INTERNATIONALISATION AND PRICING BEHAVIOUR: SOME EVIDENCE FOR AUSTRALIA

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Abstract

Standard trade theory suggests that internationalisation of an economy should lead to increased competitive pressures and an improvement in the efficiency with which domestic goods are produced and priced. We examine a number of ways in which the pricing behaviour of the Australian manufacturing industry has changed over the past couple of decades, and relate this to the substantial opening up of the economy which has occurred. Using disaggregated industry-level data, we find evidence that, when measured in the same currency, prices of Australian-produced goods have fallen relative to foreign-produced goods in many of Australia's manufacturing industries. We attribute this, in part, to increased international competition driving inefficient domestic producers from the market. We also find, not surprisingly, that domestic price setters tend to be more sensitive to changes in foreign prices in the traded sector than in the non-traded sector, and that the more open the industry the higher the sensitivity to foreign prices.

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1. Introduction

In recent years, increasing attention has been paid to the various impacts that internationalisation has had on the operation of the economy.[1] The implications of internationalisation for price setting behaviour and inflation have received much attention, particularly in policy-making circles. Alan Greenspan recently put one of the central arguments.

> '[Internationalisation implies that] a growing share of all output competes in an increasingly global marketplace, allowing fixed costs to be spread over ever broader markets, promoting greater specialisation and efficiency, and enhancing price competition… These trends leave the level of both wages and prices lower than historical relationships would predict.'
>
> *Alan Greenspan, Chairman, Board of Governors of the Federal Reserve System, Committee on Banking, Housing, and Urban Affairs, US Senate, July 18 1996.*

In addition to lowering prices, and even perhaps inflation, it has also been argued that international integration has altered the cyclical behaviour of inflation. By increasing the size of the traded goods sector, more prices become sensitive to movements in the exchange rate, and the presence of international competition reduces the ability of domestic producers to increase prices in periods of strong demand.

In this paper, we examine some of the Australian evidence for these arguments using disaggregated industry-level producer price data for domestic and foreign firms, and wholesale import price data. We take two broad approaches. First, we examine how prices set by domestic producers have changed relative to world prices over the past 25 years. Second, over the period since the float of the

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1 See for example, Lowe and Dwyer (1994).

Australian dollar, we examine the dynamic response of domestic price setters to movements in foreign prices. In both cases, we examine the extent to which changes in international competition can explain the differential results across industries and across time.

Four main conclusions can be drawn from our analysis. First, the prices of goods produced by most Australian manufacturers have declined relative to world prices over the past 25 years. That import shares in manufacturing have also increased over this period, is suggestive of the fact that this improvement in the domestic competitive position of Australian manufacturing may reflect rationalisation in the manufacturing sector as a consequence of internationalisation. Second, while internationalisation is expected to lead to a once-off improvement in domestic resource allocation, this study suggests that adjustment can be protracted. The disinflationary effects of structural adjustments appear to persist for a considerable length of time.

With respect to the dynamic behaviour of domestic prices, our third conclusion is that prices in the tradeables sector respond more rapidly than prices in the non-tradeables sector to a shock to foreign prices. And, finally, within the tradeables sector we find that the speed of response of domestic prices to changes in foreign prices depends on the degree of openness of the industry. These two conclusions imply that as industries within the traded sector become more open, foreign price shocks will be more rapidly reflected in domestic prices.

The rest of the paper is organised as follows. In Section 2 we provide the context for this investigation, and briefly discuss some of the theoretical and empirical evidence on the links between openness and price setting. In Section 3 we examine long-term trends in real exchange rates for a number of Australian manufacturing industries. We use data disaggregated into 27 industry groups, and examine developments between 1969 and 1994. We first examine these trends graphically and examine the relationship between these trends and changes in openness of the industries. We then test for evidence that domestic and foreign prices have been more closely linked in the later years of our sample.

In Section 4, we look more closely at whether the dynamics of inflation have changed with increased openness. Matching data on the prices of domestically produced manufactures with the domestic prices of their imported competitors, we

examine whether the pass-through of import price shocks to domestic prices is a function of the degree of openness of the industry, and whether these relationships have changed over time. Conclusions are offered in Section 5.

2. Trends in Openness and Previous Work on the Relationship between Openness and Price Setting

The Australian economy is clearly more outwardly oriented today than it was a decade or two ago. Import and export shares have both risen steadily, particularly in the manufacturing sector, as have inward and outward levels of foreign investment. The ratio of imports of manufactures to domestic sales was 35 per cent in 1994/95, up from 17 per cent in 1968/69. The proportion of output of domestic manufacturing firms which is exported has risen similarly. In 1968/69, around 9 per cent of domestic manufacturing production was exported; by 1994/95 this ratio had risen to 25 per cent.[2]

This increase in openness has not simply been driven by changes in the trade share of a few large manufacturing industries. Rather, there appears to have been a general move toward openness across the manufacturing sector. Between the late 1960s and the early 1990s, the ratio of imports to domestic sales increased in 27 of the 30 manufacturing industries considered in this study. The corresponding export ratio rose in 26 of the industries over the same period. As a result, the proportion of manufacturing industries which can be classified as import competing increased from 77 per cent to 97 per cent, and the proportion that can be classified as exportable rose from 7 per cent to 30 per cent.[3]

A number of factors have contributed to this increase in openness. First among these is that domestic protection levels have been substantially reduced. The average effective rate of assistance afforded domestic manufacturing industries fell from 36

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2 Industry Commission (1995) and Clark, Geer and Underhill (1996).

3 Following Dwyer (1990,1992), industries are classified as import competing if the ratio of imports to domestic production is greater than 10 per cent, and are classified as exportable if the ratio of exports to domestic production is greater than 10 per cent. The manufacturing sector is divided into 30 IOCC industry groupings for this analysis. Industry groupings are shown in Appendix C, Table C2, along with the concordance between ASIC and IOCC groups. Data source: Industry Commission (1995).

per cent in 1968/69 to around 12 per cent in 1992/93.[4] This change in policy has exposed domestic industry to increased foreign competition, and has encouraged resources to move towards industries in which Australia has a comparative advantage. Other government reforms, including a range of microeconomic reforms, which have been partially justified on the grounds that they will improve Australia's international competitiveness, have also encouraged industries to adopt a more outward orientation. A third factor which has driven the economy to be more outwardly oriented is growth itself. As wealth accumulates in the economy there is typically an increase in the demand for variety. This naturally leads to an increase in intra-industry trade and hence, an increasingly outwardly oriented economy.

In theoretical terms, the link between openness and price-setting behaviour follows from the presumption that having a more open economy should lead to an improvement in the efficiency with which domestic goods are produced and priced. Helpman and Krugman (1989) argue that this is one of the basic implications of international trade theory under imperfect competition. Increasing trade exposure, by raising the level of competition, should reduce the ability of domestic producers and domestic factors of production to extract rents. Thus as an economy opens up, domestic prices of tradeable goods should move toward the level implied by the law of one price, and across the business cycle, these prices should move increasingly closely with the prices of their internationally produced substitutes.

There has been relatively little work in Australia examining the implications for inflation of internationalisation. In recent work, Bloch (1996) and the Bureau of Industry Economics (1989), examine changes in the international competitiveness of the domestic manufacturing industry at varying levels of disaggregation. They find widely differing results across industries, but do not relate these to the openness of the various industries.

More recently, Dwyer and Romalis (1996) broadly followed the approach adopted by Hall (1988) to identify the mark-up of price over marginal cost for manufacturing industries, and attempted to identify the specific effect that internationalisation has had on this mark-up. They find that internationalisation has significantly eroded these mark-ups, especially in imperfectly competitive industries; however, the aggregate effect on prices is fairly small in magnitude. Dwyer and Romalis

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[4] Industry Commission (1995), p. A1.1.

acknowledge that their approach very likely understates the role played by increasing trade exposure, as it does not capture any impacts of increased trade exposure on costs and productivity growth.[5]

3. Long-term Trends in Relative Prices and Openness

In this section we examine long-term movements in the relative output prices of domestic and foreign industries and discuss a range of influences on these relative prices, one of which is internationalisation of the domestic economy.

3.1 Defining and Interpreting Movements in Relative Prices

Industry real exchange rates can be calculated by comparing the price of an industry's output with the price of output of the same industry in the rest of the world, expressed in a common currency. In conducting these calculations, account must also be taken of tariffs and transportation costs. In symbols, the relative price of a domestic industry's output and the foreign industry's output (sold in the domestic country) is given by:

$$R_t = \frac{p_t}{e_t p_t^* (1 + tariff_t + trans_t)} \qquad (1)$$

where p_t is the domestic price of a traded good, p_t^* is the world price of the same traded good, e_t is the exchange rate, $tariff_t$ is the *ad valorem* tariff rate (or more generally the rate of protection accorded domestic producers from all sources of trade barriers), and $trans_t$ is the per unit cost of international freight. This relative price is sometimes interpreted as a measure of competitiveness, as all else constant, a lower domestic price relative to the world price should mean that the domestic industry is more competitive in world markets.

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[5] Inherent difficulties in accurately measuring marginal cost can also imply that the estimated relationship between the mark-up and trade exposure, although statistically significant, is weak. Much the same problem has been identified in the industrial organisation literature where the evidence for a relationship between concentration and prices is much stronger than between concentration and profitability (Schmalensee 1989, p. 989).

Theory suggests that for a small open economy trading homogeneous goods, the prices of tradeable goods should be determined by the prices prevailing in the rest of the world. That is, the 'law of one price' should hold, after controlling for the effects of trade barriers and transportation costs. Under these assumptions, the above price ratio should always be equal to unity for tradeable goods.

In many cases, however, the assumptions underlying the law of one price do not hold. Markets may not be completely open, goods may not be perfect substitutes, and frictions in the economy may imply that it takes time for consumers and producers to adjust to shocks. In these cases, domestic suppliers or domestic factors of production may have some capacity to exploit their market power, driving the domestic price away from the level implied by foreign prices.[6]

The focus of this section of the paper is on the impact that *increasing* the openness of markets has on these relative price ratios. From a partial equilibrium perspective, allowing greater import competition should lead the price of domestically produced import-competing goods to either stay constant or fall relative to the world price.

Taking a general equilibrium perspective, however, the impact of a widespread increase in openness on relative prices in particular sectors will depend on their performance relative to other sectors. Only those sectors with productivity gains relative to the economy average would be expected to exhibit improvements in their relative price performance.[7] To the extent that the manufacturing sector is small relative to the rest of the economy, however, and provided productivity improvements resulting from internationalisation are concentrated in, and fairly evenly spread across manufacturing, one could expect to find relative price falls across much of the manufacturing sector as a result of internationalisation.

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6 Although the existence of differentiated products and rigidities implies that the law of one price will not hold exactly, as long as foreign goods are reasonable substitutes for domestically produced goods (and as long as markets are reasonably open) the law of one price should provide a guide to longer-term relative price developments.

7 This is a version of the Belassa-Samuelson effect. Imagine a country produces differentiated products in two traded goods industries, say footwear and computers, and opening up to trade primarily increases technological growth (and thus efficiency) in the computer industry. This will tend to increase the economy-wide wage rate, increase prices and worsen the country's competitiveness in the footwear industry. Hence, from a general equilibrium perspective, opening up to foreign competition will not necessarily improve a country's competitiveness in each of its traded goods sectors.

3.2 Changes in Relative Prices across the Manufacturing Sector

Changes in relative prices within different manufacturing industries are examined using data from the United Nations Industrial Development Organisation (UNIDO) database and producer price data from the Australian Bureau of Statistics. The UNIDO database covers a large number of industrialised and developing countries, and, for each country, contains annual data on nominal and real output for up to 30 manufacturing industries over the period from the late 1960s to the mid 1990s. Producer price indices are constructed from the UNIDO database by taking the ratio of nominal to real output for each industry in each country.

The Australian producer price data are available for 27 manufacturing industries, and are constructed by splicing UNIDO data for the period 1969 to 1976 to ABS producer price data for the period 1976 to 1994.[8]

The foreign price indices are constructed using price movements in 16 of Australia's major trading partners. In order to capture the competitive pressures placed on domestic producers as closely as possible, foreign prices are chain-weighted together using a moving average of foreign country export shares to Australia for each industry.[9] The foreign prices are converted to Australian dollars using bilateral exchange rates, and are tariff adjusted using Industry Commission estimates of average duty rates.[10] Transportation costs are not adjusted for in this analysis.

The resulting ratios of domestic to foreign output prices are shown in Figure 1. Summary statistics regarding movements in these indices are presented in Table 1. In drawing conclusions from these data, we have kept in mind the fact that

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[8] The ABS producer price data provide a better indicator of price developments in many industries, since the UNIDO industrial production indices are, in many cases, based on more aggregated industry groupings. See Appendix C for further discussion of this issue. Overall conclusions, however, are not substantially affected by use of the UNIDO data throughout.

[9] An alternative set of weights, using shares in total world production or shares in total world trade by industry, would capture both actual and potential sources of competition. These, however, were thought to less accurately reflect the competitive pressures facing domestic producers. In particular, transportation costs (which we do not control for) may offset the competitive advantages held by some potential foreign suppliers.

[10] These measure the extent to which import prices are raised by tariffs, tender premiums on quotas and excise. For further details about the data sources and series construction, see Appendix C.

international comparisons are fraught with difficulty. Even in industrialised countries, as suggested by the Boskin (1996) report, it is difficult to accurately measure price movements and appropriately adjust for quality and compositional changes. Many of these problems are likely to be exacerbated in developing countries. When examining these indices we are thus sceptical about the magnitude of some of the individual movements, and take from these data some overall trends rather than placing too much weight on individual industry experiences.[11] Note that since these indices have been calculated using price indices rather than actual price levels, only conclusions regarding *changes in* relative prices can be drawn.[12]

Table 1: Changes in Relative Prices by Industry

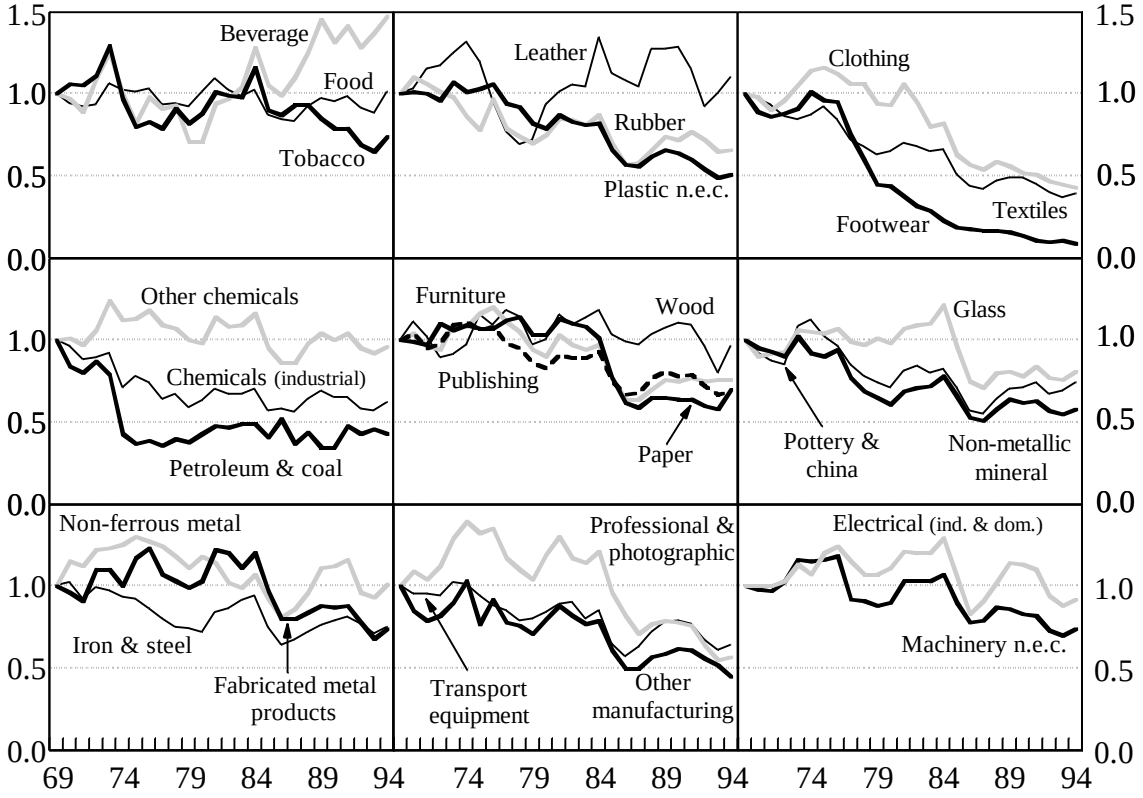
Number of industries for which relative prices have:	1969/72 to 1991/94	1969/72 to 1980/83	1980/83 to 1991/94
Decreased	21	11	21
Increased	1	4	1
Unchanged	5	12	5

Note: Based on percentage changes in the relative price measures presented in Figure 1. Industries are classified as 'unchanged' if the relative price change is less than 10 per cent in either direction.

[11] In Appendix A, we present data which are comparable to Figure 1 and Table 1, but only include Australia's *industrialised* country trading partners. Overall conclusions are little changed.

[12] Note also that in this exercise we are comparing movements in the Australian price with the movements in the price at which a foreign substitute *could be* landed, not movements in the price at which foreign goods are actually sold, in Australia.

Figure 1: Relative Prices



The main conclusion we draw from these data is that there have been widespread and substantial falls in relative prices for a large number of manufacturing industries over the three decades considered. Table 1 illustrates that over the full sample period, relative prices fell in 21 of the 27 industries, and only rose in one industry.[13] We discuss this conclusion in more detail below.

These data also illustrate that relative price shocks can be quite large and persistent, driving relative prices away from long-term trends. Following the nominal exchange rate depreciation in 1986, for example, most industries experienced a fall in their real exchange rate (Figure 1). For some industries this gain was subsequently

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[13] Bloch (1996) uses a similar data set, but does not draw this conclusion. He finds that '…the change in competitiveness of Australian producers differs substantially across industries and trading partners'. For each industry, Bloch documents the *number* of countries against which Australia's competitiveness has improved or declined over the period from 1968 to 1989 and presents the average change in competitiveness for each industry, in effect giving equal weight to each trading partner. The differences between our conclusions primarily illustrate the effect of weighting foreign country prices together, rather than examining individual bilateral movements. In this way, more general conclusions regarding Australia's competitive position can be drawn.

eroded, while for others it was maintained.[14] We attribute the persistence of relative price shocks to rigidities in the economy which imply that it takes time for consumers and producers to observe and respond to relative price changes.[15] One implication of this is that once-off movements in the price level which flow from structural adjustments, may take place over quite a long period as relative prices gradually adjust.

Returning to the main conclusion, the widespread fall in relative prices illustrated in Figure 1 and Table 1 could reflect a number of factors.[16] These include:

(a) increasing international competition;

(b) the depreciation of the aggregate real exchange rate;

(c) real unit labour cost increases in the manufacturing sectors of our trading partners;

(d) differentiated product pricing behaviour; and

(e) the fact that much of Australia's manufacturing involves refinement of resource commodities.

We discuss each of these in turn.

The first explanation for the widespread improvement fall in relative prices is that it reflects the impact of increased international exposure on the behaviour of domestic producers. To the extent that Australian firms were, in the past, somewhat protected from international competition, through both explicit trade policy and an inward-focused mentality, it seems plausible that increased international exposure may have lead to some rationalisation in the domestic industry. This rationalisation could plausibly include lower margins in factor, input and product markets, improved use

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[14] The differential responses of industries to the exchange rate movements in the mid to late 1980s broadly correspond with Lattimore's (1988) findings.

[15] Evidence is well established that exchange rate movements are not passed through to wholesale import prices instantaneously; see Dwyer, Kent and Pease (1993) for a discussion of some aggregate results for Australia. This is clearly an important rigidity which partially explains the persistence in relative price shocks over short periods of time.

[16] A change in transportation costs is a potentially important explanator for these trends which we have not explored.

of technology by domestic industry and the exiting from the industry of high-cost producers.

The most obvious competing explanation for the observed trends, however, is that they simply reflect, at an industry level, the depreciation of the real exchange rate at an aggregate level which occurred over this period. Since one could argue that the aggregate depreciation has been driven by the decline in the terms of trade, these developments could have been entirely independent of the process of internationalisation. If this is the case, the correct interpretation would be that developments at an aggregate level had simply conferred on manufacturers substantial competitive improvements.

A third explanation is that these falls in relative prices could have been driven by general equilibrium forces at work in our major trading partners, rather than domestic developments. Taking the textiles, clothing and footwear industries as an example, the substantial relative price improvements illustrated in Figure 1 must, in part, reflect the fact that wage rates have risen substantially in some of our Asian trading partners as a consequence of development.[17]

A fourth explanation for these developments comes from thinking about the output of manufacturers as being differentiated rather than homogeneous products. In this case the law of one price is no longer strictly applicable, and the widespread fall in the real exchange rate facing most Australian manufacturing industries could reflect their attempt to gain market share.

Finally, these developments could be driven by the output of Australian manufactured industries being, on average, less elaborately transformed than their foreign counterparts. Lattimore (1988) argued that at an aggregate level, Australian manufacturing output is dominated by the simple transformation of resource-based products, whose prices have been falling over time due to sluggish world demand

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[17] If the prices of men's shirts in Australia, the US and Hong Kong are compared since the early 1980s, Australian prices have fallen substantially relative to Hong Kong prices, but only marginally so when compared with US prices. While tariff reductions may have forced the exit of high-cost firms from the Australian clothing industry during the 1980s, the predominant reason why Australian prices have improved relative to Hong Kong's is probably because rapid technological growth in Hong Kong's high-technology traded industries has driven up the aggregate wage rate and hence, worsened their competitiveness in sectors such as clothing, which are less technology intensive and more labour intensive.

and growing world supply of these products. While this may be less true these days, to the extent that the output of individual Australian manufacturing industries remains, on average, more resource-based than our foreign competitors, the same argument applies. In this case the downward trend in relative prices would not reflect an improvement in competitiveness at all.

There is little doubt that the latter three explanations are relevant for understanding the observed developments. Increases in wage rates in some of our trading partners can no doubt partially explain developments in the 'light' manufacturing industries such as the textile, clothing and footwear industries. That manufactured goods are differentiated can probably explain why relative prices across countries can deviate over short- to medium-term horizons. And, for a selection of these industries it is likely that goods produced in Australia are more resource-based than goods produced in other countries. Overall, however, it seems unlikely that these explanations are sufficient to explain the fairly widespread trends observed across the manufacturing sector over the past 25 years.

To assess the relative importance of the first two factors, we examine their differential implications for trade shares and compare these with actual developments. Assuming domestic industries have some market power,[18] having an exogenous depreciation of the real exchange rate is equivalent to conferring on domestic tradeable industries an outward shift in the demand curve they face. This is because the increase in foreign prices relative to domestic prices (in domestic currency terms) should lead consumers to switch their demand from foreign to domestically sourced goods. Across industries, falls in relative prices would thus be expected to be correlated with reductions in import shares.

Increased international competition, by contrast, drives a fall in the real exchange rate facing the domestic industry by forcing a reduction in the price at which goods are sold in the domestic market place. For domestic producers to survive, they are forced to either lower margins and/or improve their use of available technology. High-cost domestic producers who cannot restructure their operations are priced out of the market and exit from the industry. The initial impact of an increase in international competition is thus to increase the import share, as high-cost domestic

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[18] As long as domestically produced goods are not perfect substitutes for foreign produced goods, the demand curve faced by domestic industries would be expected to be downward sloping.

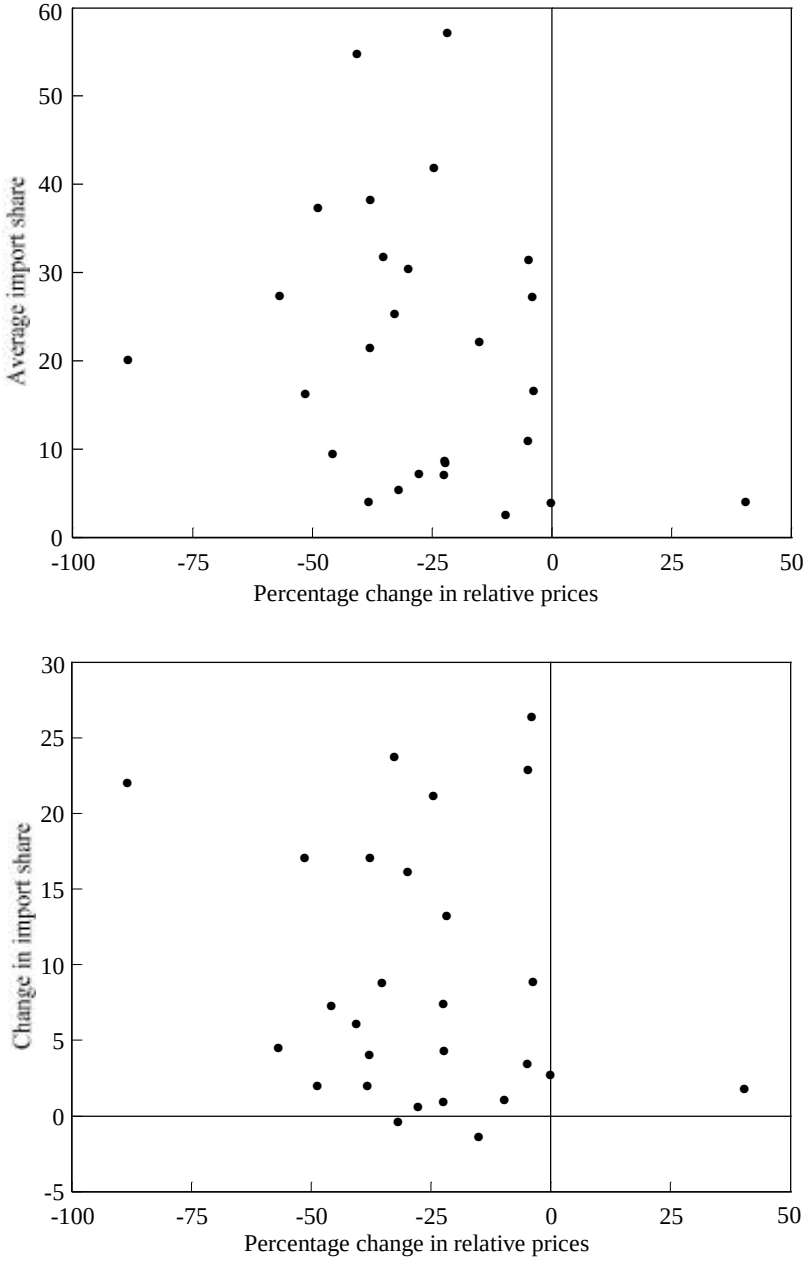
products are replaced with imports. To the extent that the restructured domestic industry subsequently improves its competitive position *vis-à-vis* foreign producers, the increased import share could be partially unwound.

Figure 2 shows scatter plots, by industry, of changes in relative prices against average levels of, and changes in, import shares. These show that at an industry level there is very little evidence that changes in relative prices and import shares are positively related; in only 3 of the 27 industries are changes in relative prices and changes in import share of the same sign. Combined with the fact that the domestic import-competing sector has, if anything, been declining over time, these results suggest that it is not simply an exogenous depreciation of the exchange rate which has caused these changes in relative prices.

While Figure 2 is suggestive of a negative association between relative price changes and openness, these data do not show that industries which have opened up the most have enjoyed *significantly* larger falls in relative prices. Even after controlling for the relative levels of concentration in the industry, and allowing

Figure 2: Relative Prices and Openness by Industry

1969 to 1994



concentration to interact with trade exposure, a significant negative correlation between relative price movements and trade exposure could not be found.[19] This may suggest that to uncover the cross-industry relationship between relative price

[19] Several studies, see for example, Bloch (1974) and Levinsohn (1993), argue that it is not trade exposure on its own, but the interaction between trade exposure and concentration in the industry which is crucial. This makes sense; if a domestic industry was highly competitive before increasing its trade exposure, the disciplinary effect of increasing its trade exposure would be expected to be limited.

changes and trade exposure it is necessary to control for other product-specific factors and market-structure indicators, including those additional factors discussed above.[20]

3.3 Changes in Price Setting Behaviour over Time

The above analysis suggests that there has been a widespread fall in Australian prices relative to foreign prices across the tradeable industries since the late 1960s. In this section, we provide a preliminary investigation of whether a structural change in price setting behaviour has occurred with the opening up of the economy. In particular, we examine whether across the manufacturing sector there has been a greater tendency for domestic prices to move with foreign prices in the later years of our sample, as would be expected if internationalisation has changed the price setting behaviour of domestic producers.[21]

To explore this issue, we examine whether the price ratio series we derived in Equation (1) are stationary. Identifying stationarity in a series which is subject to substantial and persistent relative price shocks, however, can be difficult. This is especially the case in small samples, where short-term relative price shocks may obscure longer-term trends. To partially overcome these problems, we follow the approach adopted in Wu (1996) and take advantage of the panel-data set to increase the power of the tests for stationarity. This approach involves pooling the price ratio series for the 27 industries, and testing the null hypothesis that each series contains a unit root against the alternative that the series are jointly stationary.

We assume a fixed-effects model, and allow the intercept to vary across industries to incorporate industry-specific effects. Our model is thus:

$$R_{i,t} = \alpha_i + \rho R_{i,t-1} + u_{i,t} \qquad (2)$$

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[20] Controlling explicitly for changes in quantitative restrictions may also be important, since the application of quantitative restrictions, rather than tariffs, generally provides more protection for the domestic industry from foreign competitors.

[21] In effect this involves testing a necessary, but not sufficient, condition for the law of one price to hold.

where $R_{i,t}$ is the price ratio, defined in Equation (1), of industry *i* in period *t*, α_i is the industry-specific effect, and $u_{i,t}$ the idiosyncratic disturbance.[22] Under the null hypothesis that the relative price series are non-stationary, the coefficient ρ will equal unity. If this is rejected, and ρ is significantly less than unity, it suggests that the relative price terms are jointly stationary and hence that domestic and foreign prices are linked together over time.

The results are presented in Table 2. They show that over the full sample period, the estimate of ρ is very high, at 0.85, suggesting that shocks to the relative price series are long-lived. The test statistics imply that the null hypothesis of non-stationarity cannot be rejected, and hence, that relative prices have not exhibited mean reversion over the full sample, a result which is consistent with casual observation of Figure 1.

Table 2: Augmented Dickey-Fuller Tests

	1969–1994	1969–1978	1978–1986	1986–1994
Estimate of ρ	0.85	0.40	0.35	0.15
	(0.02)	(0.09)	(0.13)	(0.09)
	[0.65]	[0.45]	[0.96]	[0.00]

Notes: Standard errors are presented in parentheses ( ), p-values are in brackets [ ].
The finite-sample distributions of the test statistics for ρ are estimated using Monte Carlo simulations calibrated to the sample.[23]

[22] Rather than estimate Equation (2) with its numerous dummy variables, the industry-specific effects can be removed from the data by subtracting from each observation its industry mean. An augmented Dickey-Fuller test can then be used to test the stationarity of the transformed data by estimating the following equation:

$$\Delta \tilde{R}_{i,t} = (r-1)\tilde{R}_{i,t-1} + \sum_{j=1}^{J} b_j \Delta \tilde{R}_{i,t-j} + \tilde{u}_{i,t} \qquad (3)$$

where $\tilde{R}_{i,t} = R_{i,t} - \frac{1}{T}\sum_{t=1}^{T} R_{i,t}$. The equations are estimated with two lags to correct for possible serial correlation over a two-year period. Similar results are obtained if time-specific, in addition to industry-specific, effects are allowed for.

[23] For the full sample period, this involves generating 27 synthetic data series, each a random-walk time series with 26 periods. Values of t_ρ are obtained by pooling the series and using them to estimate Equation (4). This process is repeated ten thousand times to produce the empirical distribution of the test statistic. To generate the distribution of t_ρ for the smaller sub-periods, the same process was used but with random-walk series of 10 and 9 periods.

Splitting the sample into three sub-periods, these estimates suggest that domestic prices have been more closely aligned with foreign prices in recent years than earlier. The second last column of Table 2 shows that relative prices were most unstable in the middle sample period, when non-stationarity of the relative price series can be rejected at all conventional significance levels. For the sample period from 1986 to 1994, by contrast, the estimate of *?* is relatively low at around 0.15, and critical values imply that the null hypothesis of non-stationarity can be rejected at a 1 per cent significance level.[24]

These results thus provide some econometric evidence that there was a realignment of relative prices in Australia during the 1970s and 1980s, and that for the past decade or so, there has been more of a tendency for domestic prices to respond to foreign prices.[25] The latter issue is investigated further in Section 4.

4. Openness and the Dynamic Response of Domestic Prices to Changes in Import Prices

There are two main channels through which changes in imported goods prices affect the domestic price level. Both of these are likely to be affected by openness.

Changes in import prices affect the domestic price level *directly* through the prices of imported final goods which are consumed in the economy.[26] The importance of

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[24] Rolling regression estimates through the sample period, using a fixed 10 year window, show that there were periods in the early 1970s in which relative prices were also stable. This is somewhat puzzling. It is probably explained by the fact that the nominal exchange rate appreciation which occurred in 1973 was substantial, but was reversed relatively rapidly. Since domestic and foreign price levels moved similarly over this period, the real exchange rate exhibits a reasonable degree of 'mean reversion' due to the nature of the exchange rate shocks which occurred.

[25] We regard these results as indicative of the changes which have been taking place. However, due to the characteristics of our data set, we rely more on their qualitative, rather than their precise quantitative, information. For example, the UNIDO data are collected from individual country sources, and since not all countries collect data on a calendar year basis we cannot be confident that measurement error due to timing issues has been avoided.

[26] Dwyer and Lam (1994) examine the relationship between the over-the-docks (wholesale) price of imports and the retail price. They find that changes in wholesale import prices are fully passed through to retail import prices, though taking into account domestic add-on costs, the retail import price moves by around two thirds of the change in the wholesale price.

this channel clearly depends on the share of imported goods in the bundle of goods consumed domestically. As discussed in Gruen and Sheutrim (1994), if increasing the openness of the economy leads to a higher proportion of imported goods in the consumption bundle, it should also lead to a commensurate increase in the impact that a given change in the price of imported goods (or, similarly, a change in the exchange rate) has on the aggregate inflation rate.

Changes in import prices also affect the domestic price level *indirectly* through the prices set for domestically produced goods. This occurs in two ways. First, to the extent that domestic industries use imported intermediate inputs in production, increases in import prices may be passed on to domestic prices. Second, since relative prices matter, domestic price setters in import-competing industries may be sensitive to import prices. The degree of sensitivity of domestic price setters to import prices depends on the substitutability of goods and the openness of markets. While most tradeable goods are not perfect substitutes for each other, opening up the economy should nonetheless deepen the market for categories of goods which have similar attributes, and should increase the sensitivity of domestic price setters to changes in the prices of their imported substitutes.

In this section we focus on the *indirect* channel through which import prices affect the domestic price level and examine how it depends on the degree of openness of the economy. We start by examining the different aggregate responses of domestically produced tradeable and non-tradeable goods prices to changes in import prices. We then turn to more disaggregated industry-level data on the prices of domestically produced import-competing goods to identify the role of openness in this relationship.

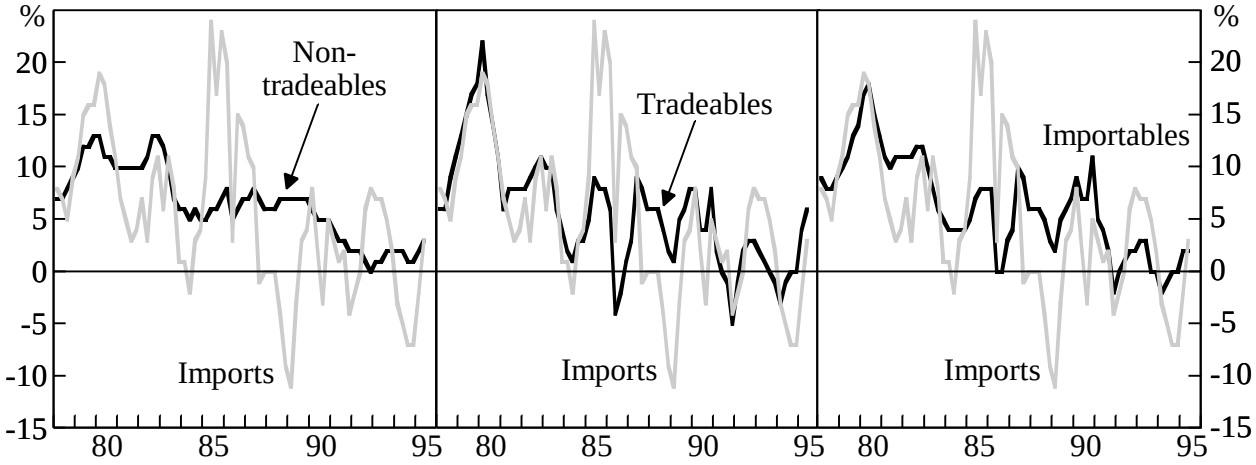
4.1 Tradeable and Non-tradeable Goods Prices and Import Prices

An initial assessment of the impact that changes in openness may have on price-setting behaviour can be made by comparing the responses to changes in import prices of domestic industries which primarily produce traded goods with those which primarily produce non-traded goods. Prices in both types of industries would be expected to respond to import prices to the extent that intermediate imported goods are used in production. Given that tradeable goods are presumably closer substitutes with the imported goods, however, their sensitivity to changes in imported goods prices would be expected to be greater.

To examine the response of domestic producer prices to import prices, we make use of producer price indices recently published by the ABS for the non-tradeable, tradeable and importable sectors of the domestic economy.[27] Year-ended changes in these indices are shown along with changes in import prices in Figure 3. This figure illustrates that tradeable and importable prices move more closely with imported prices than do non-tradeable prices, though common long-term trends are evident for all three series.

Figure 3: Prices of Domestically Produced Goods and Import Prices

Year-ended percentage change



To examine these relationships more rigorously, we estimate an error-correction model for each sector, and on the basis of this, derive both the elasticity of domestic prices with respect to import prices in each sector and the speed of response of domestic prices to a shock to import prices. That is, for each sector we estimate a model of the following form:

$$\Delta p_t = \lambda(\delta m_{t-1} - p_{t-1}) + \gamma + \sum_{i=1}^{I} \alpha_i \Delta p_{t-i} + \sum_{i=0}^{I} \beta_i \Delta m_{t-i} + u_t \qquad (4)$$

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[27] These indices have been compiled by Johnson (1996), broadly following the methodology developed in Dwyer (1990,1992). Industries are classified as tradeable if either their import share or their export share is greater than 10 per cent and are classified as importable if their import share is greater than 10 per cent. For this study we use the chained tornqvist indices calculated by Johnson.

where p_t is the price of the domestically produced good in a sector, m_t is the price of imported goods and all prices are expressed in logs.[28] The following results are based on the most parsimonious equations estimated using a general-to-specific modelling strategy using up to eight lags on the first difference terms.

In this exercise, we have not taken into account the way any variables other than import prices affect domestic prices. This is because we want to capture the total impact that changes in import prices have on domestic prices. Changes in costs may reflect changes in import prices to the extent that costs include the prices of imported intermediate inputs and to the extent that there are some components of costs, in particular wages or productivity, which may vary in response to changes in the international environment. We wish to attribute these indirect effects to the total impact of changes in import prices.

This approach will overstate the influence of import prices, however, to the extent that imported goods prices are endogenous to changes in other costs in the domestic economy. For example, a positive wages shock would be expected to lead to an exchange rate depreciation and hence, an increase in imported goods prices. The long-run response of domestic prices (both tradeable and non-tradeable) to import prices, will thus in part reflect the fact that, in history, the exchange rate has responded to such exogenous inflationary shocks.

A summary of the results from these regressions is presented in Table 3. For each sector, this table shows the estimated long-run elasticity (d) and speed-of-adjustment coefficient (l) over three sample periods.

Over the full sample period, these results suggest that the long-run responses of the non-tradeable and importable sectors to a change in import prices are high; they are both insignificantly different from 1 at a one per cent level of significance. The long-run response of all tradeable prices to import prices is lower, presumably reflecting the different composition of our importable and exportable sectors and the understandably lower response of exportable prices to import prices.

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[28] The price of imported goods is measured by the implicit price deflator for imported goods.

Table 3: Sectoral Responses to Import Prices[(a)]

Sector	1977:Q1–1995:Q2		1977:Q1–1989:Q2		1984:Q2–1995:Q2	
	Long-run elasticity	Speed of adjustment	Long-run elasticity	Speed of adjustment	Long-run elasticity	Speed of adjustment
Non-tradeables	0.85 (0.08)	0.05 (0.01)	0.84 (0.07)	0.05 (0.01)	0.93 (0.11)	0.04 (0.01)
Tradeables	0.72 (0.05)	0.12 (0.02)	0.67 (0.04)	0.14 (0.03)	0.76 (0.08)	0.11 (0.03)
Importables	0.87 (0.07)	0.08 (0.02)	0.80 (0.05)	0.10 (0.03)	0.96 (0.14)	0.07 (0.02)
Joint significance of tradeables and non-tradeables[(b)]	2.74 [0.10]		5.96 [0.01]		2.04 [0.15]	

Notes: (a) These equations have been estimated within a SUR system to allow for cross-equation correlations in errors. Numbers in parentheses ( ) are standard errors. Numbers in brackets [ ] are p-values. For the long-run elasticity estimates, standard errors have been derived using a Bewley transformation.

(b) Chi-squared test of the cross-equation restriction that the non-tradeables and tradeables coefficient estimates are equal. The p-value gives the level of significance at which one can reject the null hypothesis.

These sectors differ more markedly from each other, however, in the speed of adjustment to disequilibrium between imported and domestic prices. Prices in the tradeables sector respond over twice as rapidly as non-tradeable prices, and also somewhat faster than importables prices. One year after a shock to import prices, non-tradeable prices have made under 20 per cent of the total adjustment to the import price shock, while tradeable prices have adjusted by around 40 per cent. It is somewhat puzzling that importables respond less rapidly to a shock to import prices than exportables and importables taken together. This may reflect the fact that exchange rate shocks (which are the major source of shocks to import prices) are more quickly passed through to many of our export prices, because the bulk of our exports are homogeneous commodities whose prices are essentially set on world markets. The importable sector, in contrast, comprises a larger proportion of differentiated goods, which do not tend to be as sensitive, over the short term, to a divergence between the prices of imported and domestically produced items.

Since the degree of import penetration has increased over the past two decades, a further assessment of the impact of openness on price setting behaviour can be made by examining these relationships over two sub-samples. The results of this exercise, reported in the second two panels in Table 3, are somewhat mixed. The speed of

response of domestic tradeable prices to import prices does not appear to have increased over the two sample periods, and although the long-run response of domestic prices to import prices has increased in each of the sectors, standard errors on the estimates for the second sample period are sufficiently large to preclude any strong conclusions being drawn.

In summary, given that the tradeable sector is by definition more open than the non-tradeable sector, these results provide evidence that openness increases the sensitivity of domestic prices to variations in world prices and the exchange rate.

4.2 Openness and Industry Level Responses to Import Prices

We now turn to disaggregated industry-level data for import-competing manufacturing industries to better discern the differential impact that openness may have within tradeable industries.

There has, to our knowledge, been no study which has examined at a disaggregated level the relationship between import prices and the prices set by domestic producers of import-competing goods in Australia since Gregory (1978). Gregory used disaggregated industry-level data over the period from 1970 to 1974 to assess how relative price changes across industries could be related to relative import price changes, relative cost changes and changes in the pattern of demand. He found that relative import price changes could not explain relative price changes; domestic producers appeared to adjust their market share rather than their price when faced with a change in the price of imports.[29]

In this section of the paper we examine the sensitivity of domestic producers of import-competing goods to the prices of their imported substitutes, using disaggregated data for the manufacturing industry.[30] For each of 30 industry groups,

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[29] For his central results, Gregory used a panel regression in which he restricted the response of domestic prices to import prices to be the same across industries. When he allowed some variation across industries based on the degree of import competition, he did find a significant positive response among the more open industries, although other explanators remained much more important for explaining movements in domestic prices.

[30] Industries were included if they had been import competing at some time during the sample period.

we match quarterly data on the prices of domestically produced goods and imported goods over the period from June 1983 to June 1995.

A preliminary look at the data, using simple correlation analysis, is provided in Table 4. This shows the contemporaneous correlation between quarterly percentage changes in import prices and domestic prices for each industry. These correlation coefficients have been averaged over all of the industries in a given group. The degree of international exposure of each industry is measured by the import share, and for the purposes of this table, the industries have been divided into three roughly even sized groups.

Table 4: Correlation between Quarterly Changes in Import Prices and Domestic Prices[(a)]

	All industries	Degree of international exposure[(b)]		
		Low	Medium	High
1983:Q3–1995:Q2	0.18	0.10	0.19	0.25
1983:Q3–1989:Q2	0.13	0.02	0.15	0.23
1989:Q3–1995:Q2	0.19	0.13	0.17	0.26

Notes: (a) Simple averages of the correlation between quarterly percentage changes in imported and domestically produced goods prices in each industry.
(b) Based on the average level of the import share over the period 1983–1992. 'Low' industries have an import share less than 20 per cent, 'medium' industries have an import share between 20 and 39 per cent, and 'high' industries have an import share above 39 per cent.

This table suggests that the correlation between import price changes and domestic price changes is positively related to the degree of international exposure of the industry; those industries which have higher import shares also have a consistently higher correlation between changes in import prices and changes in domestic prices. Across all industries and each sub-group of industries, the average correlation has also been higher over the second half of the sample than the first half. Given that the degree of international exposure has increased in all but three of the industries we examined, this is also suggestive of a positive relationship between openness and the sensitivity of domestic producers to import prices.

The average correlation coefficients quoted above, however, are relatively small. In part, this is because this analysis only captures the contemporaneous correlation

between the two series and is thus an incomplete description of the underlying relationship.

To look more comprehensively at these relationships, we estimate error-correction models for each industry, using the same structure as Equation (4).[31] Estimates of the long-run elasticities of domestic prices to import prices within each industry are presented in Table 5.[32] This shows that for 27 of the 30 industries, the long-run elasticity estimates are significantly greater than zero, and for 21 of these industries, the elasticities are significantly less than one. That these elasticities are significant, but less than one, is consistent with the results in Table 3. It is also consistent with the conclusion from Table 1 that domestic prices have been increasing less rapidly than foreign prices in many manufacturing industries. For these 27 industries, the estimated elasticities range between 0.33 and 1.15, and average 0.67.

Table 5 also presents estimates of the speed-of-adjustment coefficient for each industry. These are significant in all but 6 industries, suggesting that domestic and imported goods prices are linked together over the long-run. The coefficient estimates are, however, relatively low, ranging between 0.02 and 0.13, suggesting that there can be substantial deviations from this long-run relationship through time.[33] Interestingly, the speed-of-adjustment coefficients presented in Table 5 are substantially lower than those presented in Table 3 for the tradeables industries, though they are close to those presented for the importables industries. This may

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[31] All import price series are tariff adjusted using the average duty rates series compiled from ABS data. For further details on data sources and series construction, see Appendix C. There is little difference between the results obtained using tariff-adjusted and unadjusted data.

[32] The results presented and discussed here are estimated using the seemingly unrelated regression (SUR) technique. Applying this technique improves the precision of the coefficient estimates by taking into account the correlation of errors across equations. Estimates based on OLS regressions are similar, and are presented in Appendix B.

[33] On average, these coefficients imply that only half of the response of domestic prices to a shock to import prices takes place in two and a half years.

Table 5: Industry Estimates of Long-run Import Price Elasticity and Speed of Adjustment[(a)]

Industry	Long-run elasticity		Speed of adjustment	
	Point estimate	t-statistic	Point estimate	t-statistic
Fruit and vegetables	0.36	1.89	0.016	2.77
Margarines, oils and fats	-0.04	-0.47	0.025	0.82
Alcohol	0.61	11.99	0.044	3.71
Textiles	0.86	15.29	0.083	6.38
Clothing	0.81	4.08	0.019	3.49
Footwear	0.62	7.66	0.037	3.07
Sawmill products	0.63	30.01	0.105	2.77
Woodboards, veneers and joinery	0.77	12.85	0.052	4.14
Furniture and mattresses	0.62	5.41	0.030	4.39
Pulp, paper and paperboard	0.89	10.38	0.032	1.16
Chemical fertilisers	-0.35	-3.39	0.035	2.28
Basic chemicals	0.77	17.90	0.041	0.98
Pharmaceutical and veterinary products; pesticides	0.45	3.56	0.027	3.38
Cosmetics and toilet preparations	0.44	9.80	0.050	1.71
Petroleum and coal products	0.63	15.98	0.090	1.29
Glass and glass products	0.43	11.82	0.069	2.77
Clay products	0.35	6.02	0.018	2.86
Structural products, sheet metal	0.55	9.47	0.042	3.92
Motor vehicles and parts	0.64	18.88	0.059	4.82
Photographic, professional and scientific equipment	0.33	11.62	0.126	2.56
Electronic equipment	0.55	6.65	0.040	1.34
Refrigerators, household	0.65	6.65	0.056	4.33
Electrical equipment n.e.c.	1.15	6.42	0.031	3.09
Agricultural machinery[(b)]	1.15	4.32	0.072	3.59
Construction machinery	0.98	12.28	0.078	2.87
Machinery and equipment n.e.c.	0.44	11.22	0.055	3.02
Leather products	0.65	12.43	0.105	2.34
Rubber products	0.96	12.76	0.061	4.55
Signs, advert displays; writing equipment	0.99	19.38	0.098	5.29
Manufacturing n.e.c.	0.65	9.56	0.067	3.10

Notes: (a) Estimated by SUR. The industries (excluding agricultural machinery) were divided into three groups, and each group was estimated as a system. The distribution of the t-statistics on the speed-of-adjustment coefficients are between a standard normal and Dickey-Fuller distributions. The distribution of t-statistics on the long-run elasticity estimates (derived using a Bewley transformation) are standard.

(b) Estimated by OLS.

be because, at a disaggregated level, industry-specific factors are more important, making the underlying relationship harder to identify.[34]

The wide range of estimated elasticities across industries may reflect a number of factors. It may reflect the fact that some industries are more open than others, and hence, are more sensitive to changes in import prices. Alternatively, it may reflect the fact that the data are not sufficiently disaggregated, and the composition of the domestically produced goods vary significantly from the goods which are imported. In this case, one would not expect the domestic price series to respond fully to changes in import prices even if the law of one price held. Finally, it may reflect a tendency towards price stickiness on the part of some groups of domestic producers, and suggest that producers are still prepared to concede market share to imports when the price of imports fall.

To examine the role of openness in driving the differential results across industries, we examine the relationship between the estimated elasticities and the industry import shares. Figure 4 suggests that there is little relationship between the degree of openness of an industry, as measured by the import share, and the elasticities; econometric estimation confirms this.[35]

The relationship between the speed-of-adjustment coefficients and the degree of openness of the industries is presented in Figure 5. This figure shows a much clearer positive relationship. A regression of the industry speed-of-adjustment

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[34] Measurement error in the disaggregated data could also bias the speed-of-adjustment coefficient estimates toward zero. To the extent that these errors are uncorrelated across industries, they would be smaller in the aggregated data.

[35] The cross-section regression results are as follows: $lre_i = \underset{(3.93)}{0.48} + \underset{(1.22)}{0.004}\, open_i$, where lre_i is the long-run elasticity estimate for industry i, $open_i$ is the import share for industry i, and t-statistics are presented in parentheses. If this cross-section regression is restricted to those industries in which a significant long-run relationship between domestic and imported prices is found, the results are essentially unchanged. We attempted to control for the concentration of the industry by including either the concentration of the industry, or the interaction between concentration and openness, however these explanators were insignificant.

Figure 4: Import Price Elasticities and Openness

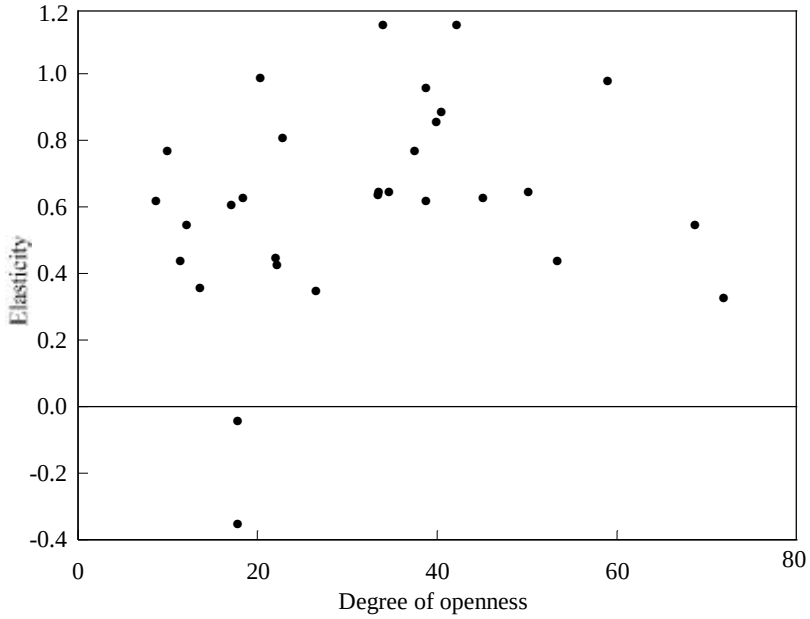
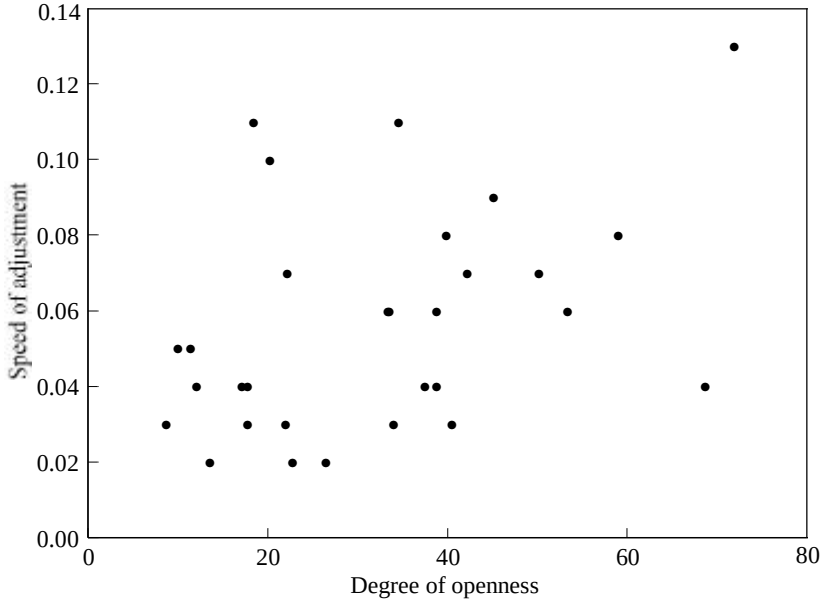


Figure 5: Speed of Adjustment and Openness



estimates against the degree of openness of the industry finds that this relationship is significant.[36]

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[36] The cross-section regression results are as follows: $adj_i = \underset{(3.17)}{0.033} + \underset{(2.35)}{0.0007}\, open_i$, where adj_i is the coefficient on the error-correction term (or speed-of-adjustment coefficient) for industry *i*, $open_i$ is the import share for industry *i*, and t-statistics are presented in parentheses. This

Our interpretation of the combined elasticity and speed-of-adjustment results is as follows. For a given degree of openness of an industry, the long-run response of domestic prices to import prices reflects the composition and substitutability of domestically produced and imported goods. The more open the industry, however, the faster domestic price setters will respond to any change in the price of the imported goods with which they compete. More open industries thus do appear to be more sensitive to the prices of foreign-produced substitute goods, in the sense that they respond more rapidly to a change in the price of these goods than do less open industries.[37]

5. Conclusions

This paper provides a number of pieces of evidence on how pricing behaviour has changed in Australia over the past three decades. The analysis presented in the paper is not conclusive, but suggests that internationalisation of the Australian economy may have been an important driver of these changes.

First, we take a long-term perspective and examine changes in the relative prices charged by Australian producers compared with foreign producers (expressed in a common currency) in different manufacturing industries. Over the 25 years between 1969 and 1994, we find that these relative prices fell in most manufacturing industries. Since this was a period during which the international exposure of Australia's manufacturing sector increased considerably, it is likely that, by increasing competitive pressures, internationalisation was partially responsible for this reduction in prices and costs.

Second, we find some evidence that domestic and foreign prices have been more closely linked since the mid 1980s than during the 1970s and early 1980s,

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relationship is stronger if only industries in which a significant long-run relationship between domestic and import prices exists are included. Controlling for the different concentration ratios across industries makes little difference to the results.

[37] We examined whether the responsiveness of domestic prices to import price changed over the sample period by splitting the sample into two, and comparing both the long-run elasticities and speed of adjustment across sample periods. The shorter sample periods substantially reduced the statistical significance of the estimates, however, precluding any conclusions being drawn.

suggesting that domestic price setting has become more sensitive to foreign prices over time. Across the manufacturing sector, we also find clear evidence that domestic price setters are more sensitive to import prices in more open industries.

These results imply that the dynamics of inflation may well have changed with the process of internationalisation. They suggest that, in the short-run, domestic inflation is becoming increasingly sensitive to shocks to foreign prices and the exchange rate. Previous work has established the direct effect that changes in import prices have on consumer prices, and has noted that this effect increases as imports make up a larger share of the consumption basket. This paper suggests that the indirect effect of changes in import prices on consumption prices also increases as the economy opens up, as the prices of domestically produced goods, especially traded goods, become increasingly sensitive to imported goods prices.

While the inflation rate is ultimately determined by monetary policy, this paper suggests that the process of internationalisation may have provided some disinflationary pressure over the last couple of decades and has likely changed the dynamics of inflation, particularly by increasing the importance of the exchange rate in determining short-run inflation outcomes.

Appendix A: Relative Prices – Industrial Countries

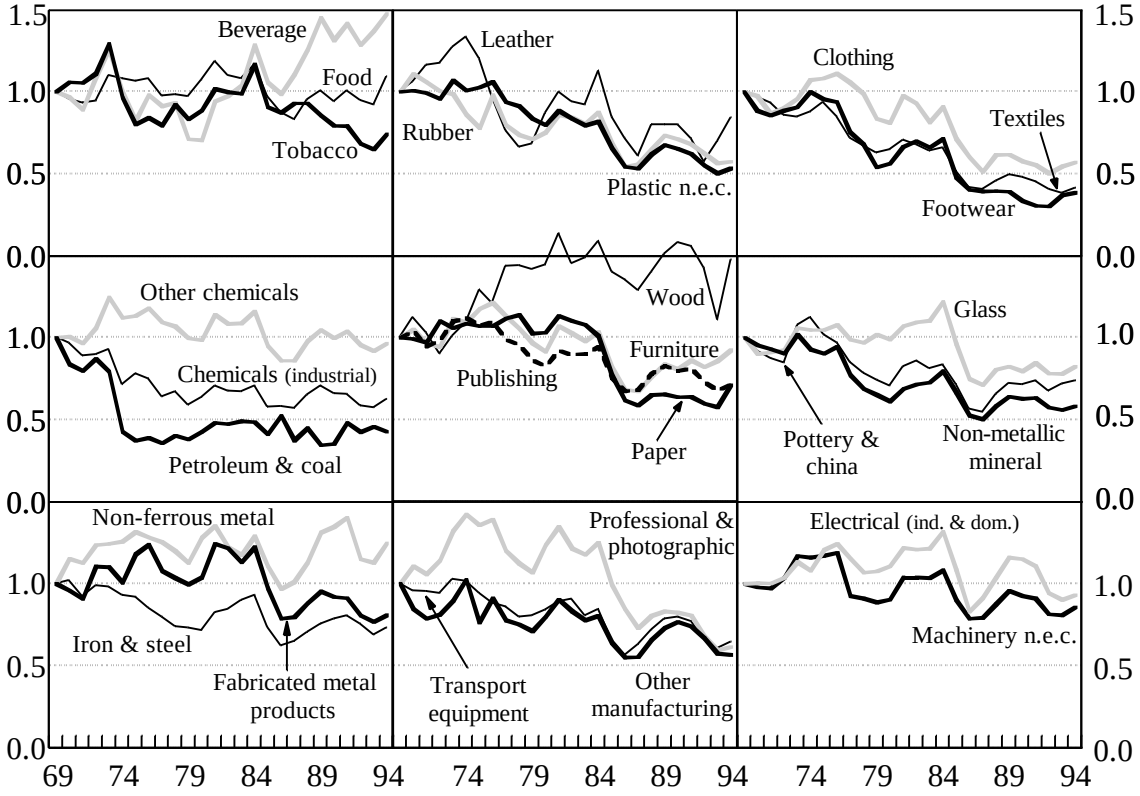
To check whether our results in Section 3 are materially affected by unreliable data from developing countries, we calculate price ratios using only the industrialised countries (Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, the UK and the US) in our sample. Data corresponding to Figure 1 and Table 1 are presented below. As can be seen, overall results are little changed when the developing countries are excluded.

Table A1: Changes in Relative Prices by Industry

Number of industries for which relative prices have:	1969/72 to 1991/94	1969/72 to 1980/83	1980/83 to 1991/94
Decreased	21	12	21
Increased	2	7	1
Unchanged	4	8	5

Note: Based on percentage changes in the relative prices presented in Figure A1. Industries are classified as 'unchanged' if the relative price change is less than 10 per cent in either direction.

Figure A1: Relative Prices – Industrial Countries Only



Appendix B: OLS Estimates of Industry Level Responses to Import Prices

Table B1: Industry Estimates of Long-run Import Price Elasticity and Speed of Adjustment[(a)]

Industry	Long-run elasticity		Speed of adjustment	
	Point estimate	t-statistic	Point estimate	t-statistic
Fruit and vegetables	-1.52	-1.42	0.016	2.52
Margarines, oils and fats	2.08	0.94	0.026	1.03
Alcohol	0.72	4.50	0.043	3.02
Textiles	0.82	8.50	0.079	4.68
Clothing	1.13	1.36	0.019	3.14
Footwear	-0.19	-0.39	0.034	2.34
Sawmill products	0.67	12.04	0.116	2.77
Woodboards, veneers and joinery	0.56	3.43	0.049	3.52
Furniture and mattresses	0.59	2.25	0.038	4.77
Pulp, paper and paperboard	1.21	1.44	-0.018	-0.61
Chemical fertilisers	-0.73	-0.94	0.027	1.83
Basic chemicals	0.45	0.91	0.048	0.96
Pharmaceutical and veterinary products; pesticides	0.61	0.82	0.018	2.05
Cosmetics and toilet preparations	0.39	1.28	0.052	1.63
Petroleum and coal products	0.73	2.83	0.136	1.68
Glass and glass products	0.51	4.39	0.081	2.71
Clay products	0.38	2.00	0.020	2.82
Structural products, sheet metal	0.79	2.90	0.031	2.11
Motor vehicles and parts	0.68	6.05	0.039	2.53
Photographic, professional and scientific equipment	0.49	3.87	0.128	2.24
Electronic equipment	0.67	1.91	0.054	1.71
Refrigerators, household	0.83	5.27	0.062	4.53
Electrical equipment n.e.c.	0.49	0.67	0.025	2.28
Agricultural machinery	1.15	4.32	0.072	3.59
Construction machinery	0.90	4.31	0.084	2.77
Machinery and equipment n.e.c.	0.36	2.83	0.058	3.00
Leather products	0.74	3.26	0.088	1.71
Rubber products	0.73	3.25	0.062	3.68
Signs, advert displays; writing equipment	0.87	9.45	0.112	5.32
Manufacturing n.e.c.	0.37	1.15	0.057	2.34

Note: (a) Estimated in single equations using OLS. The distribution of the t-statistics on the speed-of-adjustment coefficients are between a standard normal and Dickey-Fuller distributions. The distribution of t-statistics on the long-run elasticity estimates (derived using a Bewley transformation) are standard.

Appendix C: Data Sources and Description

C.1 Section 3 Data Sources

C.1.1 Price ratio

The price ratio is calculated:

$$R_{i,t} = \frac{p_{i,t}}{p^*_{i,t}(1+tariff_{i,t})} \qquad \text{(C1)}$$

where $p_{i,t}$ is the Australian price index, $p^*_{i,t}$ the weighted-average foreign price index in Australian dollars, and $tariff_{i,t}$ the average tariff rate, for ISIC class *i* in period *t*.

Australian data – price indices

Annual data from 1969 to 1994 are calculated by splicing UNIDO data for the period up to 1976 to ABS data for 1975/76 to 1993/94. Data are disaggregated into 27 three-digit ISIC classes within the manufacturing sector. See Table C1 for a list of the classes and a concordance between ISIC classes (according to which UNIDO data are classified) and IOCC classes (according to which ABS data are classified).

UNIDO price indices are calculated for each industry by dividing the nominal gross output series by the index of industrial production.

The UNIDO data are adjusted for: the 1990 series break for ISIC class 353 (petroleum refineries) which has been attributed to a change in the accounting practices of the petroleum industry; and for the fact that industrial production data for most industries appear to have been allocated to a year earlier than they should have been. Two classes, ISIC 353 (petroleum refineries) and 354 (miscellaneous products of petroleum and coal) are combined by summing their nominal gross output series; the industrial index series provided is common to the two classes.

ABS producer price indices for the period 1975/76 to 1993/94 were supplied for 109 input-output industries, based on the Australian input-output classification code

(IOCC). These data are unpublished. IOCC classes are aggregated, where necessary, into ISIC classes by weighting together individual indices using shares of gross product from 1989/90 input-output tables. Annual averages of quarterly data are calculated.

Sources: UNIDO Industrial database; ABS unpublished data; ABS Cat. No. 5209.0

Australian data – average tariffs

Total duty paid on imports as a proportion of the total value of imports is used as a measure of average tariffs. Three- and four-digit ASIC data on duty paid and value of imports are matched with ISIC classes using concordances in Table C1. Tariffs in 1993/94 were set equal to the previous year's value as the tariff data only extend to 1992/93.

Source: Industry Commission (1995)

Foreign data – price indices

Foreign price data for fifteen of Australia's top trading partners are used. Countries included are: Canada, France, (West) Germany, Indonesia, Italy, Japan, Korea, Malaysia, the Netherlands, New Zealand, Singapore, Sweden, Taiwan, the UK and the US. After 1990, the German data relate only to the former West Germany. The foreign country data are provided on a calendar year basis.

For each industry in each country, a price index for 1969 to 1994 is constructed from UNIDO data by dividing the nominal gross output by the index of industrial production. These indices are converted into Australian dollars using bilateral exchange rates (see below). To obtain a single foreign price index, the individual

country indices expressed in Australian dollars are chain-weighted together using the formula:

$$p^*_{i,t} = p^*_{i,t-1} \cdot \sum_c w_{c,i,t-1} \cdot \frac{p_{c,i,t}}{p_{c,i,t-1}} \qquad \text{for } t = 2, 3,\ldots \qquad \text{(C2)}$$

where

$$p^*_{i,1} = 100 . \sum_c w_{c,i,0} \cdot \frac{p_{c,i,1}}{p_{c,i,0}} \qquad \text{(C3)}$$

and $p_{c,i,t}$ is the price index, in Australian dollars, of country *c* for industry *i* in time *t*; and $w_{c,i,t}$ is country *c*'s weight for industry *i* in time *t*.

Foreign country weights for each ISIC class are five year moving averages of each country's share of exports in that ISIC class to Australia. The export data are supplied by UNIDO, and are only available for 1970 to 1994. As such, the weights for 1969 to 1974 are fixed at the 1974 moving average value, subject to normalisation for missing price data.

The foreign price data are also adjusted for breaks in the nominal gross output series for the Netherlands (in 1981) and the UK (in 1992).

Source: UNIDO Industrial database

Foreign data – exchange rates

For all countries except Taiwan, average bilateral exchange rates for each year are calculated by averaging IFS monthly average exchange rates. To match the UNIDO data, for all countries except New Zealand, the exchange rate is calculated for the calendar year; for New Zealand the fiscal year is used. The Taiwanese exchange rate is taken from *Monthly Bulletin of Statistics* for 1969 to 1973 and *Financial Statistics* for 1974 to 1994.

Sources: IMF *International Financial Statistics*; *Monthly Bulletin of Statistics,* the Republic of China, (produced by the Directorate-General of Budget, Accounting and Statistics); and *Financial Statistics*, Taiwan District, the Republic of China.

C.1.2 Import share

Measured by the ratio of world exports to Australia as a proportion of total supply of the good:

$$\frac{X^*_{t,i}}{X^*_{t,i} + Q_{t,i}} \tag{C4}$$

where $X^*_{t,i}$ is world exports to Australia of goods from industry *i* in year *t*, and $Q_{t,i}$ is the Australian gross output of industry *i*, in year *t*.

Source: UNIDO Industrial database

C.1.3 Concentration measures

The concentration of each ISIC class is measured by a Herfindahl index calculated for 1987/88:

$$I = \sum_i N_i . \left(\frac{T_i}{N_i T_T} \right)^2 \tag{C5}$$

where N_i is the number of firms in the *i*th enterprise group, T_i is the combined turnover of firms in the *i*th enterprise group, and T_T is the total turnover of all firms in the ISIC class. The ABS data, grouped by ASIC class, are concorded to ISIC classes using concordances in Table C1.

Source: ABS Cat. No. 8207.0

C.2 Section 4 Data Sources

C.2.1 Aggregated data

Tradeables and non-tradeables producer price indices

Chained tornqvist indices of tradeable, importable and non-tradeable producer prices, presented in Johnson (1996). An industry is defined as tradeable if either its import share or export share is greater than 10 per cent.

Source: ABS unpublished data

Import prices

Implicit price deflator of total imports, f.o.b.

Source: ABS Cat. No. 5302.0

C.2.2 Disaggregated data

Australian domestic prices

Quarterly domestic prices obtained from the ABS for 109 input-output industries. These are aggregated to match the import data for 30 import-competing industries. See Table C2 for a list of the industries included and concordance between IOCC and SITC classifications. Shares of gross product from 1989/90 input-output tables are used to weight producer price series together where required.

Sources: ABS unpublished data; ABS Cat. No. 5209.0

Import prices

Quarterly import price indices at two- and three-digit SITC levels obtained from the ABS. For some categories, these are aggregated to match the domestic price data (see Table C2). Proportions of the value of imports for 1988/89–1989/90 are used to weight import price indices together where required.

Source: ABS unpublished data; ABS Cat. No. 5426.0, Table 2

Import share

As defined in C.1.2 above. Ratios are constructed from three- and four-digit ASIC data, aggregated to match the domestic price series using concordances in Table C2.

Source: Industry Commission (1995)

Tariffs

Quarterly duty and import data for March 1983 to June 1996 are provided by the ABS at the four-digit ASIC level. These are aggregated to match the industry breakdown using concordances in Table C2.

Source: ABS unpublished data

Table C1: Concordance: ISIC, ASIC and IOCC

ISIC title	ISIC class	ASIC codes	IOCC
Food manufacturing	311, 312	211, 2, 3, 4, 5, 6, 7	2101, 2, 3, 4, 5, 6, 7, 8
Beverage industries	313	218	2109–2111
Tobacco	314	219	2201
Textiles	321	234, 235, 244	2301, 2, 3, 4, 5, 6, 7, 2401
Wearing apparel excluding footwear	322	245	2402
Leather, leather products, leather substitutes and fur, excluding footwear and clothing	323	345	3401
Footwear, excluding rubber or plastic footwear	324	246	2403
Wood and wood and cork, excluding furniture	331	253	2501, 2, 3
Furniture and fixtures, except metal	332	254	2504
Paper and paper products	341	263	2601, 2, 3
Printing, publishing and allied industries	342	264	2604, 5
Industrial chemicals	351	275, 2764	2701, 2
Other chemical products	352	276 less 2764	2703, 4, 5, 6, 7
Petroleum refineries	353	277	2708
Miscellaneous products of petroleum and coal	354	278	2708
Rubber products	355	346	3402
Plastic products n.e.c.	356	347	3403
Pottery, china and earthenware	361	2 864	2802 (part)
Glass and glass products	362	285	2801
Other non-metallic mineral products	369	286 (less 2864), 287, 288	2802, 3, 4, 5, 6
Iron and steel basic industries	371	294	2901
Non-ferrous metal basic industries	372	295, 296	2902
Fabricated metal products, except machinery and equipment	381	31	3101, 2, 3
Machinery, except electrical	382	336, 3352	3305, 6, 7
Electrical machinery apparatus, appliances and supplies	383	335 (less 3352), 3233	3302, 3, 4
Transport equipment	384	32 less 3233	3201, 2, 3, 4
Professional, scientific, measuring and controlling equipment n.e.c. and photographic and optical goods	385	334, 3481	3301
Other manufacturing industries	390	348 less 3481	3404, 5

Table C2: Concordance: IOCC, ASIC and STIC

Input-output classification	IOCC code	ASIC code	SITC classification	SITC code
Fruit and vegetables	2103	213	Vegetables and fruit	05
Margarines, oils and fats	2104	214	Misc. edible products	09
			Animal oils and fats	41
			Vegetable oils and fats	42
Alcohol	2110, 2111	2186, 7, 8, 9	Alcoholic beverages	112
Textiles	2301, 2, 3,4, 5, 6, 7	234, 235	Textile fibres and wastes	26
			Textile yarn, fabrics	65
Clothing (including knitting)	2401, 2	244, 245	Articles of apparel	84
Footwear	2403	246	Footwear	85
Sawmill products	2501	2531, 2, 6, 7	Wood, simply worked	248
Woodboards, veneers and joinery products	2502, 3	2533, 4, 5, 8	Cork and wood manufactures	63
Furniture and mattresses	2504	254	Furniture, bedding, mattresses	82
Pulp, paper and paperboard	2601	2631	Pulp and waste paper	251
			Paper and paperboard	641
Chemical fertilisers	2701	2751	Fertilisers	56
Basic chemicals	2702	2752, 3, 4, 5	Organic chemicals	51
			Inorganic chemicals	52
			Synthetic rubber	232
Pharmaceutical and veterinary products; pesticides	2704	2763, 2764	Medicinal and pharmaceutical products	54
			Insecticides, fungicides etc.	591
Cosmetics and toilet preparations	2706	2766	Perfumery, cosmetics or toilet preparations	553
Petroleum and coal products	2708	277, 278	Coal, coke and briquettes	32
			Petroleum, petroleum products	33
Glass and glass products	2801	285	Glass	664
			Glassware	665
Clay products	2802	286	Clay construction materials	662
Structural products, sheet metal products & metal products n.e.c.	3101, 2, 3	314, 315, 316	Manufactures of metal n.e.s.	69
Motor vehicles and parts	3201	323	Road vehicles and parts	78
Photographic, professional and scientific equipment	3301	334	Photographic apparatus and equipment	881
			Photographic supplies	882
			Professional, measuring equipment	87

Table C2: Concordance: IOCC, ASIC and STIC *(continued)*

Input-output classification	IOCC code	ASIC code	SITC classification	SITC code
Electronic equipment	3302	3351, 2	Telecommunications and sound equipment	76
			Office machines	751
Refrigerators, household appliances, and water heating systems	3303	3353, 4	Household electrical and non-electrical equipment	775
Electrical equipment n.e.c.	3304	3355, 6, 7	Equipment for distributing electricity	773
			Electrical machinery and apparatus	778
Agricultural machinery	3305	3361	Agricultural machinery and parts	721
			Tractors	722
Construction machinery	3306	3362, 3	Civil engineering and contractors' plant and equipment	723
Machinery and equipment n.e.c.	3307	3364, 5, 6, 7, 8, 9	Textile and leather machinery	724
			Paper mill machinery	725
			Printing machinery	726
			Food processing machinery	727
			Other machinery and equipment	728
			Metal working machinery	73
			Industrial machinery n.e.s.	74
Leather products	3401	345	Leather and leather manufactures	61
Rubber products	3402	346	Rubber manufactures n.e.c.	62
Signs & advertising displays; writing and marking equipment	3404	3484, 6	Printed matter	892
			Stationary supplies n.e.s.	895
Manufacturing n.e.c.	3405	3481, 2, 3, 5, 7	Optical goods	884
			Watches and clocks	885
			Sports equipment	894
			Jewellery	897
			Misc. manufactured materials	899

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