.08	100	101	+	0.01
1.13 Welfare[c]	na	na	na	1	na

* The numbers in columns (I), (II) and (III) are *Base case* projections from *Monash-Sugar*. Column (I) shows average annual percentage growth rates between 1994-95 and 2006-07. Columns (II) and (III) show starting and end values for each variable. For example, in the *base case* real GDP is projected to grow at an average annual rate of 2.68 per cent, or from 455,675m in 1994-95 to 625,687m (1994-95 prices) in 2006-07.

The numbers in columns (IV) and (V) relate to the year 2006-07. They show the projected effects in that year of removing the sugar tariff in 1997-98. Column (IV) shows the absolute differences. Column (V) shows the percentage differences calculated by expressing the numbers in column (IV) as a percentage of the numbers in column (III). For example, due to the tariff cut real GDP (in 1994-95 prices) is projected to be $3m higher in 2007-08 than what it otherwise would have been. This is negligible as a percentage of the *status-quo* level of real GDP in 2007-08.

(a) The values in rows 1.1 to 1.6, 1.8, 1.9 and 1.13 are measured in $m at constant 1994-95 prices. The values in rows 1.7 and 1.10 to 1.12 are indexes with a base of 100 in 1994-95.

(b) + means non-zero and positive, but very small in absolute size.
- means non-zero and negative, but very small in absolute size.

(c) *Welfare* is the projected change in real consumption arising from the tariff cut, calculated by assuming that the cut has no effect on aggregate employment, on industry capital stocks, on industry investment and on the balance of trade. In other words, it shows how much additional real consumption society can afford in 2006-07 due to the tariff cut without working any harder or investing any more.

Table 3 (cont): Projections (1994-95 to 2006-07): Effects of Removing Tariff in 1997-98*

	(I)	(II)	(III)	(IV)	(V)
		Base case		Difference in 2006-07 due to removal of tariff	
	Average annual %Δ	Level in 1994-95[a]	Level in 2006-07[a]	Absolute[a,b]	per cent
2. Aggregated industries. Real production					
2.1 Agriculture, forestry, fishing	2.96	24889	35306	-30	-0.08
2.2 Mining	4.31	32358	53690	46	0.09
2.3 Food, beverages and tobacco	2.97	36606	52011	-34	-0.07
2.4 Textiles, clothing and footwear	0.57	10532	11270	1	0.01
2.5 Wood and wood products	2.71	9541	13145	3	0.02
2.6 Paper, paper products, printing	4.50	15490	26256	3	0.01
2.7 Chemicals, petrol, coal prods.	3.81	28898	45266	12	0.03
2.8 Cement and clay products	1.93	6102	7671	1	0.01
2.9 Basic metal products	3.00	33723	48064	16	0.03
2.10 Cars, other transport equip.	2.15	15774	20353	6	0.03
2.11 Electronic equipment	3.71	17598	27209	8	0.03
2.12 Leather, rubber, plastic prods.	2.40	8775	11660	3	0.03
2.13 Electricity, gas and water	2.73	24165	33400	-3	-0.01
2.14 Construction	4.64	60555	104318	4	0.00
2.15 Wholesale and retail trade	3.86	110014	173387	5	0.00
2.16 Transport and storage	2.59	42212	57373	-2	0.00
2.17 Communications	6.17	17271	35442	3	0.01
2.18 Finance, other bus. services	3.78	96026	149861	12	0.01
2.19 Ownership of dwellings	1.98	53435	67577	1	0.00
2.20 Public administration, defence	0.32	28242	29347	1	0.00
2.21 Health, education and welfare	1.58	79316	95788	4	0.00
2.22 Hospitality, leisure services	3.86	36744	57888	8	0.01
3. Sugar and related industries: Real production					
3.1 Cane growing	2.96	1311	1859	-84	-4.51
3.2 Confectionery manufacturing	2.08	1118	1431	1	0.05
3.3 Sugar milling	2.95	2025	2870	-129	-4.51
3.4 Sugar refining	2.55	791	1069	4	0.36
3.5 Soft drinks manufacturing	2.25	1695	2215	1	0.04
3.6 Beer and malt manufacturing	2.95	2463	3491	1	0.03
4. Real exports:					
4.1 Raw sugar	2.89	1564	2202	-132	-5.99
4.2 Refined sugar	3.16	59	86	3	3.27

* See corresponding notes on previous page.

(a) The values of all variables in sections 2, 3 and 4 of this table are expressed in $m at constant 1994-95 prices.

(b) + means non-zero and positive, but very small in absolute size.

- means non-zero and negative, but very small in absolute size.

3.1.2 Sectoral growth prospects

Turning to column 1/section 2 of Table 3, we that the sector with the best growth prospects (6.2 per cent average annual growth over the forecast period) is *Communications* (row 2.17). This sector benefits the most from technological shifts and changes in household tastes increasing the intensity with which its products are used by domestic firms and households. Other sectors to benefit from favorable changes in technology and tastes are *Electronic equipment* (row 2.11), *Paper, paper products, printing* (row 2.6), and *Finance and other business services* (row 2.18).

Construction (row 2.14) is ranked second. Its prospects follow our macro assumptions for growth in non-equipment investment (which is assumed to grow at a faster rate than real investment overall, see row 1.4). Relatively fast growth in construction is likely to occur from a low point in the construction cycle (especially housing) in the first year of our forecasts, 1994-95.

Hospitality, leisure services (row 2.22) and *Wholesale and retail trade* (row 2.15) are other highly ranked sectors. Hospitality, etc. benefits from strong growth in international tourism and from shifts in the composition of household expenditure. The trade industries do well because of their role, particularly the wholesale component, in facilitating international trade.

The prospects of *Agriculture, forestry and fishing* (row 2.1) and *mining* (row 2.2) are governed by our assumptions for growth in traditional exports. These come mainly from ABARE.

The lowest ranking sector is *Public administration and defence* (row 2.20). Prospects for this sector reflect our assumption for public expenditure. The other lowly ranked sectors, *Textiles, clothing and footwear* (row 2.4), *Cars and other transport equipment* (row 2.10), and *Leather, rubber and other products* (row 2.14), owe their positions mainly to severe import competition, and to the effects of reductions in protection in the first six years of the projection period.

In view of the rapid growth forecast for international trade over the projection period, the middle ranking of *Transport and storage* (row 2.16) may seem surprising. We expect the sector's output growth to be restrained by technological changes economizing on the use of transport inputs.

As with transport and storage, most of the other middle-ranking sectors are affected in our forecasts by counteracting forces. For example, our close-to-average GDP forecast for *Electricity, gas and water* (row 2.13) is explained by two offsetting forces. First, we are projecting rapid microeconomic reform for the sector. This makes its products relatively cheap and encourages substitution towards them by consumers. However, the greater competitiveness of the sector is offset by an assumed shift in consumer tastes away from electricity, gas and water, reflecting increasing awareness of conservation issues. For *food, beverages and tobacco* (row 2.3), strong export growth potential is offset by low income elasticities of demand, making domestic sales from the sector comparatively insensitive to per capita income growth in the forecast period.

3.1.3 Sugar industry prospects

The base case growth prospects for cane growing (row 3.1) and sugar milling (row 3.3) were imposed at rates consistent with information supplied by the Queensland Sugar Corporation (QSC). This was achieved by setting output exogenously, allowing the model to project the position of the export demand curve for raw sugar required to accommodate the necessary exports (row 4.1).

Since most refined sugar is consumed either directly or indirectly via confectionery (row 3.2), soft drinks (row 3.5) and beer (row 3.6), its growth prospects depend crucially on our macro assumption for private consumption (row 1.2). The projected growth rate for refined sugar (row 3.4) is a little below that of consumption due to a low income elasticity for refined sugar and to relatively poor growth prospects for the confectionery industry. The latter reflects strong import competition.

The growth rate for exports of refined sugar (row 4.2) was set exogenously according to information from the QSC. This was accommodated by allowing the model to project the position of the corresponding foreign demand curve.

3.1.4 The sugar market in 1996-97

One of the purposes of the base case projection is to give a starting point for the economy in 1996-97 for all our subsequent projections. Table 4 shows critical data for the sugar industries in 1996-97 implied by the base case projection.

Table 4: Data for the Sugar Industries in 1996-97*

	(I)	(II)	(III)
	Cane	Raw sugar	Refined sugar
(1) Total value of sales to producers	$1296 m	$2003m	$821m
(1a) Export receipts	0 m	$1664m	$80m
(1b) Domestic sales	$1296 m	$339m	$740m
(2) Total volume of sales	39573kt	5340kt	na
(2a) Exports	0kt	4050kt	na
(2b) Domestic	39573kt	1290kt	na
(3) World raw-sugar price fob ($Aus)[a]		$363.2/tonne	
(4) Effective tariff	nr	$36.8/tonne	$36.8/tonne
(4) Freight differential for raw sugar		$5/tonne	

na means not available for publication, nr means not relevant

* All data are expressed in Australian dollars, 1996-97 prices

(a) Our base case projection to 2000-01 for the domestic-currency world price (fob) of raw sugar are consistent with ABARE forecasts given in ABARE (1996, pp. 417-425)

Based on these data and values for supply and demand elasticities implied by the MONASH-Sugar database, the value of the consumer transfer to producers arising from the sugar tariff (ie the area ABCD in Figure 1) is

$$(36.8/363.2) \times \$339m = \$34.3m \text{ in 1996-97 prices,}$$

and the total deadweight loss (ie the combined areas of triangles CDE and XYZ) from equation (4) is

$$\frac{1}{2}\{(1,450t)\ \$36.8/t\} + \frac{1}{2}\{(235,107t)\ \$6/t\} = \$0.73 \text{ million in 1996-97 prices.}$$

3.2. Effects of removing the sugar tariff in 1997-98

Our projections of the effects of removing the sugar tariff in 1997-98 are given in columns (IV) and (V) of Table . These were computed by comparing the values of variables in the base case projection with their values from a projection in which the

economy is allowed to deviate from its base case path in response to the removal of the sugar tariff in 1997-98. The comparison-year is 2006-07.

This section has three parts. In the first we describe how the deviation path was computed, and give the major assumptions. The effects are explained in Sub-section 4.2. In the final sub section we examine the sensitivity of the results to a different labour market assumption and to a higher export demand elasticity.

3.2.1 Computing the effects, and main assumptions

In the base case simulation most macroeconomic variables and the volumes and prices of traditional exports are exogenous and set according to assumptions supplied by specialist forecasting organizations. To allow us to set the macroeconomic variables exogenously, some aspects of technology and some shift variables in the model's macroeconomic relationships were endogenous. For example, growth rates for GDP, employment and investment are all included in the exogenous macroeconomic scenario. Hence, the model implies a value for the rate of change of primary-factor-saving technical change necessary to reconcile the assumed growth rates in output and in factor inputs. A second example is that aggregate investment expenditure and the economy-wide rate of return on capital are both parts of the macroeconomic scenario. Hence, the model determines a uniform shift in each industry's investment equation to reconcile the assumed values for these two variables. A similar procedure is adopted to allow the base case simulation to reconcile our assumptions about export volumes and prices (including those for sugar). In this case, the model projects shifts in the relevant export supply and demand schedules.

For the deviation simulation, we wish to allow most macroeconomic variables, and traditional export volumes and prices to deviate from the status-quo values in response to a change in the sugar tariff. On the other hand, we wish to hold technology, macroeconomic parameters such as the shift in investment equations, and the positions of export supply and demand schedules fixed at the values which are implied for them in the base case. To achieve this we define a ***deviation closure*** for the deviation simulation. In this closure technology, most macroeconomic parameters, and the positions of export supply and demand schedules (including those for sugar) are all fixed exogenously, while the corresponding macroeconomic variables, export values and export prices (which were previously exogenous) are endogenous.

In the deviation simulation, a number of macroeconomic variables remain exogenous and thus do not deviate from their values in the base case simulation. In other words, their projected paths are unaffected by the tariff cut. These variables are:

- the balance of trade;
- real Government consumption;
- the Consumer Price Index (CPI);
- the economy-wide rate of return on capital, and
- aggregate employment.

Holding the balance of trade fixed is consistent with the idea that external balance is a primary target of the Government's macroeconomic policies. Hence any shock to the economy, such as the tariff cut, can be expected to have a negligible impact on the balance of trade, particularly in the long run. In our modeling, we assume that income tax rates adjust to ensure that changes in national income are matched by changes in domestic absorption. The other tool of fiscal spending, public consumption expenditure, is assumed to be unaffected by the cut in sugar tariff.

Another reason for fixing the balance of trade is that it facilitates welfare comparisons. In both the base case and deviation runs, the economy reaches the end of the projection period with the same external liability.

Fixing the CPI fixes a typical consumption bundle as the *numeraire*. This means that all goods and services in the economy are valued in terms of the number of consumption bundles for which they can be exchanged. Note though, that this does not preclude the possibility that the cut in tariff will effect inflation, only CPI-inflation is unaffected. For example, if the tariff cut affects Australia's terms of trade, this would flow through to the GDP-deflator and hence producer-price-inflation.[14]

Because we are concerned with the long run, we allow for capital reallocation in our deviation simulation. However, we fix the economy-wide rate of return on capital on the assumption that it is determined by world interest rates. These are unaffected by the change in sugar tariff.

We assume that the tariff cut does not affect aggregate employment. This is justified by the idea that in the long run, aggregate employment is determined by

[14] An expenditure deflator like the CPI includes the price of imports but not the price of exports, while a producer deflator like the GDP deflator includes the price of exports but not the price of imports.

demographic variables, participation rates and the natural rate of unemployment.[14] These variables are unrelated to the sugar tariff. Under this assumption, any economy-wide increase in demand for labour arising from the tariff cut increases the real wage rate paid to the exogenously fixed employed.

In sub section 4.3 we examine the sensitivity of our projections to this last assumption. There we present an alternative set of long-run effects, in which any stimulus to labour demand is accommodated by a combination of increased real wage and increased employment.

5.2.2 Effects of tariff cut

As illustrated in Figure 1, removing the sugar tariff has two immediate effects: (a) it reduces the price of raw sugar to domestic customers, and (b) it reduces the average price received by sugar millers. We estimate that the immediate loss in mill revenue (equivalent to the area of the rectangle AFYZ) is $34.3m in 1996-97 prices (see section 3.4), or 1.7 per cent of total revenue.

The ultimate effects on production and exports of the sugar and related industries are given in parts 3 and 4 of Table 3 under columns (IV) and (V). Production of both sugar cane (row 3.1) and raw sugar (row 3.3) falls by 4.5 per cent, while raw-sugar exports contract by 6 per cent. The refining industry and the main sugar-using industries expand their output, but this is limited by a low average consumption demand elasticity for sugar based products. Most of the expansion in refining production is exported.

Macroeconomic effects

The macroeconomic effects are given in part 1 of Table 3. These are very small. This is not surprising given the nature and size of the shock, and the size of the directly affected industries, canegrowing and milling, as a proportion of GDP. According to our estimates, in 1996-97 value added in these industries account for less than 0.2 per cent GDP.

Most of the macro effects from the shock stem from distribution factors. In our simulations, with overall employment of labour and land held fixed and no change in productivity, changes in real GDP reflect, in the main, deviations in the economy's

[14] This is the standard long run assumption of most modern macroeconomic models such as the Murphy model and the Treasury's model, TRYM.

employment of capital.[15] Economy-wide employment of capital can rise only if capital becomes cheaper relative to labour, and this is possible only if the real wage rate rises relative to the fixed economy-wide rate of return on capital. The cut in tariff has little impact on the real wage rate (row 1.10). Thus real capital input (row 1.9) and real GDP (row 1.1) are largely unaffected (see below).

With Australia's trade balance held constant, the contraction in sugar exports must be offset by increased exports elsewhere and by import replacement. The mechanism is real exchange rate devaluation (row 1.7) which enhances the competitiveness of Australian products on local and overseas markets. Non-sugar exporters have, on average, import intensive production technologies. Thus the increase in non-sugar exports leads, somewhat perversely, to an expansion in imports. Overall, import volumes rise (row 1.6), but by less than if there were no real devaluation. Export volumes (row 1.5) also rise. However, the necessary expansion in export volumes is less than that of import volumes due to an improvement in the terms of trade (row 1.12). This improvement is the net outcome of a rise in world sugar price due to the contraction in Australian sugar exports, and of declines in other world prices (especially for mining and primary agricultural products) due to the expansion in non-sugar Australian exports.

It is the terms-of-trade improvement which provides what little room there is for the real wage rate (row 1.1) to increase and for real GDP (row 1.1) and real capital input (row 1.9) to expand. We assume that investment (row 1.4) deviates from the base case roughly in line with the deviation in the capital stock. These outcomes, and our assumptions for the trade balance and real public consumption (row 1.3), imply an increase in real private consumption (row 1.2).

The only macroeconomic variable in Table 3 yet to be explained is *welfare* (row 1.13). This is the projected change in real consumption arising from the tariff cut, calculated by assuming that the cut has no effect on aggregate employment, on industry capital stocks, on industry investment and on the balance of trade.[16] In other words, it shows how much additional real consumption society can afford in 2006-07 due to the tariff cut without working any harder or investing any more. According to our

---

[15] Another factor is changes in real commodity tax collections (net of subsidies). This explains the discrepancy in column (IV) of Table 3 between the deviation in real GDP (row 1.1) and that in real capital input (row 1.9).

[16] This is calculated in a separate simulation from those generating the base case and tariff-removal results. In these latter simulations, capital and investment are allowed to move.

projections the tariff cut increases *welfare* by around $1m (constant 1994-95 prices), an amount close to that worked out in the partial equilibrium framework of Figure 1.

Effects on industry sectors

The implications of the tariff cut for the industrial structure of the economy are given in columns (IV) and (V) in part 2 of Table 3. *Agriculture, forestry and fishing* (row 2.1 and *Food, beverages and tobacco* (row 2.3) include the directly affected industries. The indirect effects are attributable to two main factors.

- *Devaluation of the real exchange rate*. This leads to expansion in the export-oriented sectors such as *Mining* (row 2.2), *Basic metal products* (row 2.9) and *Tourism* (row 2.22), and serves to offset the immediate adverse effects in agriculture and food products. It also has beneficial effects on the sectors most exposed to import competition such as *Electronic equipment* (row 2.11) and *Cars and other transport equipment* (row 2.10).
- *Input-output linkages*. These explain the contractionary effects of the cut on sectors which supply inputs to the directly affected activities, notably *Electricity, gas and water* (row 2.13) and *Transport and storage* (row 2.16).

3.2.3 Sensitivity

In this sub-section we examine the sensitivity of the projections in Table 3 to a higher export demand elasticity for sugar and to a different macroeconomic labour market assumption.

The export demand elasticity for sugar is one of the key parameters underlying our projections given in Table 3. For the projections in Table 3, the elasticity was set to -5. However, there is some evidence in support of a higher setting. For example, recent work by Jim Longmire at the University of Queensland suggests a long-run value of -9.3. In light of this uncertainty we have re-computed the effects of removing the tariff with an export demand elasticity of -10. The results of this simulation are shown in column (II) of Table 5.

Of the macroeconomic assumptions given in sub section 4.1, the most contentious would seem to be the fixing of aggregate employment. The alternative is to allow aggregate employment to respond to the cut in tariff by fixing the real wage rate. This alternative is known as the slack labour market assumption. The effects of removing the tariff with a slack labour market are shown in column (III) of Table 5.

Comparing column (II) with column (I), which is taken directly from Table 3, shows that a higher export demand elasticity increases the negative effects on the sugar industries and reduces the overall terms of trade increase. The latter induces a smaller positive effect on real capital input, and hence on real GDP, investment and the volume of trade.

Comparing column (III) with column (I) shows that allowing employment to respond generally increases the size of the macroeconomic effects, but has virtually no impact on the sugar-industry results. The welfare effect remains the same.

Table 5: Sensitivity of Effects in Table 3 to a Higher Sugar Export Demand Elasticity and a Different Labour Market Assumption*

	(I)	(II)	(III)
	Absolute effect		
	Table 3	Export elasticity = -10	Slack labour market
1. Macroeconomic Variables[a][c]			
1.1 Real GDP	2	1	29
1.2 Real private consumption	3	+	21
1.4 Real private investment	8	4	10
1.5 Real exports	13	23	8
1.6 Real imports	22	26	10
1.7 Real exchange rate deval.	+	+	+
1.8 Real labour input	0	0	12
1.9 Real capital input	13	6	16
1.12 Terms of trade	+	+	+
1.13 Welfare	1	+	1
3. Sugar and related industries: Real production			
3.1 Cane growing	-84	-97	-79
3.3 Sugar milling	-129	-150	120
3.4 Sugar refining	4	4	4
4. Real exports:			
4.1 Raw sugar	-132	-139	-130
4.2 Refined sugar	3	3	2

* Column (I) is drawn directly from column (IV) in Table 3. Column (II) was computed with the sugar export demand elasticity set to -10. Column (III) was computed under the slack labour market assumption. That is, the real wage rate is assumed to be unaffected by the shock, and any induced expansion in labour demand causes an increase in employment.

Other than the numbers in rows 1.7 and 1.12, all numbers are expressed in $m at constant 1994-95 prices. The values in rows 1.7 and 1.12 are indexes with a base of 100 in 1994-95.

+ means non-zero and positive, but very small in absolute size.
- means non-zero and negative, but very small in absolute size.

4. CONCLUSION

Output of the sugar related industries accounts for about 0.2 per cent of Australia's GDP. Consequently, reforms of sugar regulations cannot be expected to have significant macro implications. In this report we found that removal of the sugar tariff would improve economic welfare by about $1 million a year (that is, 0.00025 per cent of GDP). This raises the question of whether reforms are worthwhile.

Microeconomic reform in individual industries will usually have a small welfare effect. However, in aggregate the gains to Australia from widespread microeconomic reform will be significant. For this reason, reform in the sugar industry should proceed as part of the overall reform of the Australian economy.

References

ABARE (1990), "Australia's influence on World Sugar Prices: A Comparative Static Analysis" *Agriculture and Resources Quarterly*, March.

ABARE (1991), "The Australian Sugar Industry in the 1990s, *Submission 91.5*, to Industry Assistance Inquiry, AGPS, Canberra.

ABARE (1996), *Agriculture*, Volume 2 from the proceedings of the National Agricultural and Resources Outlook Conference, Canberra, 6-8 February.

Adams, P.D., P.B. Dixon, D. McDonald, G.A. Meagher and B.R. Parmenter, (1994), "Forecasts for the Australian Economy Using the MONASH Model", *International Journal of Forecasting*, Vol. 10, pp. 557-571.

Adams, P.D., and P.B. Dixon, (1995), "Prospects for Australian Industries, States and Regions: 1993-94 to 2001-02", *Australian Bulletin of Labour*, Vol. 21, No. 2, June, pp. 87-108.

Borrell, B. and M. Lawrence (1984), "Australian Sugar Industry Regulations Under the Economic Microscope", paper presented to the 28th Annual Conference of the Australian Agricultural Economics Society, University of Sydney, February, mimeo.

Borrell, B. and G. Wong (1986), "Efficiency of Transport Milling and Handling in the Sugar Industry: A Case Study of the Mackay Region", *BAE Occasional Paper*, No. 96, AGPS, Canberra.

Dixon, P.B. and D. Johnson (1988), "Pricing of Queensland Sugar Cane: Appraisal of the Present Formula and a Suggestion for Reform", *Review of Marketing and Agricultural Economics*, Vol 56, No. 1, April, pp. 27-35.

Dixon, P.B. and B.R. Parmenter (1996), "Computable General Equilibrium Modeling for Policy Analysis and Forecasting", chapter 1 in H. Amman, D. Kendrick and J. Rust (eds), *Handbook of Computational Economics*, North-Holland, Amsterdam (forthcoming).

Dixon, P.B., B.R. Parmenter, D.P. Vincent and J. Sutton (1982), *ORANI: A Multisectoral Model of the Australian Economy*, North Holland, Amsterdam.

Dixon, P.B. and D. McDonald (1992), *Creating 1990-91 Input-Output Tables for Australia by ORANI Simulation*, mimeo, Centre of Policy Studies, December.

Edwards, G. (1993), "Two Government Failures? A Tale of Sugar and Wool", *Review of Marketing and Agricultural Economics*, Vol. 61, No. 2, August, pp. 97-112.

Industry Commission (1992), "The Australian Sugar Industry", *Report No. 19*, Australian Government Publishing Service, March.

Powell, A.A. and R.H. Snape (1993), "The Contribution of Applied General Equilibrium Analysis to Policy Reform in Australia", *Journal of Policy Modeling* 15(4), pp. 393-414.