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IN AN AUSTRALIAN SHORT RUN
FUEL SUBSTITUTION TAX MODEL

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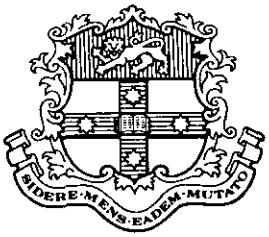

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V.B. Hall, T.P. Truong and V.A. Nguyen*

1. INTRODUCTION

This paper reports results from using the Australian short run fuel substitution tax model, ORANI-LFT, to simulate the effects of simultaneous world oil and coal price shocks. The aim behind this is:

- to get some feel for the relative directions and strengths of impact from these two major interdependent world energy markets, and
- to provide some analytical basis for examining recent Australian experience with weaker world coal markets.

One key institutional element incorporated is the Australian Government's recent switch from significant dependence on crude oil levy revenue to petroleum products excise revenue, while preserving nominal liquid fuel tax revenue neutrality. Actual movements for 1986-87 are illustrated in Figure 1.

Another key feature is that results currently reflect the modelling of two important strands of the Australian Government's pre-1988 oil regulatory framework, namely the import parity pricing and domestic allocation systems for crude oil. But with the Government's decision to deregulate crude oil marketing having taken effect from January 1 1988, the paper also points out how the model can be used in the future to investigate impacts from various forms of "deregulated" oil market.

The catalyst assumed for the fall in crude oil levy revenue is a ten per cent fall in the world price of crude oil, and the coal shock is implemented through a ten per cent cut in the world price for Australian black coal.

The background to and relevant aspects of ORANI-LFT are presented briefly in section 2. Major results are given in section 3, and concluding remarks appear in section 4.

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* Departments of Economics at the Universities of Sydney, New South Wales and Sydney respectively. We acknowledge helpful comments received during presentations at the Reserve Bank of Australia, Stanford University, the University of California Santa Barbara, and at the Tenth Annual International Association for Energy Economics Conference, Luxembourg, 4-7 July 1988.

2. THE FUEL SUBSTITUTION TAX MODEL: ORANI-LFT

ORANI-LFT is a short run applied general equilibrium model, consisting of three distinct modules: the currently available standard version of the ORANI multi-sectoral model of the Australian economy, documented in Dixon, Parmenter, Sutton and Vincent(1982)(hereafter DPSV); the industrial sector interfuel substitution module which together with ORANI has been termed ORANI-FUEL, and for which a full presentation can be found in Truong(1986)[1]; and the Liquid Fuel Tax(LFT) module, which when incorporated into ORANI-FUEL provides ORANI-LFT. It has recently been set out and explained in Hall, Truong and Nguyen(1988)(hereafter HTN).

Key aspects of the ORANI module and ORANI-FUEL[2], relevant to the experiments reported here, are as follows:

- In ORANI, the basic price of domestically produced output of each good is dependent on the cost of materials inputs (whether domestic or foreign in origin), costs of aggregate labour, capital and agricultural land inputs, "other cost tickets" (including taxes on production such as the crude oil levy), various forms of technical change, and relevant cost shares. The basic price therefore excludes sales taxes and margin costs, and does not vary across industries.
- Purchaser's prices, paid by the domestic industrial and household sector users of those goods, are in turn dependent on the basic price, sales taxes (such as petroleum products excise), costs of "margin" services (i.e. transportation costs, wholesale and retail margins), and share variables. These prices can therefore vary across users.
- Per unit tax rates on production and sales are expressed in terms of a consumer price index(CPI) influence and a real ad valorem or real specific tax rate. This enables tax revenue to reflect indexation, real tax rate and volume of output or sales effects.
- ORANI's production structure, while allowing for imperfect substitution at a second tier level between domestic and imported material inputs and between aggregate labour, capital and agricultural land, assumes at the first tier level that each material input, the aggregate primary factor, and "other cost tickets" are combined in Leontief fixed proportions. This standard framework therefore doesn't allow for substitution between individual material (including energy) inputs nor

1 ORANI-FUEL was used in Truong(1986) to examine the relative strengths of income and substitution effects on industry output, resulting from a cut in the world price of crude oil.

2 For the relevant equations, reference should be made to DPSV(1982) and Truong(1986).

between aggregate energy and other aggregate factor inputs. Consequently, it doesn't permit any change in relative prices of energy inputs to affect input demands through the interfuel substitution process nor to affect industry outputs through long run interfactor substitution processes.

- In ORANI-FUEL, however, allowance is made for interfuel (but not interfactor) substitution influences, by introducing non-Leontief technology for a separate energy inputs block. This is done by taking the relevant Leontief expression with its technological change coefficient, equating it with a Theil(1980) cost minimising input demand equation, and finding the technological change coefficient to be a function of individual fuel price and share variables, own price and cross price elasticity of demand parameters, total energy demand for the industry and its elasticity of demand parameter.

The LFT module is currently set up to reflect recent liquid fuel tax and crude oil market regulatory arrangements. It therefore consists of[3]:

- a liquid fuel tax revenue neutrality constraint (see Flow Chart 3), allowing a choice between nominal and real revenue neutrality,
- a petroleum product excise constraint, imposing a common rate change for all industries and the household sector, and
- import parity pricing constraints on both the crude oil and petroleum products markets (see Flow Charts 1 and 2).

When conducting experiments with ORANI-LFT, assumptions have to be made in three areas: short run macroeconomic closure, values for the industrial sector interfuel substitution price elasticities of demand, and the form of regime for LFT.

With respect to short run macroeconomic closure[4], it is necessary to choose three of the following variables as exogenous: either the aggregate price level or exchange rate; the aggregate real wage or the level of employment; and either real absorption or the real balance of trade. For the experiments reported here, we have taken the nominal exchange rate as fixed, thereby allowing the real exchange rate to vary with the CPI variable; we have assumed an unchanged real wage, implying full wage indexation, labour in excess supply and aggregate employment determined endogenously; and we present results for the varying balance of trade case.[5]

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3 Equations can be found in HTN(1988, sections 3 and 4).

4 For further explanation, see Cooper, McLaren and Powell(1985). Standard treatment for short run closure is to take the capital stock employed in each industry as fixed, thereby allowing rates of return in each industry to be determined endogenously.

5 HTN(1988) provide detail on the extent to which results are sensitive to choosing varying real absorption rather than varying

The industrial interfuel substitution price elasticities imposed are the mid-range own price and cross price values for ten industries used by Truong(1986), and reproduced in HTN(1988, Appendix B).[6]

In relation to the form of regime chosen for LFT, it is necessary to specify both the source of the shock to crude oil levy revenue and the form of regulatory environment applicable to the crude oil market. The historical variations in crude oil and petroleum products revenue depicted in Figure 1 can variously be attributed to changes in oil prices and excise rates, and movements in production or sales volumes. But as indicated in section 1, the shock to liquid fuel revenue chosen was a ten per cent fall in the price of crude, and the regulatory environment for crude oil has been taken as the pre-1988 regulated market.

3. ILLUSTRATIVE EMPIRICAL RESULTS

The impact on the crude oil and petroleum products markets of the ten per cent cut in world crude oil prices can be traced through in general terms, with the assistance of Flow Charts 1 to 3. The shock is imposed on the c.i.f foreign currency price of imported crude. This provides an equivalent shock to its basic price, which is in turn translated through the import parity price(IPP) mechanism to the basic price of domestic crude. To achieve the latter, the Government is required to vary the production levy on domestic crude. The shock to the IPP for crude then feeds through to the basic price of domestically produced petroleum product, constrained also through IPP to be equal to the basic price of imported petroleum product. From Flow Chart 2, it is clear that the change in the basic price of petroleum products, changes in the cost of "margin" services, and the petroleum products excise tax change required to achieve revenue neutrality (as in Flow Chart 3), combine to determine the various purchase prices for petroleum products in each industry.

The ten per cent cut in world coal prices is imposed through shocking the f.o.b foreign currency export price of black coal via a shift term in ORANI's export demand equation. Its major channels of influence on the oil sector and the rest of the economy will become clear from sub-sections 3.1 to 3.3.

The empirical results presented in Tables 1 to 4 relate primarily to the effects on oil sector price, excise tax rate and revenue changes; comparative static effects on such macroeconomic variables as the CPI, the balance of trade and employment; basic price, industry activity, and household consumption changes in fuel and

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balance of trade, following a world oil price shock.

6 Truong(1986, Tables 4,5) has reported on the sensitivity of ORANI-FUEL results to assuming different elasticity values.

related industries; and structural effects on industry output and employment.

3.1 Impact of the Oil Price Shock

Empirical results for an "oil shock alone" case, with alternative macroeconomic closure assumptions, have been set out in HTN(1988). Principal outcomes for the varying balance of trade short run closure are presented in the first columns of Tables 1 to 4, and can be summarised as follows:

- The uniform petroleum products excise rate increase required to achieve nominal liquid fuel tax revenue neutrality is 12.9 per cent.
- Corresponding tax revenue figures (in 1977-78 $A) are a fall of around -$115m in crude oil levy revenue, paid for in increased petroleum products excise of around $52m by the industrial sector and $63m by the household sector
- The basic price of petroleum products to all industries falls by -6.2 per cent, leading to a fall in the domestic purchase price for almost all industries (i.e. after adding on the petroleum products excise increase and after taking into account the differing margins, transport costs and initial tax levels across industries). Falls varied from -0.6 to -4.0 per cent. Minor increases are recorded for a small number of industries (such as `wholesale trade' and `ownership of dwellings') with particular cost and tax structures.
- Aggregate effects are for the CPI to fall by -0.5 per cent; the balance of trade to increase by $.23b, due to exports increasing by .57 per cent and imports falling by -1.02 per cent; and employment to increase by .21 per cent. In contrast, the varying real absorption closure assumption would lead to an increased CPI of .3 per cent, increased real absorption of .4 per cent and increased employment of .3 per cent, thereby confirming the differential strengths of impact of alternative macro assumptions[7]
- There are significantly different effects on individual industry output and employment levels.
- As regards the effects on individual fuels and closely related activities: except for coal, the basic prices of other fuel and transport commodities fall between -0.5 and -1.0 per cent; industry activity levels increase between .1 and .9 per cent; and in the household sector there is increased demand for consumption of oil, petroleum products and gas, decreased demand for black coal and negligible effect on electricity demand.

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7 This point has been emphasised previously in a wider context for Australian energy models by Hall(1986,pp.2,8). It is similarly important for structural output and employment outcomes.

3.2 Impact of the Coal Price Shock[8]

Effects from the coal price shock on the domestic activity, aggregate employment, trade and liquid fuel tax variables have almost all been in the opposite direction to those from the oil price shock. An important reason for this is that coal is a major export commodity and crude oil is a significant net import commodity in the standard ORANI (1977-78) data base. A fall in the price of crude therefore tends to stimulate domestic economic activity and the aggregate level of employment through reduced production costs, and lead to increased export competitiveness and reduced import penetration. A fall in the price of coal, on the other hand, could be expected to depress economic activity, first in the coal industry and then spread to other industries. Reduced economic activity in the coal industry can be explained as follows. Firstly, the cut in the world price of coal means a fall in the Australian export supply price of coal, due to the export-parity price assumption. A fall of -11.6 per cent occurs in the domestic basic price of coal. There is also a substantial fall in export quantities following the fall in export price, as the export supply curve is assumed elastic. In principle, this could have been offset by increased domestic demand for coal, but with the domestic own price elasticity being low, any increase in domestic demand is not great. The reduced economic activity is accompanied by a fall of -0.21 per cent in aggregate employment and reduced import expenditure of -0.27 per cent. However, since export revenue is reduced even more substantially by -2.40 per cent, the overall balance of trade deficit from the coal shock is -$.31b.

The reduced economic activity and aggregate employment are accompanied by lower nominal wages (equal to the fall in the ORANI CPI of -0.27 per cent), a fall of -0.3 per cent in the expected general rate of return, and very substantial reductions of -69 and -16 per cent in current rates of return in the coal and crude oil industries. Total production costs are therefore lower in both the black coal and crude oil industries. To offset the reduced production costs for crude, and in accordance with the requirement that the domestic price of crude oil has to remain in parity with the world price of crude (which is assumed unchanged for the coal shock alone), the Government then has to increase the crude oil levy so as to yield increased revenue of $44.4m. That leads to a fall of -5.07 per cent in the petroleum products excise rate, and hence lower petroleum product prices. If interfuel substitution effects are additionally considered, and cheaper coal prices result in some substitution from oil to coal, then the reduction in domestic petroleum product prices due to the lower excise rate would help reduce this substitution effect.

8 It is reemphasised that these results and the consequent economic arguments are illustrative, due to differences in certain areas between recent Australian behaviour and imposed model assumptions.

3.3 Economic Adjustments following the Combined Oil and Coal Price Shocks

From Tables 1 and 3, it is easily deduced that the basic prices of all fuels, the CPI, and the domestic purchase price of petroleum products for industries have all declined in the face of the combined shock. From the coal shock alone, the fall in the basic price of black coal is -11.6 per cent, leading to the further fall in the CPI of -0.27 per cent and a fall in the aggregate nominal wage (due to its imposed full indexation to the CPI). Lower wage costs help explain the effects on the basic prices of other fuels being a reduction of -0.14 per cent for petroleum products (making a combined -6.38 per cent), a substantial fall of -1.44 per cent for electricity (due to the importance of black coal in its generation in some States), and gas prices declining by -0.44 per cent. The extra boost from lower wage and fuel costs is therefore sufficient to ensure that, despite an increased petroleum products excise rate, the domestic purchase price of petroleum products is lower for all industries.

The trade surplus of $.23b generated by the oil shock has been more than eliminated by the deficit of -$.31b associated with the coal shock, moving the balance of trade for the combined shock into a small deficit of -$.08b.

Aggregate employment growth becomes stagnant if the combined shock is imposed, as against a .2 per cent increase for the oil shock alone. This can be attributed to the combination of the balance of trade deficit and continued imposition of no growth in real absorption. Not surprisingly(see Table 4), the employment decline is particularly severe in the black coal industry (a net -21.4 per cent) and in services to mining (now -4.1 per cent). Relatively higher employment is recorded for some industries, though.

The liquid fuel tax revenue and rate results presented in Table 2 seem crucially dependent on our modelling assumptions relating to the IPP condition for crude oil. The fall in crude oil levy revenue is only $71.1m under the combined shock, compared with -$115.5m for the oil shock alone, thereby requiring an increase in petroleum products excise rate of only 7.84 per cent compared with 12.91 per cent. The coal shock induced $44.4m increase has occurred because increased receipts due to the higher crude oil levy rate have outweighed the decline in receipts due to small falls in the CPI and in crude oil production of -0.26 and -0.49 per cent.[9] Less

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9 In this respect, it is worth pointing out that the elasticity of supply of crude oil for the domestic market is very low. An estimated short run value of .093 is presented in Horridge, Parmenter and Warr(1987, p.239), for example. The substantial ten per cent cut in the crude oil price under the oil shock alone is associated with the very small 0.48 per cent activity response reported in Table 3. Similarly, following the coal shock which resulted in lower production costs and the imposition of an offsetting levy on crude oil, only a very small oil activity response of -0.49 per cent followed.

petroleum products excise revenue from a lower excise rate for both industry and households is therefore needed to preserve nominal liquid fuel tax revenue neutrality in the case of the combined shock.

Finally, with respect to individual fuel prices and quantities:

- As already indicated, the basic prices of all fuels other than crude oil have fallen due to the coal shock, with the net result being that these fuel prices have fallen further than if there had only been an oil shock.
- The corresponding industry activity levels are all reduced as a result of the coal shock alone. The decline of -12.2 per cent for coal is the most severe, and wipes out completely the minor gains from the oil shock alone. Net increases remain only for the petroleum products and electricity industries. Thus, with the coal shock alone, fall in economic activity effects brought on by reduced black coal production have outweighed any increased activity due to the above mentioned lower fuel prices.
- Household consumption effects are more diverse. Due to the black coal price cut, there is increased consumption of black coal, electricity, and gas. But oil and petroleum products consumption is relatively unchanged. So, in contrast to the industry responses, increased consumer purchases of coal, electricity and gas following fuel price falls have outweighed any fall off due to a decline in overall activity.

4. CONCLUDING REMARKS

The illustrative empirical results presented in section 3 provide evidence that, even for a model environment in which no net change is permitted in nominal liquid fuel tax revenue receipts, combined world oil and coal price shocks lead to substantially different effects than would occur from an oil shock alone. This means that, for a small open economy such as Australia, particular attention has to be paid to the interdependent nature of world energy markets both when analysing the effects of such shocks and when formulating appropriate macroeconomic and energy policy responses.

The results produced to date with ORANI-LFT have reflected modelling of two important strands of the pre-1988 crude oil regulatory framework. In particular, this mean't: firstly, ensuring that imported crude did not increase its share of the domestic market, by (a) setting the domestic-import elasticity of substitution for crude to the high value of 50 and (b) ensuring IPP values for crude from both domestic and foreign sources are imposed equal; secondly, requiring IPP values for refined petroleum products from both sources to be the same; and thirdly, imposing import-export parity pricing through the f.o.b export price and the import price of crude oil having to change in the same proportion.

In terms of future work, a next analytical step would be to modify ORANI-LFT so as to be suitable for investigating "deregulated" oil market regimes. For example, key elements of the Australian

Government's decision to deregulate crude oil marketing from 1 January 1988 are:

- abolition of the domestic crude oil allocation system,
- an end to Government's monthly fixing of the IPP at which this crude must be purchased, and
- termination of the Bass Straight Oil Freight Adjustment Scheme.

Translating these key elements into specific modelling assumptions requires, as a minimum, abolition of parity pricing constraints, and decisions on what particular oil price and other shocks to impose on the model, the value at which to set the domestic-import elasticity of substitution for crude, the way in which margins (which include transport costs) should be adjusted, and appropriate underlying liquid fuel tax revenue settings.

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TABLE 1

Short-run Effects of a Fall in Crude Oil Levy Revenue:

ORANI-LFT, with Nominal Liquid Fuel Tax Revenue Neutrality+

	World Crude Oil Price Shock	World Black Coal Export Price Shock
IPP crude oil	-10.0*	0.0*
Black coal export price	0.0*	-10.0*
Basic prices		
Petroleum products	-6.24	-0.14
Black coal	0.11	-11.5
Domestic purchase price of petroleum products for:++		
Non-residential buildings	-2.82	-0.50
Basic iron and steel	-2.26	-0.36
Wheat-sheep	-1.33	-0.87
Wholesale trade	0.64	-1.49
Aggregate effects		
ORANI CPI	-0.54	-0.27
Exports	0.57	-2.41
Imports	-1.02	-0.27
Balance of trade ($b)	0.23	-0.31
Real private absorption	0.0*	0.0*
Employment	0.21	-0.21

+ Results are percentage changes, except for balance of trade figures which are in base period (1977-78 billions of dollars. They reflect an imposed short run macroeconomic closure assumption of constant real absorption and varying balance of trade, and imposed mid-range industrial interfuel substitution price elasticities of demand.

++ Reflects petroleum products price change, net of IPP fall and petroleum products excise rate rise. Figures are for four representative industries only. Price changes differ by industry in accordance with industry margins.

* Value chosen exogenously.

TABLE 2

Liquid Fuel Tax Revenue and Petroleum Products Excise Rate Effects[+]

	World Crude Oil Price Shock	World Black Coal Export Price Shock
LFT Revenue Effects[++] ($m)		
Crude oil levy revenue	-115.5	44.4
Petroleum products excise revenue		
. Industrial sector	52.3	-22.0
. Household sector	63.2	-22.5
Petroleum Products Excise Rate		
(percentage change)	12.91	-5.07

+ From ORANI-LFT, with nominal liquid fuel tax revenue neutrality, real private absorption constant and varying balance of trade, and mid-range interfuel substitution price elasticities of demand.

++ Revenue figures are expressed in terms of base period (1977-78) millions of dollars.

TABLE 3

Basic Price, Industry Activity, and Household Commodity Consumption Changes for Fuel and Related Industries[+]

		World Crude Oil Price Shock	World Black Coal Export Price Shock
Basic Price of Domestic Commodities			
16	Black coal	0.11	-11.59
17	Crude oil	-10.0*	0.0*
58	Petroleum products	-6.24	-0.14
86	Electricity	-0.55	-1.44
87	Gas	-0.64	-0.44
95	Road transport	-0.93	-0.27
96	Rail etc. transport	-0.60	-0.32
97	Water transport	-0.65	-0.36
98	Air transport	-1.03	-0.23
Industry Activity Levels			
14	Black coal	0.86	-12.23
15	Crude oil	0.48	-0.49
56	Petroleum products	0.63	-0.30
84	Electricity	0.13	-0.12
85	Gas	0.11	-0.17
93	Road transport	0.22	-0.22
94	Rail etc. transport	0.28	-1.16
95	Water transport	0.27	-0.26
96	Air transport	0.56	-0.02
Household Demands for Domestic Consumption			
16	Black coal	-0.24	4.22
17	Crude oil	3.46	-0.10
58	Petroleum products	1.44	-0.04
86	Electricity	-0.01	0.64
87	Gas	0.04	0.09

+ From ORANI-LFT, with nominal liquid fuel tax revenue neturality, real private absorption constant and varying balance of trade, and mid-range interfuel substitution price elasticities of demand. The two digit numbers down the left hand side are ORANI commodity and industry numbers.

* Value chosen exogenously.

TABLE 4

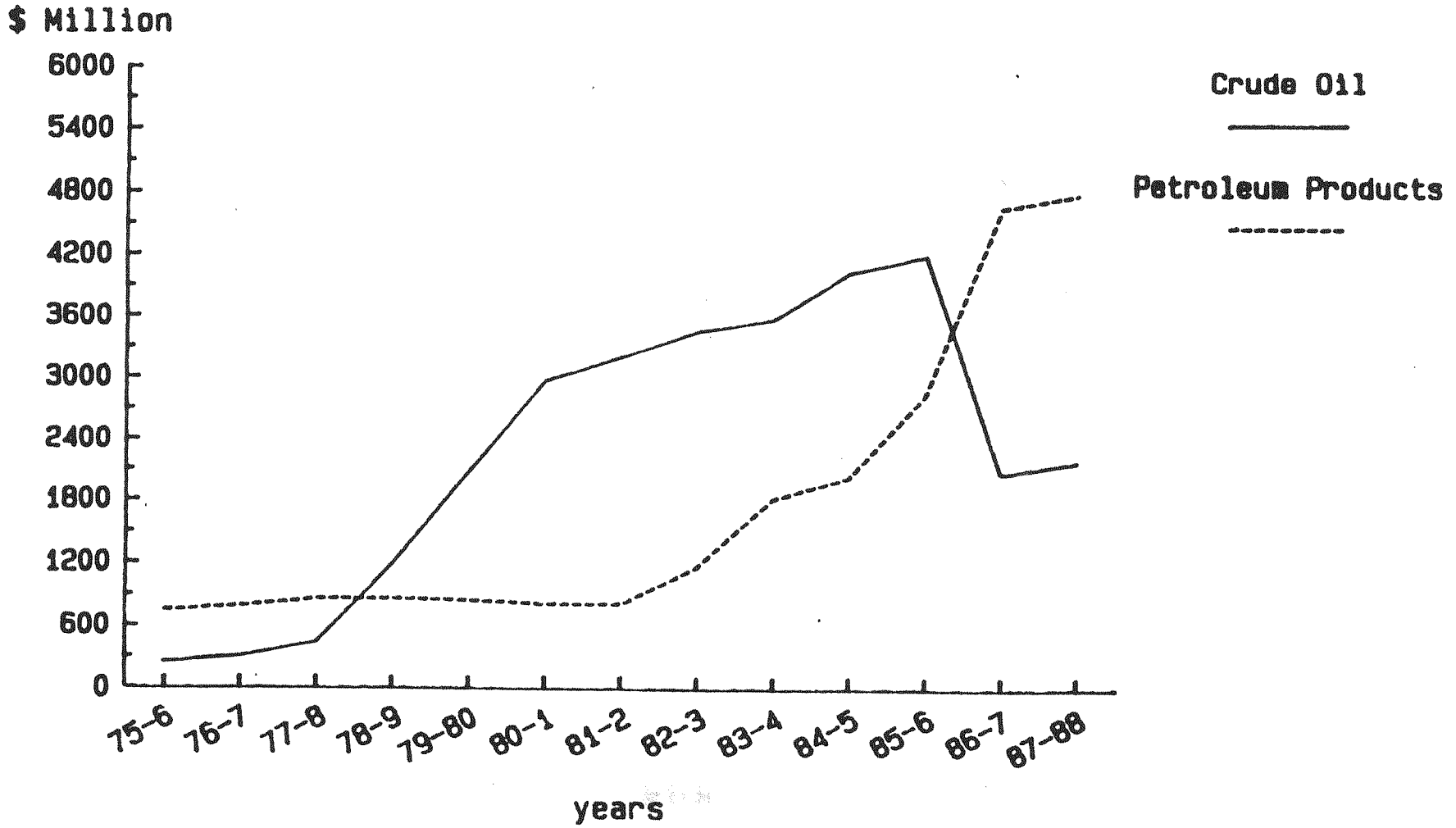
Percentage Changes in Industry Activity and Employment Levels+

Shock		World Crude Oil Price Shock		World Black Coal Export Price Shock	
Industry\Variable		Output	Employment	Output	Employment
76	Agricultural machinery	2.22	2.42	2.34	2.55
25	Other food products	1.39	1.93	0.70	0.97
17	Services to mining	1.04	1.14	-4.76	-5.19
*64	Other basic metals	0.97	1.66	0.56	0.96
31	Man-made fibres, yarns	0.88	0.95	0.43	0.47
14	Black coal	0.86	1.61	-12.23	-23.03
6	Other farm	0.80	1.17	0.40	0.58
4	Northern beef	0.78	1.61	0.41	0.84
*18	Meat products	0.73	0.89	0.39	0.47
13	Non-ferrous metal ores	0.70	1.36	0.36	0.70
56	Petroleum products	0.63	1.06	-0.30	-0.50
*50	Other basic chemicals	0.54	0.83	0.14	0.21
96	Air transport	0.56	0.68	-0.02	-0.02
15	Crude oil	0.48	4.72	-0.49	-4.84
68	Motor vehicles & parts	0.48	0.50	0.43	0.46
94	Rail etc.transport	0.28	0.28	-1.16	-1.16
95	Water transport	0.27	0.36	-0.26	-0.34
*89	Wholesale trade	0.23	0.30	0.00	0.01
93	Road transport	0.22	0.23	-0.22	-0.24
*63	Basic iron & steel	0.20	0.23	0.04	0.05
*58	Clay products	0.20	0.24	0.10	0.13
84	Electricity	0.13	0.25	-0.12	-0.23
85	Gas	0.11	0.20	-0.17	-0.31
*90	Retail trade	-0.02	-0.03	-0.01	-0.01
*88	Other construction	-0.03	-0.03	0.11	0.12

\+ From ORANI-LFT, with nominal liquid fuel tax revenue neutrality, real private absorption constant, and mid-range interfuel substitution price elasticities of demand.

* Indicates an industry for which explicit non-zero own-price and cross-price elasticities of demand were imposed.

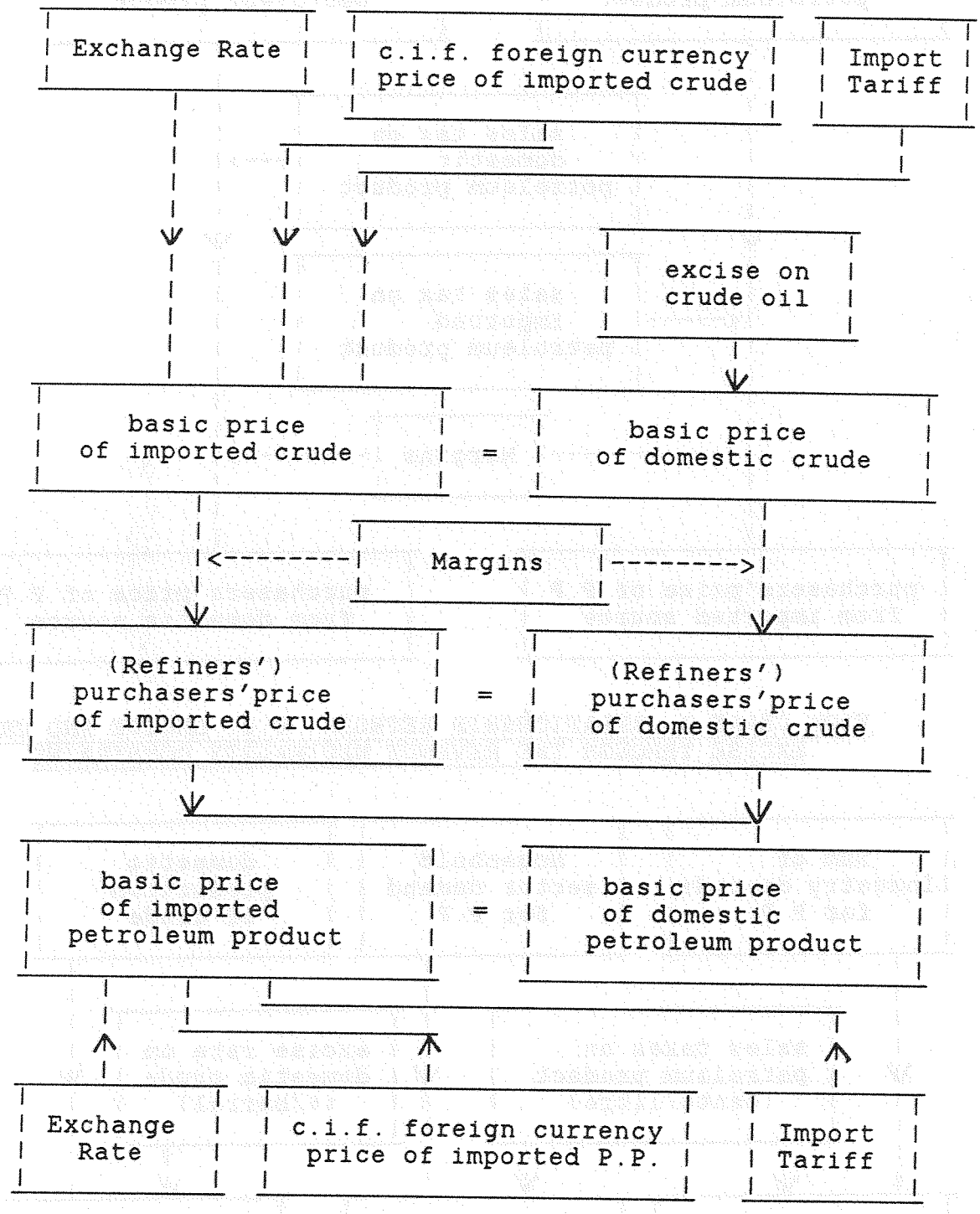
Figure 1: Revenue from Excise Duty on Crude Oil and Petroleum Products



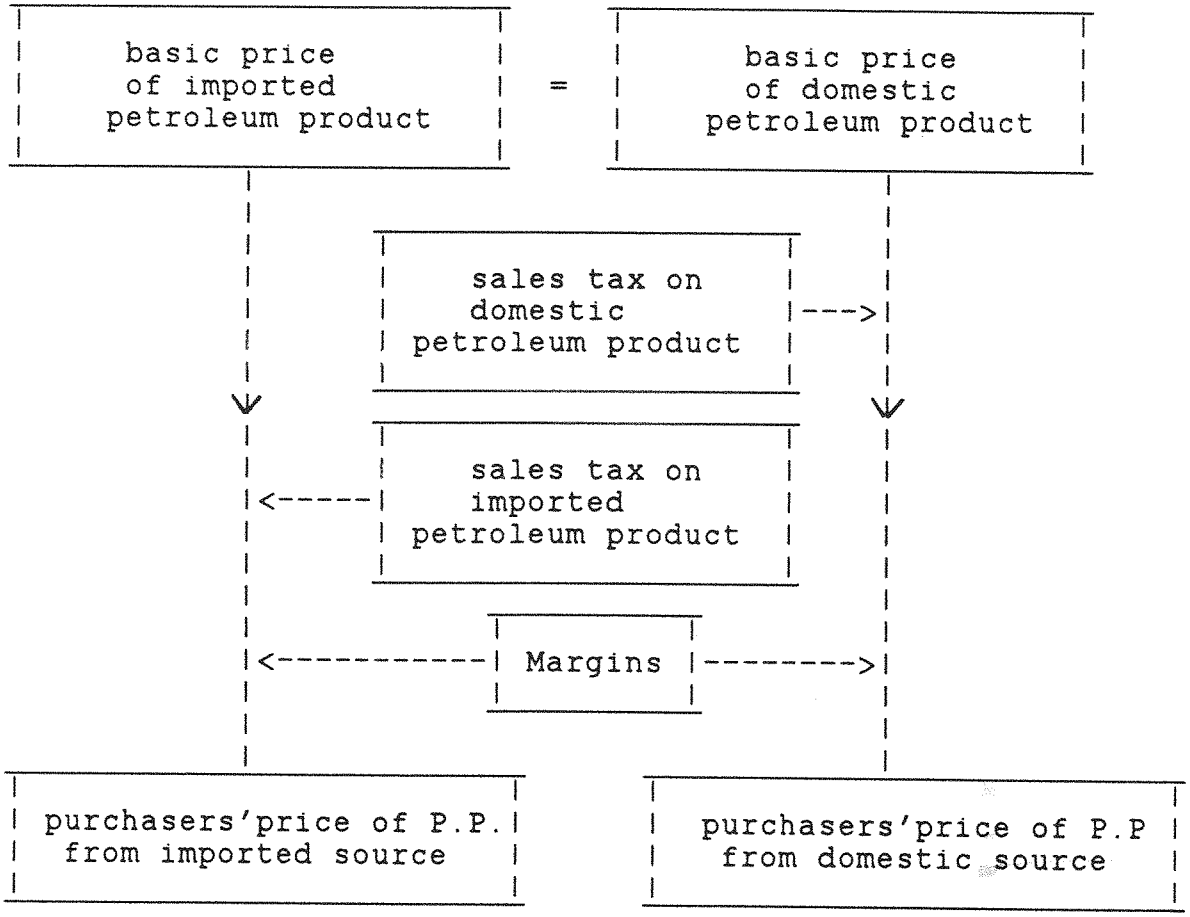
Sources: Budget Statements (AGPS, Canberra)
ABS Catalogue Nos. 5427.0 and 5425.0
IAC Second Draft Report on "Certain Petroleum Products-Taxation Measures"(1986, Table 3.2)

FLOW CHART 1: IMPORT-PARITY PRICING FOR CRUDE OIL AND PETROLEUM PRODUCTS (P.P.)

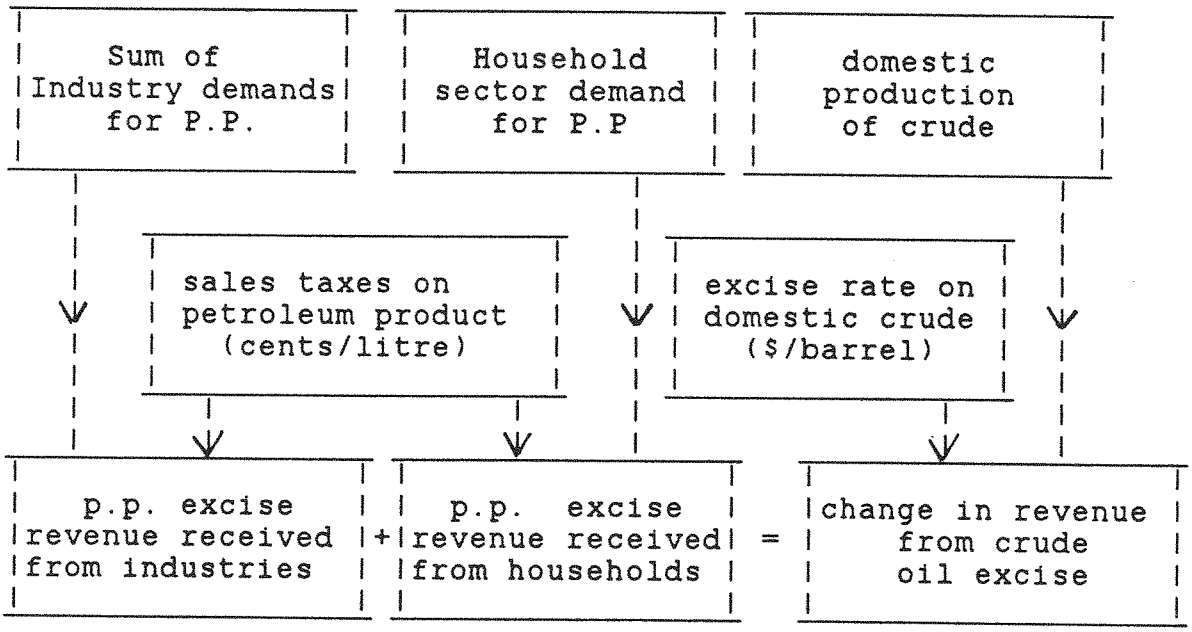
Following an exogenous shock to the c.i.f. price of imported crude (and/or the exchange rate), the government is assumed to use excise on crude oil to maintain the import parity price.



FLOW CHART 2: IMPORT-PARITY PRICING FOR PETROLEUM PRODUCTS TO ENSURE CONSTANT DOMESTIC/IMPORTED SHARES



FLOW CHART 3: RELATIONSHIP BETWEEN P.P. EXCISE AND CRUDE EXCISE THROUGH THE REVENUE NEUTRALITY CONSTRAINT



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