Studies of the Disaggregated Australian Export Functions

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I. Introduction

The Australian export structure shows a unique combination of features, in part typical of "less developed primary-producing economy and in part typical of an industrial economy. This peculiar structure merits a special study-which is the main concern of this paper. At the outset however, there are a few interesting methodological problems requiring attention.

In spite of the proliferation of literature concerned with demand elasticities of imports and exports, estimates of elasticities for individual commodities are rare. Kreinin (1967)reports that the estimates of elasticities for commodities classified on an SITC basis are even rarer. Until we know more about these individual elasticities, quantitative trade policies or tariff policies will obtain little assistance from estimates of elasticities at the aggregate level.

Furthermore a large part of the literature is devoted to the estimation of elasticities from international cross section data, where changes are usually obtained between two points in time, and these are decomposed into various composition shift effects such as commodity composition, composition of trading partners etc. These practices yield valuable intercountry comparisons of causes of changes in the balance of payments. For practical trade policy purposes, however, one frequently needs a better understanding of the causes which determine the changes in exports and imports of a single country.

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This paper intends to partly fill this gap by studying the behaviour of Australian exports and the factors which determine changes in exports at a fairly disaggregated level.

The most obvious characteristics of Australian exports are their concentration. First, the export structure is concentrated in a narrow range of products, especially primary products and raw materials. Second, there is a concentration of trading partners.

The ten most important export product groups for Australia, are in ascending order of SITC numbers: Meat of Bovine animals-(SIT 011.10), Wheat and meslin (unmilled)-(041), Fruits and vegetables (05), Raw sugar, beets, cane (excluding syrups)-(061.10), Hides and skin (undressed)-(21), sheep and lambs, greasy or fleece-(262.10), Iron ore and concentrates-(281.30), Coal-(321.40) Pig iron and steel-(67), Nonferrous metals-(68). In general, each item accounted for at least 2% of total exports in value during the last decade. Also each product is a primary input product based on either agriculture or mining. The combined weight of these eight items accounted for approximately half of total exports over the last decade. On the other hand, the total combined weight of manufactured products represents only between one-fifth and one-fourth of the total. Besides, more than half these manufactured exports are accounted for by steel, pig iron, copper, lead, zinc and a couple of chemical compounds (the bases of metallic oxides and aluminium oxides).

The concentration of trading partners follows for two reasons; one is historical and the other follows from the commodity structure of Australian exports. During the greater part of her colonial days, Australia was one of the main suppliers of various raw materials, especially wool, whaling products, and food-stuffs to the Mother Country, Britain. Basically this pattern continued to exist in the first half of this century, modified by changes occasioned by the expansion of Australian domestic industry.

The second reason for the concentration of trading partners is quite obvious. Since the major industrialized countries of the world import most of the world's total exports of raw materials, the same industrialized nations also import the greater part of Australian exports; Japan, U.S.A. and U.K. have in recent years taken around one half of Australia's exports.

If the claim that Australian exports very in response to the demand variation of a few major industrial nations of the world is to be tested, the demand equation should be specified to include a variable reflecting the state of the economy of those industrial nations. In this study a few principal components of the major business indicators of some of the dominant customer countries of Australian products will be used. The countries chosen as the dominant customers are Japan, U.S.A. and the U.K, plus West Germany.[1]

II. The Model

The model is so established that demand and supply receive a more or less equal chance to contribute to the explanation of export behaviour. It will be a partial equilibrium model of supply of and demand for exports, which enable us to determine all price effects as well as income and capacity effects.

Suppose commodity exports of Australia are observed at the equilibrium of export supply and demand, being jointly determined with the equilibrium price of exports. This can be interpreted as the existence of a simultaneous equation system of supply and demand, each depending on the export price and other exogenous variables. To regress exports on variables which include price would therefore yield as simultaneity bias as causation runs both ways.

In an attempt to estimate the income and price elasticities of world trade, Houthakker and Mages (1969) used an income variable which is a weighted average of national incomes of all major trading partners (26 countries), and a price variable which is alternatively an export price index, divided by the consumer price index for importers or the wholesale price indexes of exporters. Apart from the serial correlation problems they encountered[2], they were on their own admission essentially estimating export demand functions and completely disregarding the supply side[3]. Such practice may be admissible in the estimation of aggregate levels of exports, but for individual commodity exports one cannot disregard the danger of simultaneity bias in their estimates.

1 New Zealand has also been important for a long time, but during the last decade, this importance has been taken over by the European community. Besides, the exports to New Zealand have a bias towards non-primary products hence this country is not suitable for our purpose. Germany is selected to represent the state of the economy of the European community.

2 They used the Cochrane-Orcutt interation method to overcome this problem, but neither the insufficiency of specification nor simultaneity bias are resolved.

3 See the conclusion of Houthakker (1969) p. 22.

In the present study, the export price and capacity variables will separately appear in the structural equations of demand and supply. A broad spectrum of 27 variables that represent the general business conditions of the four major customer countries is chosen here. From these indicators four principal components are calculated as proxies for the capacity-to-import variables or simply the income effect.

Five broad categories can be cited to represent the variables which influence the import capacity of foreign countries: the level of their domestic economic activity, their domestic price levels, import demand in general, the ability to pay for imports (or the balance of payment situation) and the purchasing power of the currency. For the first category, an industrial production index is used. This is considered to be a better indicator than GNP, because Australian exports are predominantly input products. Consumer price indexes and wage indexes are chosen to represent the second group. For import demand, actual imports are used, and for ability to pay, current account balances and long-term capital account balances are used.[4] Finally, the exchange rate expressed against the U.S. dollar is used to represent the strength of currency of the country.[5]

For the price variable, Houthakker and Magree used the ratio of export price index divided by either foreign consumer prices or domestic wholesale prices. Obviously there is no such price ratio which would singularly reflect the relative market attractiveness of Australian export goods in both Australia and overseas. Therefore, in the present study, the export price indexes themselves are used as the common price variable in demand and supply functions.[6]

It is important to note that the Australian export price series

4 The inclusion of imports of customer countries in the set of original indicators raise some problems because such imports include part of Australian exports. But this problem is more spurious than real. The reasons are following. (1) Australian exports to these countries are only a small part of their total imports. (2) Although changes in import demand is a function of other variables such as the level of income and the elasticity of substitution between domestic and imported goods, since the income variable is already included separately and the elasticity of substitution requires an entirely new study on its own, variation in imports themselves is used as a proxy for the change in import demand. The other question is that having included variables for ability to pay (balance-of-payment conditions here) why should one need to include imports. The simple answer is that the ability to pay alone does not determine imports but the income elasticity and substitution elasticity are also important. Since imports are chosen as proxy for the effect of the latter, imports and the balance-of-payment conditions should complement each other.

5 The simple exchange rates used here are not purchasing power parity exchange rates. Rather they are used as a convenient proxy for the latter concept.

6 The obvious difficulty of using an export price index as the price variable is that it

are remarkably stable or show a very small decline throughout the data period, except for meat. For instance, the export price index of all groups (base 1959-60 = 100) moved from 102 in September 1965 to 100 in December 1971. On the other hand due to global inflation both foreign and domestic prices have risen markedly. This has special importance for understanding the coefficients of export prices in both the supply and demand equations.

If the export price in the demand equations is expressed as a ratio to foreign prices, the negativity and significance of the coefficients are accentuated. This is confirmed in this study by using ratios between export prices and a weighted average of the consumer price indexes of major trading partners where the weights are relative shares in Australian imports.

If, on the other hand, export prices are divided by domestic prices and used in the supply equations, the signs of the coefficients are still negative and "incorrect". This makes it tempting to regard Australian exports as a function of demand only and completely disregard the role played by supply. Unlike most other studies, by not dividing the export price by other rising prices, we avoid 'inducing' our export-price coefficients to be negative. In this way we can avoid the danger of wrongly identifying the supply equation as a demand equation.

The demand equation is specified in a partial adjustment form,

$$\Delta RX_t^{Dk} = \theta\,(RX_t^{D*} - RX_{t-1}^{Dk}) + \epsilon_t^{D} \quad (k = 1 \ldots . \ 13) \quad (t = 1 \ldots . \ n) \qquad (1)$$

where ΔRX_t^{Dk} is the change in demand for real exports (value of exports deflated by export price index of category k at time t). Superscript k will be suppressed in the following unless it is necessary. Δ signifies discrete changes, θ is the partial adjustment coefficient, superscript * signifies desired value of the variable, and ϵ is a disturbance term which is assumed to be spherically distributed. The value of θ lies between 0 and 1. If de-

may not measure the relative attractiveness of Australian exports either to importers or to exporters. This problem is partly met by including the Australian Wholesale Price Index in the supply equation, and foreign price levels in the principal components which appear in the demand equations for exports.

mand adjusts quickly to changes in the determinants of the desired demand then θ will be close to 1; if adjustment is slow θ will be close to 0. Desired demand for real exports is assumed to depend on selected principal components (PC) of the 27 overseas economic indicators mentioned above and the export price (EP) of Australian goods and services, both lagged one period. Thus

$$RX_t^{D*} = \beta' PC_{t-1} + \gamma EP_{t-1} \quad (t = 1 \ldots. n) \tag{2}$$

β is a column vector of coefficients, PC_t is a vector of selected principal components, and γ is a coefficient to be estimated. The export data are collected at the shipping stage according to the *Monthly Bulletin of Overseas Trade* published by the Australian Bureau of Statistics. It is customary for the period between the arrival of the letter of credit, which should depend on the export prices and capacity-to-import variables of importing countries, and actual shipping to be approximately one quarter. This is the reason for lagging variables by one period in the right hand side of equation (2).

Substituting (2) in (1) the structural demand equation becomes

$$RX_t^D = (1-\theta)\, RX_{t-1}^D + \theta\beta' PC_{t-1} + \theta\gamma EP_{t-1} + \epsilon_t^D$$

$$(t = 1 \ldots. n) \tag{3}$$

That is, the demand for real exports depends on overseas conditions, Australian export prices and the demand for real exports in the preceding period.

Now we turn to the supply side. In an attempt to determine the causes of the declining share of British exports of manufactured goods in the total world trade, Ball, Eaton, and Steuer (1966), and Cooper *et al* (1969) hypothesised that the British export of manufactured goods is negatively related to the internal pressure of demand, Ball, *et al,* in particular, represented the internal demand pressure by a capacity utilization index and some non-linear function of the unemployment rate. By regressing British exports against these variables, they implicitly estimated an export supply equation. Again this is not a reduced form because the exogenous variables of the demand equations do not appear in this estimate.

What they have missed is the fact that export supply depends not only on the capacity to supply for export under competition from domestic consumption, but also on the attractiveness of the export market relative to the domestic market. Therefore, without the export price variable, estimates of the internal demand pressure would be biased. We will use the supply capacity variable and the price variable as separate regressors.

One of the salient features of Australian conditions is that export decisions are subject to the existence of longrun contracts in minerals and cobweb type adjustments in agricultural exports. To reflect these constraints the export supply equations used are

$$\Delta RX_t^S = \lambda\ (RX_t^{S*} - RX_t^L) + \epsilon_t^S \quad (t = 1\ \ldots .\ n) \qquad (4)$$

$$|\lambda| < 1$$

where the actual change in export supply (ΔRX_t^S) depends on the difference between desired level of supply (RX_t^{S*}) and supply required to meet longrun contracts in the case of mineral exports or supply reflecting simply past experience in the case of agricultural exports (RX_t^L). If, for example, desired export supply is higher than longrun-contract exports, then actual exports rise, and vice versa. The adjustment coefficient λ in this equation can be either 1 or less than 1. The meaning of $\lambda = 1$ is that when the desired export supply is higher than RX_t^L, suppliers can instantaneously switch stocks from the domestic to the external market. As shown later in the estimation section the value of λ is separately tested. The result supports $\lambda = 1$ in all but two cases. Desired supply of exports is specified as,

$$RX_t^{S*} = \alpha' y_{t-1} \qquad (t = 1\ \ldots .\ n) \qquad (5)$$

where α is a column vector of constants and y_t is a column vector whose elements are, for each good, the export price, level of domestic real output (RD_{t-1}), domestic price (P_{t-1}), and its change. The price change is included to represent expectations. The supply bound by longrun contract or by past experience is,

$$RX_t^L = \sum_{\tau=1}^{m} w_\tau \; RX_{t-\tau} \tag{6}$$

ie, the weighted moving average of past exports. Solving (4) to (6) we get

$$RX_t^S = \alpha' y_{t-1} + \sum_{\tau=1}^{m} V_\tau \; RX^s_{t-\tau} + \epsilon^s_t \;\; (t = 1 \ldots n, m < n) \tag{7}$$

$$\text{where } V_\tau = \begin{cases} (1 - w_1) & \text{for } \tau = 1 \\ - w_\tau & \text{otherwise} \end{cases}$$

By estimating this equation, weights of moving averages can be determined. If such weights are high and significant at longer lags, then this can be interpreted as the evidence of dominance of longrun contracts. Furthermore since the w_τ are weights of moving averages, one can expect that except in the case of explosive growth, $\sum_1^m w_\tau$ will be close to unity, and this can provide a rough check for the validity of specification.

The model described above will be used for all commodity groups and total categories, except iron ore. Iron ore export have expanded enormously from obscurity to the status of a major export item in the data period due to the relaxation of the embargo. This was achieved by increasing Australia's share of the existing world market, rather than following the total size of the market. The demand equation will therefore be quite meaningfuless in this circumstance. On the other hand the supply must have adjusted in an explosive manner. To capture this experience, the supply adjustment process is assumed to be successive and partial such that;

$$\sum_{\tau=1}^{m} \frac{RXt^s - RXt^s - \tau}{\tau} = \downarrow \sum_{\tau=1}^{m} w_\tau \frac{RXt^{s*} - RXt^s - \tau}{\tau} + \epsilon^s_t \tag{8}$$ [7]

7 In case of iron ore, the supply equation described in equations (4) and (5) gave an unusual shape in the distribution of the lag coefficients which is U-shaped, indicating the inadequacy of the supply equation specification. The strong upward trend can be captured in many alternative ways including time variable. In this study the idea of successive partial adjustment is adopted. Equation (8) is designed to ensure that the effects of relatively remote experiences are reflected in the learning process as well as the immediate past ones. Division by τ is simply to eliminate the scale problem in the size of adjustment. As will be seen in the section dealing with estimation, this specification yields rather plausible distribution of weights.

where the desired level of supply is still the same as (5), and w_τ are partial adjustment coefficients. Supply is assumed to adjust to a weighted average of all past discrepancies between desired and actual supply. Then

$$RX_t^s = \delta \sum_{\tau=1}^{m} v_\tau RX_{t-\tau}^s + \delta \sum_{\tau=1}^{m} \frac{w_\tau}{\tau} (\alpha y_{t-1}) + \delta \epsilon_t^s$$

$$(t = 1 \ldots . n) \qquad (9)$$

$$\text{where } \delta = \left(\sum_{\tau=1}^{m} \frac{1}{\tau}\right)^{-1} \text{ which is constant}$$

$$\text{and } v_\tau = \left(\frac{1 - w_\tau}{\tau}\right) \text{ for all } \tau = 1 \ldots . m$$

Higher values of w_τ would still imply high adjustment to the τ period lag differences, but Σw_τ is not likely to be unity. If a sufficiently long period is considered w_τ is likely to diminish quickly.

Together with equilibrium conditions, the system for each commodity group is now complete. This model when properly estimated should yield coefficients free of simultaneity bias. In the absence of evidence that proves Australian exports are either entirely demand-or supply-oriented, it would be difficult to claim that estimation of models similar to either Houthakker - Magee or Ball *et al* is bias-free. Furthermore even if one assumes such models are reduced forms, that will require export prices to be exogenous to the system, which is theoretically unsound.

Data and Principal Components

All data are on a quarterly basis. The 27 economic indicators for selected countries are all available from the *Economic Indicators of the OECD Countries* published by OECD. As for the real exports of various categories, initially 9 SITC-digit-one categories were used but the results were not very illuminating because the various classes do not correspond to economically meaningful groups in Australian exports. For instances one class included wool and coal under the same category. Therefore 10 selected commodities are chosen as described in the introduction. In addition to this, total manufactured goods (SITC: 5 + 6 + 7 + 8), total merchandise exports, and total exports are added as three aggregate groups. Thus we have three types of general groups: six agricultural exports, four mineral exports and three total groups.

The data for exports, export prices and real production statistics come from various publications of the Australian Bureau of Statistics. All of the agricultural statistics of production are annual series converted into quarterly series by interpolation. The export data are in values of shipments. These are deflated by relevant export prices. Domestic prices come from various A.B.S. publications. The Consumer Price Index for meat, and fruits and vegetables are used as domestic prices for these goods. For the domestic steel price BHP's Basic Price Index is converted into quarterly series taking into account the nearest changes of prices in each quarter. Domestic price for non-ferrous metals is obtained from the publication of the Copper Producers Association of Australia and the Coal price comes from the Annual Report of Coal Producers Association. The old Wholesale Price Index for All Groups is used for the total groups.

Table A-1 in the appendix reports the factor matrix of the 27 indicators chosen. Values reported are simply correlation coefficients between individual indicators and four principal components chosen. Communalities, which are the sum of squares of these correlation coefficients, clearly show that the four principal components together account for most of the variation in the original 27 indicators. For instance take the first row of Table A-1. It can be seen that the four principal components chosen as regressors in the export demand equations explain approximately 97 1/2% of the variation in the industrial production index of Japan. The figure 97 1/2% is simply the sum of squares of the preceding numbers in the same row. Detailed discussions are made in Park (1975).

Estimates of Demand and Supply Equations for Exports

To avoid simultaneity bias mentioned in earlier sections, demand and supply equations are estimated by the two-stage least-squares (2SLS) method. The results are reported in tables A-2 and A-3. To facilitate comparison, implied values of the coefficients of adjustment, weights of moving averages, and elasticities computed at mean values are separately reported in tables 1, 2, 3 and A-4.

Before analysing the estimates of various elasticities, the problem of serial correlation has been investigated using the type II test proposed by Durbin (1970)[8] The result shows that, except in the case of non-ferrous metals export, all the demand and supply equations are free from autocorrelation. This result combined with the use of the 2SLS method of estimation implies that the estimates of both parameters and standard errors are free of systematic biases.

The coefficients of demand adjustment (see equation (1)' and (3)) given in the first column of table 1 show that the total group adjusts very slowly to the desired demand (about 10% per cent of the difference between the desired and actual demand is removed each quarter), the mineral group adjusts reasonably fast except iron ore and the agricultural group adjusts very fast (almost instantaneously).

In other words if Australian export prices and overseas economic conditions are such as to lead our customers to reduce (or increase) their imports from Australia, they seem to be able to do so rather quickly with commodity imports but not with total imports from Australia. Perhaps this may mean that although demand for individual commodity exports varies rapidly, they tend to move in a way to cancel each other out and therefore the demand for total Australian exports adjust much more slowly.

Referring back to the first column of table 1, it can be seen that in several cases the demand overadjusts with the coefficient greater than one. This is likely to be due to the wide fluctuation of demand in these categories.[9] Such fluctuations could come from seasonality in export demands. Although it is not likely that export demand for total groups and mineral exports are subject to seasonal variation, in the case of agricultural exports there are at least two reasons for suspecting seasonality in export demand: (1) the demand for food and clothing in customer countries may be conditioned by some seasonal variations, and (2) the domestic supply of agricultural products in customer countries is likely to be affected by seasonal factors. To see the effect of seasonality in export demand, the demand equations are re-estimated using seasonal dum-

8 The simplified procedure and the power of this maximum likelihood estimation is reported in Maddala, Rao (1973).

9 This is so because the homogenous solution to the underlying difference equation for demand adjustment is $RX_t = RX_0\ (1\text{-}\theta)t$ and $(1\text{-}\theta) < 0$.

Table 1

COEFFICIENT OF DEMAND ADJUSTMENT

Exports of	**Without Seasonal Dummies**	**With Seasonal Dummies**
Total Manufacturing	.36	.48
Total Commodity	.33	.44
Total Export	.10	.22
Meat	1.23	1.12*
Wheat	.87*	.92*
Fruit	1.29	1.06*
Sugar	1.10*	1.24
Hides	.78	.38
Wool	1.06*	.71
Iron Ore	.03	.01
Coal	.67	.78
Steel and Pig Iron	.51	.42
Non-ferrous Metals	1.03*	1.08*

Means not siginficantly different from 1 at 5% level of significance.
Source: Table A-2

mies. This exercise yields substantially unaltered results for all elasticities hence these are not reported. The new adjustment coefficients of all groups are recorded in a separate column in table 1.

Export demands for meat, fruit which previously showed overadjustment, now turn out to be a little lower and not significantly different from cases of instantaneous adjustment. In the case of sugar, however, the seasonality correciton makes demand overadjust. For hides and wool such correction makes the signs of export prices less credible. Probably the sound inference has to be that in the last three cases, export demand is not subject to seasonal variations. In the total and mineral groups adjustment coefficients became slightly faster but are still quite slow.

In each demand equation there are two other elasticities measuring the substitution and income effects. The first is calculated from the coefficients of export price variables and the second from the sum of the coefficients of all principal components. The elasticities are computed at the mean value of each variable. These are reported in table 2.

It has already been mentioned that to avoid the simultaneity problem, it was necessary to correctly specify the structural equations and estimate them efficiently. To do so it was necessary to use absolute levels of export prices instead of arbitrary price ratios. In fact experiments with export prices divided by a weighted average of the consumer price indexes of trading partners gave correct signs for all the export price variables only in the demand equation, as expected.

According to the table, taking total exports as an example, if

Table 2

ELASTICITIES IN DEMAND EQUATIONS

Exports of	Elasticites with respect to	
	Export Price	all Principal components
Total Manufactures	-8.01	1.13
Total Commodity	-4.03	.31
Total Export	-8.66	.59
Meat	7.15	1.81
Wheat	1.04*	-2.08
Fruit	-21.19	1.89
Sugar	-.75	7.27
Hides	-.37	.60
Wool	.54*	0
Iron Ore	-.40	-.49*
Coal	.40	3.25
Steel and Pig Iron	1.19*	0
Non-ferrous Metals	1.64	2.08

Source: Table A-2.

* Not significant from zero at 5% level.

foreign demand, as measured by the four principal components rose by 10%, then Australian exports would rise by 11.3%, whereas if our export prices rose by 10%, total exports would have declined by 86.6%. In otherwords if, during the data period, Australian export prices rose by any appreciable degree, exports would have suffered enormously. The fact is that export prices remained at near constant levels and did not hamper the rising export demand originating from the income effect.

Most of the export price elasticities have correct signs or are not significantly different from zero with the exceptions of meat, coal and non-ferrous metal exports. In these three cases the income effect measured by the principal components register very high elasticities. As our export-price coefficients are not induced to be negative, these results can be used for identification purposes. Therefore in cases of meat, wool and non-ferrous metals it is possible that the demand equations are not stable and only supply equations can be estimated. This will be seen when we come to the estimates of supply functions.

With regard to the demand equations two points are noteworthy. (1) The export price elasticities are generally higher in the total categories. From the trading partners point of view there are alternative sources from which they can import. This is more so in the cases of total and manufactured goods than individual commodities which are generally inputs in character. (2) The effect of increased capacity to import, is generally more prominant in the individual categories than in the total groups. Again this proxy for income elasticity is higher when there is less substitution as in individual groups and is lower when the substitutes are ubiquitous as in the total categories.[10]

To estimate supply equations Almon variables of real exports are used. The estimated Almon weights are likely to reflect the seasonalities in exports unless this is specifically allowed for. Furthermore, other regressors such as real output and domestic prices are seasonally adjusted or merely interpolations of annual figures and hence are free of seasonality. Therefore in supply equations seasonal dummies are included.[11] Regression results are presented

10 The negative income elasticity of wheat demand is difficult to explain. It may be partly due to the Engel's law, partly because United States is a competitor in wheat exports or partly because some of our main wheat customers, such as Russia, China have economies moving on different paths from our Western customers.

11 For the justification of mixing seasonally adjusted variables and seasonal dummies as regressor, see Johnston, pp. 186-192.

in table A-3 and the elasticities calculated at mean values and the coefficients of moving averages are reported in tables 3 and A-4 respectively.

The supply equations are designed to jointly determine the export prices (together with demand equations) as well as to reflect the possible internal pressures of supply and the lagged partial adjustments in supply decisions. The elasticity estimates summarized in table 3 show varied success in achieving these tasks.

Table 3

ELASTICITIES IN SUPPLY EQUATIONS

Exports of	Elasticities in Respect to			
	Export Prices	Real Domestic Outputs	Domestic Prices	Change in Domestic Prices
Total Manufactures	-1.06*	3.01	.88	.02
Total Commodity	-.97*	2.04	.17*	.00*
Total Export	-.76*	1.87	.13*	.00*
Meat	1.44	1.09	-1.89*	.12*
Wheat	1.07*	.14	5.57	-.07*
Fruit	-.89*	.12	1.14	-.08*
Sugar	.00*	2.88	-1.85	.10
Hides	-.55	.78	-3.84	-.04*
Wood	-.30*	.89	.41*	-.01*
Iron Ore	.06*	.58	-1.07	-.03*
Coal	-2.94	.42*	9.82	.05*
Steel and Pig Iron	-.69*	.47	-.27*	.06*
Non-ferrous Metals	1.75	.04*	.00*	-.01*

Source: Table A-3

* Not siginficant to 5% level of significance.

Most of the export price elasticities show either correct signs or are not significantly different from zero, with two exceptions; hides and coal. In these two cases the absolute values of the elasticities with respect to the domestic pressure variables are greater than those to foreign economic conditions. Hence the supply functions are more unstable and cannot be estimated.

Interestingly, demand for meat and non-ferrous metals, which have shown positive export price elasticities turned out to be the cases where demand shifted more than supply as can be seen by the absolute values of elasticities. For instance while the demand for non-ferrous metal exports shifts by 20.8% for a 10% increase in all foreign indicators, supply shifts virtually none for an equivalent rise in domestic indicators. This was the reason why it was impossible to estimate demand functions.

If export supply decisions respond very little to the variations in export prices, then under correct specification and efficient estimation, the relevant elasticities should not be significantly different from zero. Accrdingly in this paper the extensive insignificance of export price coefficients in supply equations can be regarded as evidences of zero elasticities. Taking total exports as the example again, supply does not appear to respond to export price changes, nor to changes in the levels of domestic prices. It does respond, however, to the availability of output with a high elasticity of 1.87.

Internal pressures are captured by three variables; levels of real output, domestic wholesale price levels, and changes in these prices (as proxies for price expectations). Again manufactured and total exports are more constrained by the capacity-to-export than are other commodities. This is to be expected because while manufactured exports have some competing domestic market, commodity exports of industrial materials have very little competing demand from domestic markets. Sugar and meat exports show higher sensitivity to output availability than do other commodities.

Expectation variables (domestic price changes) are all not significant (at the 5 per cent level) except for the cases of sugar and total manufactured goods.

The coefficients of domestic price levels in the supply equations can be interpreted in two ways. If rising exports cause discernible internal pressures, the domestic price may rise, and a positive price coefficient will be observed in the supply equation of the simultaneous model. On the other hand if export decisions are based on the relative attractiveness of foreign and domestic markets, then lower domestic wholesale prices would cause higher export supply and a negative price coefficient will be observed. Meat, sugar, hides, iron ore, and steel and pig iron show negative signs;

among them only sugar and iron ore are significant. For these commodities domestic market price functions as a signal to suppliers to switch to exporting. The case of iron ore is complicated, however, because the price used for iron ore is that of steel and pig iron. Among those showing positive coefficients only total manufactured goods, wheat and coal are statistically significant. For wheat and coal the strain of export is felt more in higher domestic prices and less in output adjustment. For manufactured goods both domestic price and output respond to the strain caused by exports.

It has already been noted that the assumption that the adjustment of supply is instantaneous can be tested. It is the same as assuming that $\lambda = 1$ in

$$\Delta RX_t^S = \lambda\ (RX_t^* - RX_t^L) + \epsilon_t^S \qquad (10)$$

In other words the production decision takes into account past experience and longrun contracts, and that whenever desired exports are higher than RX_t^L instantaneous switching of stocks from domestic to external markets is possible.

Testing this assumption requires an additional parameter, λ, to be estimated in

$$RX_t^S = \lambda\alpha' y_{t-1} + \sum_{\tau=1}^{m} V_\tau RX_{t-\tau} + \epsilon_t^S \qquad (11)$$

where

$$V_1 = 1 - \lambda w_1 \qquad \text{for } \tau = 1$$

$$V_\tau = -\lambda w_\tau \qquad \text{for all } \tau \geqq 2$$

Since we need extraneous information to determine λ, it is assumed that the sum of weights of the moving average is one. Then since $\sum_{\tau=1}^{m} V_\tau = 1 - \lambda \sum_{\tau}^{m} w_\tau$, an estimate of λ can be obtained.[12]

The resulting values of λ are indeed close to one, except coal and non-ferrous metals where values of λ are .6583 and .8579

12 Will be estimated from $(1 - \sum_{\tau}^{m} V_\tau) / \sum_{\tau}^{m} W_\tau$ where the denominator is assumed to be one.

respectively. Therefore for the rest of the cases the assumption of instantaneous switching of supply from domestic to foreign market seems to be justified. For coal and non-ferrous metals, the estimates are adjusted accordingly.

Estimated weights of moving average reported in table A-4 tend to be very high at the beginning and tend to have another hump beyond the 4th period lag. The size of these changes are very small compared to initial higher adjustments, nevertheless it is notable that the distribution of adjustment coefficients are slightly bi-model. Sum of weights of moving averages are generally close to one.

III. Conclusions

In this study models of Australian export of 10 selected major export commodities classified on the SITC basis and 3 aggregate groups are designed. These are built such that estimates of the structural coefficients would be free from simultaneity biases. The demands for exports are specified to be functions of four principal components of 27 business indicators of the major trading partners of Australia. This is to capture the income effect or more broadly the capacity-to-import effect of these countries. Supplies of exports are made functions of levels of domestic real outputs, domestic wholesale price indexes and their changes, as measures of internal pressures of exports. The export price variables are jointly determined in the model. Partial adjustment of demand and supply decisions are also estimated.

It was not always possible to identify both the demand and supply functions. One can however be reasonably confident that the demand function was indentified for all cases except meat, coal and non-ferrous metals. On the supply side, despite the fact that many export price variables were not significant, one can be reasonably confident that the functions estimated are indeed supply responses in all cases except hides and coal, and that the insignificance of the export price coefficients are evidence of near zero price elasticity of supply.

The results are in general comformity with a priori expectations. Aside from the actual values of elasticities for individual commodities, some general findings are also noteworthy. Demand for Australian exports are more sensitive to export prices in the total categories than for individual commodities. This is presumably because of the large contractual element involved in demand for minerals and several commodities and there are alternative sources from which our trading partners can buy manufactured goods. Conversely, the effect on Australian exports of changes in the capacity to import of foreign countries is more pronounced for commodities than for the total categories. (This is sensible because the commodities are industrial inputs). Supply of Australian exports adjusts not at all or very little to changes in export prices, but it adjusts to real output changes more sensitively in the total categories and less so in individual categories, because, unlike manufactured goods, most of the individual commodities would have very little competing domestic demand. Domestic prices are pushed up in some cases by export pressure but in other cases higher domestic prices raise the relative attractiveness of domestic markets and hence reduce the supply of exports, particularly for sugar.

Furthermore, in the majority of cases the supply decision to export is inelastic to either export or domestic prices, but highly elastic to capacity changes. On the other hand, the demand for exports is elastic to both price and income variables in many cases. On balance, whenever there was higher export demand (whatever the causes), the supply adjustment by output increases was so great that export prices did not have to rise much.

This separation of causes of variations in exports and export prices is not possible if one totally disregards the supply side and strictly adheres to the homogeneity property of demand functions and export price ratios.

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Table A-1

APPENDIX FOR STATISTICAL RESULTS FACTOR MATRIX OF THE 27 INDICATORS

Names of the Indicators	Factor 1	Factor 2	Factor 3	Factor 4	Communalities
1. Industrial Production Index of Japan	.98217	-.09951	.02077	-.00409	.97501
2. Wage Index of Japan	.87824	-.05421	-.29899	.13986	.88320
3. Consumer Price Index of Japan	.99305	-.02235	.04584	-.01185	.98888
4. Imports of Japan	.97494	-.08179	.04332	-.04623	.96122
5. Industrial Production Index of U.S.A.	.88454	-.27273	.16032	.12359	.89778
6. Wage Index of U.S.A.	.99215	-.03590	.03835	.00097	.98713
7. Consumer Price Index of U.S.A.	.99219	.01302	.01935	-.00254	.98499
8. Imports of U.S.A.	.98771	-.04553	.04732	.05637	.98307
9. Industrial Production Index of U.K.	.75906	-.42962	.08547	-.19186	.80485
10. Wage Index of U.K.	.98874	.02196	.02854	-.02099	.97934
11. Consumer Price Index of U.K.	.99207	.06228	.02261	-.01567	.98883
12. Imports of U.K.	.96689	-.04504	.06002	-.06009	.94412
13. Industrial Production Index of Germany	.92191	-.10812	.02013	-.09794	.87161
14. Wage Index of Germany	.98034	-.08812	.00761	-.04716	.97111
15. Consumer Price Index of Germany	.98097	.01359	.04828	-.02375	.96539
16. Imports of Germany	.97255	.12138	-.04544	-.08499	.96987
17. Exchange Rate of Japan	.62927	.41861	-.38638	.12910	.73718
18. Balance of Current Account of Japan	.73119	.39464	-.33355	.23938	.85893
19. Net Longterm capital Movement of Japan	-.44474	-.00668	.17098	.29084	.31166
20. Balance of Current Account of U.S.A.	-.83464	.26072	.03269	-.22035	.81422
21. Net Private Direct Investment of U.S.A.	-.51146	-.50597	-.43964	.22523	.76161
22. Exchange Rate of U.K.	-.79870	.40316	-.11246	-.12646	.82909
23. Balance of Current Account of U.K.	.77663	.77795	-.06728	.02655	.68564
24. Net Longterm Capital Movement of U.K.	.27011	.34507	.80921	.02581	.84752
25. Exchange Rate of Germany	.83504	.36384	-.27875	-.20812	.93486
26. Balance of Current Account of Germany	.23157	-.80919	.04898	.20299	.75155
27. Net Longterm Capital Movement of Germany	.07521	.32730	.16996	.79286	.77029

Table A-2

ESTIMATES OF EXPORT DEMAND EQUATIONS FOR SELECTED GROUPS AND COMMODITIES

	C	$E^*P^k_{-1}$	RX^k_{-1}	PC^1_{-1}	PC^2_{-1}	PC^3_{-1}	PC^4_{-1}	R^2
Total Manufactures	1461587.2284 (.5972)	-16000.5358 (.6958)	.6445 (1.2486)	-9.6758 (1.0301)	-8.3748 (.1649)	13.7604 (.3164)	61.0450 (1.3367)	.9260
Total Commodities	3390481.7235 (.5792)	-34075.2556 (.5944)	.6684 (1.8486)	-11.3633 (.5143)	-6.7725 (.0673)	36.5110 (.4646)	76.8421 (.6757)	.9608
Total Export	7606752.4489 (1.1386)	-75533.4937 (1.1474)	.8946 (2.0376)	3.7296 (.1441)	-76.4220 (.6419)	-11.8990 (.1286)	153.0223 (1.1083)	.9531
Meat	-370719.5529 (2.3198)	2590.2699 (2.1433)	-.2336 (.9114)	2.0491 (.6736)	-9.8313 (1.2846)	-7.9956 (.7023)	41.8368 (2.4373)	.4250
Wheat	179449.8569 (1.3326)	839.5836 (.6207)	.1349 (.6320)	.0055 (.0025)	-1.6403 (.2690)	-5.6366 (.4748)	-50.8573 (2.0203)	.6570
Fruits and Vegetables	509275.1239 (1.5502)	-5713.8515 (1.7661)	-.2901 (1.4274)	-1.5863 (.9177)	.3462 (.0584)	11.4133 (1.0227)	12.5428 (.6764)	.2913
Sugar	-155283.6617 (1.0926)	-319.4473 (.8031)	-.1027 (.4417)	-.6157 (.2300)	15.1126 (1.8323)	24.0827 (1.5410)	26.4903 (1.0891)	.1735
Hides	15033.1782 (.4712)	-101.2141 (1.2565)	.2182 (.9173)	- .2854 (.6777)	-.4104 (.2822)	-.4415 (.1868)	4.1353 (.9330)	.4512
Wool	47055.2144 (.0948)	1094.7430 (.5764)	-.0562 (.2351)	-4.3704 (.6667)	6.9957 (.2894)	13.0691 (.3148)	-10.5610 (.2443)	.0866
Iron Ore	45894.1869 (.6037)	-116.0041 (.3641)	.9704 (5.6797)	-.5452 (.6839)	-1.0808 (.3086)	-1.9121 (.3659)	-5.4964 (.7901)	.9821
Coal	-69114.2038 (2.3371)	75.8991 (.6201)	.3274 (1.6185)	-1.2252 (2.8539)	6.2878 (3.8953)	8.7949 (3.6362)	7.1222 (1.9087)	.9362
Steel and Pig Iron	-19022.1398 (.2703)	193.9385 (.5789)	.4896 (2.2401)	.2491 (.3306)	-.2008 (.1054)	-1.0775 (.3295)	2.9729 (.3764)	.3096
Non-Ferrous Metals	-104581.1021 (.8749)	527.1860 (.9074)	-.1324 (.3491)	-2.2990 (2.3460)	4.3850 (1.2663)	6.8966 (1.1788)	11.7217 (.9064)	.6826

Values in the parenthesis are t statistics.

Table A-3
Estimates of Export Supply Equations for Selected Groups and Commodities

	C	Seasonal Dummies: Dec.	Seasonal Dummies: Mar.	Seasonal Dummies: Jun.	$E^{\hat{}}P_{-1}$	RO_{-1}	P_{-1}	dP	R^2
Total Manufactures	-354625.8673 (.4291)	-14166.9814 (.9062)	-35052.4141 (2.2431)	-11530.4261 (.5618)	-2118.7285 (.2686)	100.0043 (3.9919)	1584.1987 (1.1244)	696.8796 (.7781)	.9187
Total Commodities	-180846.1464 (.0937)	2356.2452 (.0817)	-34143.1277 (1.1418)	-4655.2732 (.1263)	-8191.9181 (.4602)	288.0183 (7.0939)	1292.9000 (.5205)	232.2457 (.1445)	.9579
Total Export	-347462.6930 (.1805)	1753.3431 (.0593)	-34949.2343 (1.1455)	-2194.3875 (.0579)	-6667.8675 (.3749)	298.0357 (7.1473)	1052.8797 (.4094)	187.0580 (.11355)	.9582
Meat	35547.8981 (.3082)	-13003.7095 (1.9234)	-26341.4596 (3.6491)	-16768.7002 (2.4830)	523.0323 (.74021)	347.8791 (.9647)	-886.2620 (.5734)	1312.0827 (.6361)	.6849
Wheat	436528.1157 (2.1800)	-1261.5852 (.1037)	-899.0309 (.0713)	9852.5883 (.2577)	862.4951 (.6337)	52.5330 (.3540)	-1295.9347 (1.7568)	-375.5635 (.4419)	.4736
Fruit	74108.1244 (1.1621)	-6973.4237 (2.1722)	-8879.8133 (2.0953)	28471.5642 (6.5404)	-241.1265 (.3799)	14.9238 (.2752)	-300.3069 (.2674)	-501.4775 (.3146)	.9440
Sugar	8498.5982 (.1069)	1995.8994 (.2612)	-21178.6400 (2.3521)	-17802.0885 (2.4237)	1.5501 (.0046)	48.1326 (1.5420)	-745.1820 (.9580)	898.8658 (.9913)	.6904
Hides	111281.1117 (1.8946)	-2939.0377 (1.6205)	6969.0530 (3.2826)	-2111.6004 (1.1606)	-151.0438 (.8830)	122.3840 (.8515)	-855.6537 (1.3958)	-756.8598 (.5306)	.7478
Wool	-8165.0864 (.0486)	52063.0689 (3.9639)	53835.1868 (4.6043)	32880.1220 (3.3107)	-605.2231 (.2534)	680.3759 (1.1004)	202.4852 (.2927)	-228.2865 (.4823)	.8379
Iron Ore	24586.8854 (.3669)	839.5153 (.3740)	529.7877 (.2198)	581.7371 (.2513)	16.2758 (.0559)	4.7874 (1.7207)	-358.0612 (.8361)	-198.5317 (.4498)	.9861
Coal	-96527.0865 (2.8513)	389.8354 (.2323)	-2602.5055 (1.3691)	169.7875 (.1043)	-370.6104 (1.1536)	.6717 (.4452)	29874.2686 (2.5842)	4430.4853 (.3591)	.9502
Steel and Pig Iron	34646.9348 (1.3274)	-7540.1089 (2.8370)	-7555.4194 (2.8766)	-4746.4094 (1.7474)	-112.0941 (.5542)	2.1819 (.7582)	-50.6675 (.1607)	260.3799 (.5554)	.5093
Non-Ferrous Metals	-26952.7850 (.6319)	-1623.8898 (.3139)	81.8379 (.0164)	-3430.6389 (.6875)	481.3878 (.7277)	12.6419 (.0283)	.9327 (.0088)	-65.3024 (.5006)	.6632

Table A-4

WEIGHTS OF MOVING AVERAGES IN SUPPLY EQUATIONS

	(Weights of Moving Average)									
	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9	$\sum^{m} w_{\tau}$
Total Manufactures	1.1569	.0779	.0164*	-.0278*	-.0546*	-.0640*	-.0560*	-.0306*	.0122*	1.0305
Total Commodity	.9075**	-.0478*	.0010*	.0180*	.0392*	.0526*	.0582	.0560	.0459*	1.1186
Total Export	.8974**	-.0506*	.0087*	.0234*	.0455*	.0576	.0598	.0521	.0344*	1.1109
Meat	1.2520	.1835	.1197	.0606*	.0061*	-.0437*	-.0887	-.1291	-.1649*	1.1955
Wheat	.8549**	-.1644	-.1613	-.1359	-.0882*	-.6182	.0742	.1889	.3259	.9359
Fruit	.8941	-.0591	-.0211*	.0080*	.0284*	.0399	.0427	.0366*	.0216*	.9911
Sugar	1.1419	.1667	.1634	.1371	.0879	.0156*	-.0796	-.1977	-.3389	1.1013
Hides	.7989**	-.0972*	-.0174*	.0381*	.0695*	.0767*	.0597*	.0185*	.0469*	.8997
Wool	.9108**	-.0154*	.0362	.0655	.0726	.0575*	.0201*	-.0395*	-.1213	.9865
Iron Ore	.9199	.8884	.8844	.8964	8734	.8242	.7172	.5314	.2454	N.A.
Coal	1.1367**	-.1022*	.0927	.2008	.2266*	.1656*	.0193*	-.2121	-.5836	1.000***
Steel & Pig Iron	.7462	-.1102	-.0017*	.0719	.1104	.1138	.0823	.0157*	-.0860*	.9423
Non-ferrous Metals	1.2178**	-.0451*	-.1083	-.1372	-.1322	-.0929*	-.0196*	.0879*	.2295	1.000***

* Not significantly different from 0 at 5%

*** These are assumed to be one.