# EXPLAINING IMPORT PRICE INFLATION:
# A RECENT HISTORY OF SECOND STAGE PASS-THROUGH

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# ABSTRACT

This paper examines the pass-through of exchange rate changes to the domestic prices of imported consumer goods. Two distinct stages can be identified in the adjustment process. First, changes in the exchange rate are passed on to changes in the prices of imports over the docks. Second, these prices are, in turn, passed on to final retail import prices. It is found that pass-through in the first stage is rapid and complete. In the second stage, pass-through is also complete. It is, however, rather slow as importers appear able to vary their mark-ups substantially and for considerable periods of time. Moreover, the sizeable domestic costs involved in the distribution and sale of imports imply that a proportional change in the price of imports over the docks does not lead to the same proportional change in the retail import price, but rather one that is equal to the share of the imported item in the total bundle of costs faced by importers.

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# EXPLAINING IMPORT PRICE INFLATION: A RECENT HISTORY OF SECOND STAGE PASS-THROUGH

## Jacqueline Dwyer and Ricky Lam

## 1. INTRODUCTION

A recent puzzle to emerge in the analysis of inflation in Australia, and indeed elsewhere, is the failure of changes in import prices to alter inflation outcomes despite significant exchange rate movements and increases in import penetration. Following an episode of substantial currency depreciation in the early 1990s, there has been only a small increase in the contribution of retail import prices to inflation. And yet, pass-through of exchange rate changes to import prices recorded over the docks is completed quite rapidly.[1] Given that such "first stage pass-through" is rapid, the lack of inflationary pressure invites an examination of the next stage of price adjustment as imports are distributed to local markets. The responsiveness of the retail import price to changes in the import price over the docks is described here as "second stage pass-through". Understanding this stage of price adjustment is important when assessing the direct inflationary pressures that accompany exchange rate movements.[2]

The main purpose of this paper is to explore the dynamics of adjustment of retail import prices to changes in the exchange rate. This requires estimation of both first and second stage pass-through. Consequently, an attempt will be made to estimate pass-through from the exchange rate to the price of consumption imports over the docks and, in turn, from these prices to those at the retail level. Particular attention will be paid to differences in both the extent and timing of these price adjustments at each stage. Possible reasons for observed differences in pricing behaviour at the second stage will be discussed.

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[1] See Phillips (1988) and, for a more recent example, Dwyer, Kent and Pease (1993).

[2] Currency depreciation also has an indirect effect on inflation (via the cost of imported inputs, inflationary expectations and their attendant pressure on wages). These indirect effects may be substantial but are not addressed in the present paper. For an investigation of the full impact of import price changes on inflation see de Brouwer, Ericsson and Flood (1994).

The retail import is, in effect, a different good to that which lands at the dock. In the process of distribution and sale, value added is contributed by the non-traded goods sector. In consequence, its price should not be expected to move by the same proportion as the price of the imported component, but by a proportion equal to the *share* of the imported component in total unit costs. In other words, what constitutes complete pass-through at the second stage entails a proportional change in the retail import price that is less than that in the price of the import over the docks.

The paper is organised as follows. In Section 2, recent trends in exchange rates and import prices are discussed. In Section 3, a simple analytical framework is presented which forms the basis of estimation. In Section 4, features of the data required for estimation are discussed. Estimation and results are presented in Sections 5 and 6. In Section 7 the implications of the results are discussed and, finally, conclusions are drawn.

## 2. RECENT TRENDS IN IMPORT PRICES

Popular expectations had been that the substantial currency depreciation of the early 1990s would be translated into higher retail prices of imports and, thereby, higher inflation in the short term.[3] This expectation was influenced by past experience, in particular that of the mid-1980s depreciation (Stevens 1992). Inflationary pressure from higher import prices also seemed probable, if not inevitable, given the evidence that first stage pass-through is completed quite rapidly.[4]

First stage pass-through is illustrated informally in the first panel of Figure 1, which shows annual changes in the trade-weighted exchange rate (expressed in Australian dollars per unit of foreign currency) and an over-the-docks price for consumption

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[3] In the long run, however, it is generally accepted that inflation is governed by the stance of monetary policy.

[4] For example, Dwyer *et al.* (1993) found that within one year, an exchange rate change was almost fully reflected in the price of imports over the docks. In fact, the bulk of the price adjustment occurred within two quarters.

imports (which is measured "free on board").[5]  Clearly, movements in the exchange rate and free-on-board import prices are nearly identical.

**Figure 1: Changes in the Exchange Rate and Consumption Import Prices**
**(year ended percentage change)**
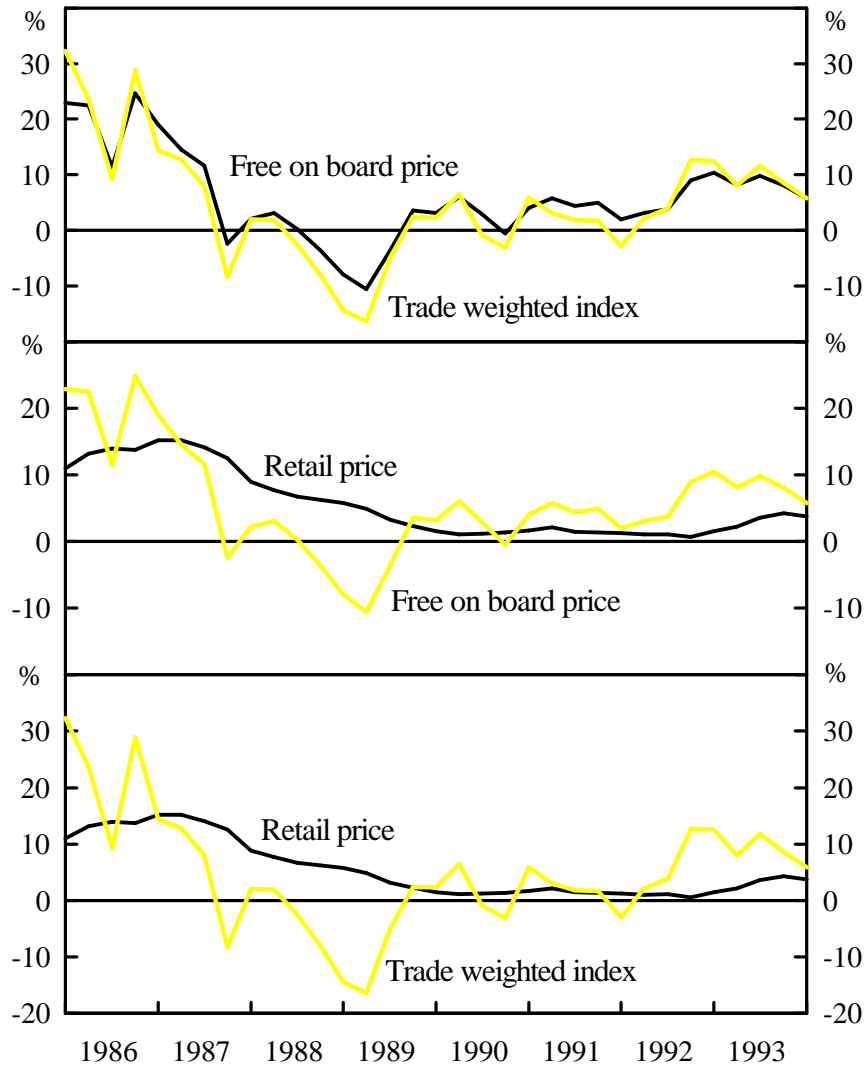


However, second stage pass-through appears much less complete, or at least much slower.  From the next panel of the figure, it can be seen that movements in the retail price of consumption imports are *less than* those for the free-on-board price.[6]

[5]  The exchange rate is the Reserve Bank's trade weighted index (TWI) inverted so that a rise in the index represents depreciation.  The free-on-board price is the consumption goods component of the Australian Bureau of Statistic's import price index.

[6]  The retail price of imports is represented by "items wholly or predominantly imported" in the regimen of the consumer price index.

In particular, decreases in free-on-board prices do not necessarily lead to lower retail import prices.

Finally, the third panel of Figure 1 depicts combined pass-through. By dint of the price adjustment at the second stage, the correlation between changes in the retail price of imports and the exchange rate is quite weak.

Clearly, the transmission of exchange rate changes to final prices has been diffused. Consequently, an important aim of this paper is to quantify differences in the nature of pass-through at the first and second stage. We do this by extending the work of Dwyer *et al.* (1993). The conceptual framework for our analysis is outlined below.

## 3.  ANALYTICAL FRAMEWORK

In essence, exchange rate pass-through is an application of the law of one price.[7] In its absolute form, the law states that the price of a traded good (for our purposes an import) will be the same in both the domestic and foreign economies, when expressed in a common currency.[8] The law can be written as follows:

$$p = p^* e \tag{1}$$

where $p$ is the domestic price of the import, $p^*$ is its corresponding world price, and $e$ is the exchange rate (in units of domestic currency per unit of foreign currency). Departures from the law occur when, for a given world price of an import, proportional changes in its domestic price are not identical to those in the exchange rate.

A pass-through relationship can now be expressed in terms of the law of one price. However, the purpose of this paper is to distinguish between first and second stage pass-through. The law will be adapted in two main respects. Import prices will be chosen that are appropriate for the stage of price adjustment. A mark-up model will

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[7]  Menon (1991a) provides a detailed discussion of the relationship between the law of one price and exchange rate pass-through.

[8]  In its relative form the law allows for a wedge factor of transactions cost. If, however, these costs are constant, both the relative and absolute forms of the law will be equivalent when expressed in log linear form or in proportional changes.

also be invoked so that a given price comprises a domestic cost component, *C*, and a mark-up, *1* .[9]

Consider first stage pass-through. It is defined as the elasticity of the domestic over-the-docks import price with respect to the exchange rate. Consequently, the domestic price is now defined as a free-on-board import price, *P*. We commence with the simple expression:

$$\textit{first stage} \qquad\qquad P = P^* e \qquad\qquad (2)$$

First stage pass-through is complete when a change in the exchange rate is not associated with a change in the world price so that:

$$\frac{dP \,/\, P}{de \,/\, e} = 1 \qquad\qquad (3)$$

Thus, in the limit, all of a change in the exchange rate can be passed on to a change in the import price over the docks. For a small open economy that is a price taker in world markets, pass-through is expected to be complete.[10] However, if the economy is not a price taker, foreigners may adjust the foreign currency price of the import following an exchange rate change. Consequently, if one allows for the foreign import price to embody a mark-up (so that $P^* = C^* 1^*$), it is apparent that, at given costs, foreign suppliers can elect to offset the effects of depreciation on *P* by lowering their mark-up so that pass-through is incomplete.[11]

Second stage pass-through is defined as the elasticity of a retail import price with respect to an over-the-docks import price. Now let the domestic import price be defined as a final retail price, *R*. Employing a simple mark-up model, this price will be determined by the total costs faced by the distributor and a mark-up, where total

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[9] See, for example, Mann (1986) and Hooper and Mann (1989).

[10] Specifically, import price pass-through will approach unity the lower is the price elasticity of demand for imports or the higher is the price elasticity of supply (Spitäller 1980; Bureau of Industry Economics 1987). For a small open economy that faces perfect elasticity of supply, foreigners will not adjust the foreign currency price of the import following a change in the exchange rate so that pass-through will be complete.

[11] Incomplete pass-through introduces issues in pricing to market when the exchange rate changes. For a survey of a series of models (dynamic and static) that seek to explain the microeconomics of pricing to market, see Krugman (1986).

costs comprise the cost of the import itself and the cost of domestic inputs used in the process of distributing and selling the import. Thus second stage pass-through can be expressed as:

*second stage* $$R = P^a C^{(1-a)} I \qquad (4)$$

where $a$ represents the share of the import in total costs.[12]

Although, the full increase in $P$ (and indeed $C$) will be passed on to $R$, the *proportional* change will be less than unity because the imported good is only one element in the bundle of costs faced by the retailer.[13] Thus second stage pass-through is complete when changes in $P$ do not lead to changes in the importers' mark-up so that:

$$\frac{dR / R}{dP / P} = a \qquad (5)$$

In other words, complete pass-through is defined by the share of the imported item in the total cost faced by the retailer. Again, however, retailers of an import can, at given costs, elect to offset the effects of an increase in $P$ by lowering their mark-up so that second stage pass-through is incomplete.

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[12] This formulation assumes a standard Cobb-Douglas production function which allows for a unitary elasticity of substitution between the import and domestic inputs. It might be argued that it is inappropriate to assume that the import and domestic inputs are substitutable. For example, the retailer of an imported television is not able to substitute additional labour for one less television and sell the same output. Leontief production technology in which inputs are employed in fixed proportions (regardless of their price) may be more appropriate. Other more flexible production functions could be considered (such as a constant elasticity of substitution or a translog production function). However, such functions are less tractable econometrically and their long-run properties are less transparent. Consequently, we adopted the Cobb-Douglas formulation but recognise the limitations of assuming a unitary substitution elasticity.

[13] However, the pass-through of a proportional change in *total* costs will be unity (since the cost shares sum to unity).

These first and second stages can now be combined to trace the full impact of an exchange rate change on the retail price of an import:

$$\textit{combined} \qquad\qquad R = [C^* I^* e]^a \, C^{(1-a)} I \qquad\qquad (6)$$

As shown in equation (6), the effect of an exchange rate change on the final retail price of an import can be diffused through three main channels: the size of $a$; variations in the mark-up by foreign suppliers; and variations in the mark-up of local distributors.  While understanding the circumstances under which mark-ups are altered requires recourse to dynamic models of imperfect competition, ultimately, the extent and speed of exchange rate pass-through is an empirical question.  In this respect, Krugman (1986) argues that what is needed is not more theory but more data to identify these relationships empirically.

The above equations form the basis of a simple model for testing first and second stage pass-through.  However, before discussing the functional form and estimation technique to be employed, some of the data challenges involved in measuring pass-through are discussed.

## 4.    THE DATA

There have been a number of practical investigations of first stage pass-through in Australia.[14]   However, there has been little investigation of second stage pass-through in Australia, and indeed elsewhere.[15]   Data constraints, in particular with respect to costs and margins, have been the key factor inhibiting empirical research.  In this paper, an attempt has been made to overcome some of these constraints.  The data to be used in estimation are listed below, with a comment on the way in which they have been derived.  For further details and sources see Appendix 1.

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[14] See Dwyer *et al.* (1993), Menon (1991b, 1991c, 1992a and 1992b), Lattimore (1989), Phillips (1988), Coppel, Simes and Horn (1987) and Richards and Stevens (1987).

[15] One of the first attempts was by Andrew and Dollery (1990).  However, they do not actually isolate the second stage of price adjustment.  Instead, they look at the *combined* pass-through of a change in the exchange rate to the retail price of Australian passenger motor vehicles.

$R$ a retail price of consumption imports.

$P$ free-on-board price of consumer imports.

$P_L$ a landed price of consumer imports (defined here as inclusive of tariffs but exclusive of international freight).

$W$ an index of world prices of consumption imports, with weights proportional to imports of consumer goods from the 17 largest suppliers to Australia.

$E$ a nominal trade-weighted exchange rate, (expressed in Australian dollars per unit of foreign currency) with weights proportional to shares of consumption imports, as in $W$.

$C$ an index of costs faced by domestic retailers of imports (unit labour costs, domestic transport, international freight and "other" payments) with weights proportional to each item's share of total costs; taxes on international freight are excluded.

$T$ an index of (1+ average tariff), where the average tariff is equal to taxes on international trade divided by the value of merchandise imports.

Central to our investigation is the retail price of imports, $R$. The final retail price of imports is typically represented by "items wholly or predominantly imported" contained in the CPI. However, this series is only available from the December quarter 1984, imposing constraints on econometric estimation of the pass-through relationship. A proxy for this series was constructed and spliced with the actual series. These additional observations permit estimation of the dynamics of pass-through to retail import prices during the depreciation of the mid 1980s as well as more recent episodes of major exchange rate movement.

Since final retail import prices are of consumption imports, all other variables to be used in estimation relate to such goods. A free-on-board price of consumption imports, $P$, was used. A published series is available for the period since the September quarter 1982. For observations prior to this date a series was constructed by removing commodity groups from the Australian Bureau of Statistic's import price index that are not predominantly of consumption goods. A landed

price for consumption imports, $P_L$, was also constructed by accounting for the average rate of duty paid.

Similarly, an index was constructed to represent the world price of Australia's consumption imports, $W$. A weighted average of the foreign currency price of consumption exports from Australia's major trading partners was used. $W$ is based on the world price index constructed by Richards and Stevens (1987), but is adapted to include the prices and volumes of consumption goods.

A nominal effective exchange rate was defined, $E$. Typically, the weight given to a country in an effective exchange rate is proportional to its total trade with the domestic economy. However, for investigating pass-through of exchange rate changes to the price of consumption imports, weights should be proportional to import shares of such goods.[16]

Finally, an index of domestic costs was constructed, $C$. Costs other than *ad valorem* taxes on international trade were compiled into a composite index of domestic costs. Domestic costs for which data were available include unit labour costs, international freight, domestic transport costs and "other" expenses; they were assumed to comprise total domestic costs. An attempt was made to apportion these domestic costs according to their share in retailers' total costs.[17] Certainly, $C$ does not represent all of the domestic costs incurred in bringing an import to a retail outlet. However, those items excluded (such as property rental and charges for utilities), fluctuate less frequently. In consequence, major changes in costs faced by importers are likely to be captured by movements in $C$.

In the following sections, these data will be employed to investigate first and second stage pass-through.

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[16] Whilst, in principle, the choice of trade weight matters, for practical purposes there is little difference between an effective exchange rate based on shares of consumption imports compared with aggregate imports (see Appendix 1). In other exercises, however, the choice of trade weight does matter. See, for example, Dwyer *et al.* (1993, pp. 10-11).

[17] Various census and survey information about the retail industry permits identification of the contribution of key costs items to the final retail *price* of an import. With a few simplifying assumptions, the corresponding shares of retailers' total *costs* can be inferred. Details of this apportionment are described in Appendix 1.

## 5.    ESTIMATING THE FIRST STAGE OF PRICE ADJUSTMENT

Recent investigations of exchange rate pass-through have employed an econometric method that combines the concepts of cointegration and error correction.[18]  Given that the data to be used in estimation are non-stationary, cointegration techniques will also be employed here.[19]

In brief, if two series are non-stationary, but a linear combination of them is a stationary process, they are said to be cointegrated (Engle and Granger 1987). Importantly, cointegration provides a framework with which to model the long-run equilibrium of an economic system.  Furthermore, the presence of a cointegrating relationship implies the existence of an error-correction equation that can describe the short-run dynamics of adjustment towards equilibrium.  This is especially pertinent to the examination of pass-through where we wish to identify the long-run relationship (about which economic theory provides strong priors) and the dynamics of adjustment (about which theory can provide little advice).

In this paper, an unrestricted error-correction model (UECM) is used.  This one-step procedure is simple and transparent.  The efficiency of the estimates of the long-run relationship between variables is enhanced because these estimates are derived whilst taking account of the short-run dynamics.

To estimate first stage pass-through from the exchange rate to free-on-board import prices, we commence with a levels equivalent of equation (2) that allows for a constant so that:[20]

$$P = fE^b W^q \tag{7}$$

and represents the long-run relationship.  It can be re-expressed as a general linear kth-order autoregressive distributed lag (ADL) model and reparamaterised to form

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[18] Menon (1991b) was the first in the Australian pass-through literature to employ cointegration techniques.  See also examples by Heath (1991) and, more recently, Dwyer *et al.* (1993).

[19] Details of the time series properties of the data are reported in Appendix 2.

[20] Given that the law of one price is seldom observed to hold absolutely, by allowing for a constant, $f$, to represent a "wedge factor" of transactions costs, we can test whether the relative version of the law holds (Officer 1976).

an UECM. This permits isolation of information about the long-run relationship between the variables as well as their behaviour in the short run.

The general form of the UECM is:

$$\Delta p_t = a_0 + \sum_{i=1}^{k-1} a_{1i}\Delta p_{t-i} + \sum_{i=0}^{k-1} a_{2i}\Delta e_{t-i} + \sum_{i=0}^{k-1} a_{3i}\Delta w_{t-i}$$
$$+b_1 p_{t-1} + b_2 e_{t-1} + b_3 w_{t-1} + u_t \tag{8}$$

Variables expressed in lower case are logarithms. This model is initially estimated with k=5. Insignificant variables were eliminated, yielding the parsimonious error-correction model presented in Table 1.

## Table 1: First Stage - Unrestricted Error Correction Model
(estimated from 1971:2 to 1993:4)

| Independent variables | Regression coefficient | Standard error (t-statistic) |
|---|---|---|
| constant | -0.60 | 0.25 (-2.39)* |
| $\Delta e(t)$ | 0.64 | 0.04 (16.14)** |
| $\Delta e(t-1)$ | 0.20 | 0.04 (4.86)** |
| $\Delta e(t-2)$ | -0.22 | 0.07 (-3.04)** |
| $\Delta w(t-1)$ | 0.59 | 0.12 (5.06)** |
| $\Delta p(t-2)$ | 0.23 | 0.09 (2.64)* |
| $p(t-1)$ | -0.13 | 0.05 (-2.50) |
| $e(t-1)$ | 0.14 | 0.05 (2.55) |
| $w(t-1)$ | 0.13 | 0.06 (2.30) |
| | | |
| Long-run elasticities | | |
| $e$ | 1.01 | 0.067 (14.97)** |
| $w$ | 0.96 | 0.069 (13.84)** |

| Diagnostics | Test statistic | Significance |
|---|---|---|
| $H_O$: No cointegration | -2.49* | |
| $H_O$: $\boldsymbol{b}=1$ | 0.08 | |
| $H_O$: $\boldsymbol{q}=1$ | 0.62 | |
| Standard error of equation | 0.01 | |
| $\overline{R}^2$ | 0.83 | |
| LM(1) serial correlation | $\boldsymbol{c}^2(1)=1.79$ | 0.18 |
| LM(4) serial correlation | $\boldsymbol{c}^2(4)=5.38$ | 0.25 |

Notes:

(a)  * indicates significance at the 5 per cent level and ** at the 1 per cent level.

(b)  In the ECM, $t$-statistics for differenced terms are distributed standard $t$; the distribution of the coefficient on $p(t-1)$ lies somewhere between the Dickey-Fuller and $N(0, 1)$ distributions; the distributions of the other lagged levels are not known.

(c)  The test for cointegration is the significance of the error-correction term in a restricted error-correction model; this is also distributed between the Dickey-Fuller and $N(0,1)$ distributions.

(d)  $t$-statistics and hypothesis tests on the long-run elasticities are carried out using standard errors generated from the corresponding Bewley (1979) transformation.

## 5.1    The Long-Run Relationship

The existence of a long-run cointegrating relationship between the variables can now be examined. The significance of the lagged level of the dependent variable (the "speed of adjustment" parameter) has been proposed by Kremers, Ericsson and Dolado (1992) as a test of cointegration; the result for this test suggests that there is cointegration, although the precise distribution of the test statistic is not known.[21] Another test of cointegration involves testing the significance of the error-correction term, in a restricted error-correction model (RECM).[22]  This test is also reported and confirms the existence of cointegration.[23]

The nature of this relationship can be described by the long-run elasticities.  In Table 1, long-run elasticities are calculated as the ratio of the lagged level of the explanatory variables to the speed of adjustment parameter. This elasticity for the exchange rate is 1.01, which is not statistically different from unity and confirms that, in the long run, first stage pass-through is complete.  A similar result is found for the world price.  These results satisfy priors about Australia as a price taker in world markets and accord with earlier findings about first stage pass-through to the price of aggregate imports.[24]

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[21] The speed of adjustment parameter indicates how quickly the system returns to equilibrium after a random shock.  The distribution of the test statistic for this parameter is not known with certainty, but lies between the Dickey-Fuller distribution in the presence of a drift and the $N(0,1)$ distribution.  The observed test statistic falls between these two distributions at the 5 per cent level of significance.

[22] The residuals from the long-run relationship were identified.  A restricted error-correction model then specified changes in import prices as a function of these lagged residuals, and changes in the other variables.  Because the RECM was found to have an insignificant drift term, the test for cointegration is distributed between the Dickey-Fuller with no drift and $N(0,1)$ distributions.

[23] Kremers *et al.* (1992) demonstrate that testing the significance of the error-correction term is a more powerful test of cointegration than direct tests based on the residuals of the cointegrating relationship.  They also show that the coefficient on the error-correction term is parametrically equivalent to that on the speed of adjustment parameter.

[24] Full pass-through of the exchange rate and world prices to the domestic price of aggregate imports has been found by Phillips (1988) and Dwyer *et al.* (1993).

In the pass-through literature, it is implicitly assumed that movements in the exchange rate are exogenous. However, cointegration does not indicate causation; it establishes that a long-run relationship exists. It is conceivable that, in the long run, changes in the exchange rate are endogenous as they may stem from changes in domestic prices relative to those abroad. Thus establishment of a cointegrating relationship between the exchange rate and domestic import prices may merely indicate that, in the long run, purchasing power parity (PPP) holds. It is more likely, though, that differentials between *general* price levels in domestic and foreign economies drive exchange rate movements in the long run, rather than differentials in the prices of a particular class of goods.[25]

## 5.2    Short-Run Dynamics

If adjustment to an exchange rate change were instantaneous, import prices would follow their long-run equilibrium path exactly. As shown in Figure 2, actual prices deviate from their long-run equilibrium, although such departures are fairly small, both in their extent and duration. Typically, it appears that there is a return to the equilibrium path within one year. The speed with which prices adjust can be confirmed by the impulse response function derived from the unrestricted error-correction model. Figure 3, shows the estimated dynamic response of import prices to a 1 per cent depreciation. The free-on-board price of consumption imports responds rapidly to changes in the exchange rate. It is estimated to rise by about 0.64 per cent in the quarter in which the depreciation occurs, and by about 0.9 per cent by the fourth quarter. This profile of adjustment is broadly similar to that found for aggregate import prices at the first stage (Dwyer *et al.* 1993, pp. 14-15).[26]

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[25] Furthermore, the contemporaneous exchange rate and world price are exogenous to changes in the domestic import price, as shown in Appendix 3.

[26] In fact, the speed with which equilibrium is reached is further evidence that in our cointegrating relationship, exchange rate changes cause changes in domestic import prices. We would not expect that, over time horizons of only a few quarters, exchange rate movements are explained by differentials in the domestic and world price of imports; to the extent that PPP is observed to hold, it is observed over much longer time horizons. Rather, we would expect that changes in domestic import prices are being explained by exogenous swings in the exchange rate.

**Figure 2: Deviations from First Stage Equilibrium**
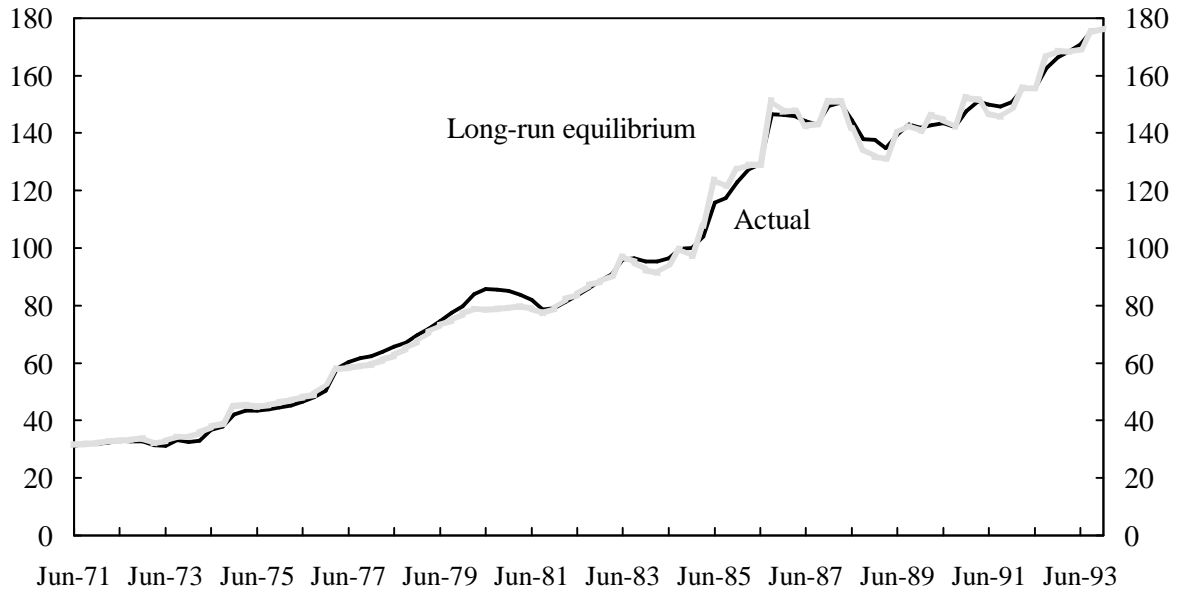


**Figure 3: First Stage Dynamics -
Exchange Rate Impulse Response Function**
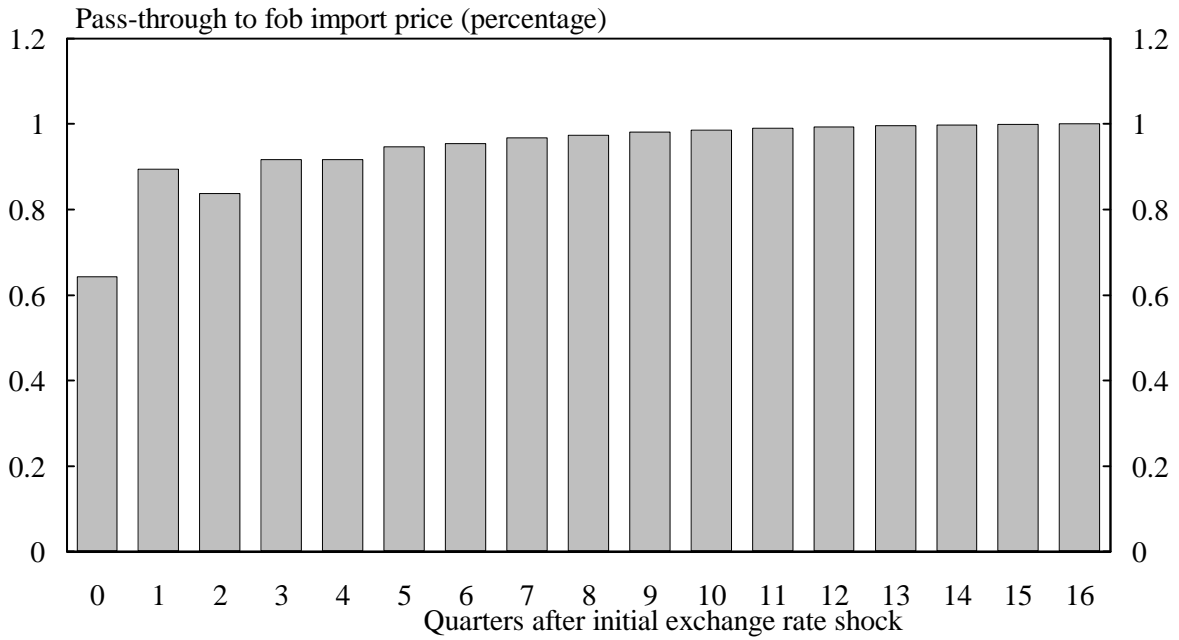
## 6. ESTIMATING THE SECOND STAGE OF PRICE ADJUSTMENT

Given that, at the first stage, pass-through of changes in the exchange rate is completed rapidly, of special interest is the nature of price adjustment at the second stage, as import prices over the docks are passed on to those at retail outlets. Here, our priors are for a significantly different profile of adjustment. To estimate second stage pass-through we commence with the following levels expression:

$$R = d P_L^a C^p \tag{9}$$

where $P_L = P \times T$ so that the retail price of an import is a function of the tariff-adjusted or landed price of the import and other domestic costs faced by the retailer.[27]

This levels expression is equivalent to equation (4) except that it does not constrain $p$ to equal $(1-a)$, and does not explicitly include a measure of the mark-up. Instead, in this empirical section, we work from the premise that the mark-up on costs is constant in the long run and so is represented by the constant term, $d$. Thus equation (9) describes a long-run relationship.

In the short run, however, we expect that the mark-up may vary and be an important explanator of retail import prices. Variation in the mark-up will be evident if short-run coefficients on $P_L$ and $C$ are less than their corresponding long-run coefficients. In fact, it will be especially evident if short-run coefficients also display asymmetry in the response of the retail price to changes in these explanators. However, in addition to the role played by changes in $P_L$ and $C$ in the short-run dynamics, we consider a role for those factors that, *a priori*, we expect to be related to the behaviour of the mark-up. One such factor is the output gap.

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[27] The tariff is not included in the index of domestic costs because *ad valorem* tariffs represent a *loading* on the free-on-board price. If all tariffs are *ad valorem*, then the elasticity of the exchange rate with respect to $P$ should be equal to that with respect to a price with a tariff loading. Hence equation (9) is equivalent to $R = d(P_L T)^a C^p$.

We consider a role for the output gap because when actual demand exceeds potential, and markets are imperfectly competitive, firms can increase their mark-up with little fear of loss of customers (Benabou 1992).[28] We also consider the possibility that, in the short run, the retail import price responds differently to changes in the landed import price during episodes of appreciation compared with depreciations (PSA 1989).

Again, we shall use an UECM to isolate the long-run relationship between the variables from their behaviour in the short run. An equation of the following general form is estimated:

$$\Delta r_t = a_0 + \sum_{i=1}^{k-1} a_{1i} \Delta r_{t-i} + \sum_{i=0}^{k-1} a_{2i} \Delta pl^A_{t-i} + \sum_{i=0}^{k-1} a_{3i} \Delta pl^D_{t-i} + \sum_{i=0}^{k-1} a_{4i} \Delta c_{t-i}$$
$$+ \sum_{i=0}^{k-1} a_{4i} GP + b_1 r_{t-1} + b_2 pl_{t-1} + b_3 c_{t-1} + e_t \tag{10}$$

where $GP$ is the level of the output gap and superscripts A and D denote episodes of appreciation and depreciation, respectively. As previously, variables expressed in lower case are logarithms. The results of this estimation are presented below in Table 2.

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[28] There is, however, considerable debate in the literature as to the relationship between mark-ups and the business cycle. Whilst Benabou (1992) argues that the relationship is procyclical, Stiglitz (1984) and Layard, Nickell and Jackman (1991) argue that it is counter-cyclical; they claim that, in the presence of imperfect competition, firms have a greater incentive to attract customers during episodes of strong demand (so that the mark-up falls), and to collude in pricing behaviour during recession (so that the mark-up increases). The empirical evidence is mixed (Layard *et al.* 1991, p. 340).

**Table 2: Second Stage - Unrestricted Error Correction Model**
(estimated from 1971:2 to 1993:4)

| Independent variables | Regression coefficient | Standard error (t-statistic) |
|---|---|---|
| $\Delta r(t-1)$ | 0.24 | 0.10 (2.34)* |
| $\Delta r(t-2)$ | 0.23 | 0.09 (2.48)* |
| $\Delta r(t-3)$ | -0.30 | 0.09 (-3.19)** |
| $\Delta r(t-4)$ | 0.43 | 0.09 (4.93)** |
| $\Delta pl^D(t)$ | 0.07 | 0.03 (2.20)* |
| $\Delta c(t)$ | 0.12 | 0.05 (2.70)** |
| $\Delta c(t-1)$ | 0.13 | 0.05 (2.72) ** |
| $r(t-1)-c(t-1)$ | -0.03 | 0.02 (-2.09) |
| $pl(t-1)-c(t-1)$ | 0.02 | 0.01 (1.79) |
| | | |
| Long-run elasticities | | |
| $pl$ | 0.66 | |
| $c$ | 0.34 | |

| Diagnostics | Test statistic | Significance |
|---|---|---|
| $H_O$: First degree homogeneity | $F(1,73)=0.04$ | |
| $H_O$: No cointegration | -2.23* | |
| Standard error of equation | 0.01 | |
| $\overline{R}^2$ | 0.72 | |
| LM(1) serial correlation | $c^2(1)=0.24$ | 0.62 |
| LM(4) serial correlation | $c^2(4)=2.54$ | 0.64 |

Notes:

(a)　The constant term was found to be insignificant and so has been removed.

(b)　* indicates significance at the 5 per cent level and ** at the 1 per cent level.

(c)　In the ECM, statistics for differenced terms are distributed standard *t*; the distribution of the lagged levels is not known.

(d)　Standard errors and *t*-statistics for the long-run elasticities could not be generated because of the imposition of first-degree homogeneity.

(e)　The test of first-degree homogeneity was carried out in the Bewley transformation.

## 6.1    The Long-Run Relationship

Equation 11 was first estimated as an UECM, with k=5.  Insignificant lags were then removed before the corresponding Bewley transformation was estimated.  The Bewley transformation provided standard errors which allowed the hypothesis of first degree homogeneity in equation (10) to be tested.  This hypothesis was accepted and is imposed in Table 2, so that $a + p = 1$.  The test of cointegration in the RECM suggests cointegration at a significance level of 5 per cent.  The long-run elasticities are calculated from the error-correction model; for a 1 per cent increase in the landed import price, the retail price is estimated to increase by 0.66 per cent, while for a 1 per cent increase in domestic costs, the retail price is estimated to increase by 0.34 per cent.

The results suggest that, of the total costs faced by local distributors of imports, 66 per cent is accounted for by the import itself and the remainder by aspects of its distribution and sale.[29]  Thus they lend support to the proposition made at the outset of the paper that the effect of an increase in the landed price of an import on its retail price is governed by the share of the imported item in the total costs.[30]  In other words, at the second stage, about 66 per cent pass-through may constitute full pass-through.

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[29] Predicated on the constant term in the estimating equation capturing a stationary mark-up in the long run.

[30] This estimate of the cost share is roughly consistent with the results published by the PSA (1989).  For more details see Appendix 1(f).  However, interpretation of these coefficients as costs shares has limitations.  An implication of the chosen functional form is that, with constant costs shares, a given increase in $R$ is the result of a corresponding increase in both $P_L$ and $C$.  We might not expect that because the price of an imported input has increased that the price of a domestic input will also increase, at least in the short run. Nonetheless, estimates of parameter stability suggest that the coefficients do, in fact, satisfy first degree homogeneity and remain stable over time.

## 6.2    Short-Run Dynamics

As previously, if the adjustment to a change in the landed price of an import were instantaneous, retail import prices would follow their long-run equilibrium path exactly. However, the short-run coefficients on price and cost variables reported in Table 2 are both clearly less than their long-run values. Furthermore, response to changes in $P_L$ is asymmetric whilst the output gap proves to be insignificant in the short-run dynamics. Consequently, the actual retail price deviates from its long-run equilibrium for lengthy periods, as shown in Figure 4.

The corollary of such a protracted departure from equilibrium is a gradual adjustment to any shock to the prices of imported or domestic inputs. This implies that the mark-up is also varied for considerable periods of time. Impulse response functions give an insight into the adjustment of retail import prices following a given shock, and permit us to make inferences about the effect of these shocks on the mark-up.

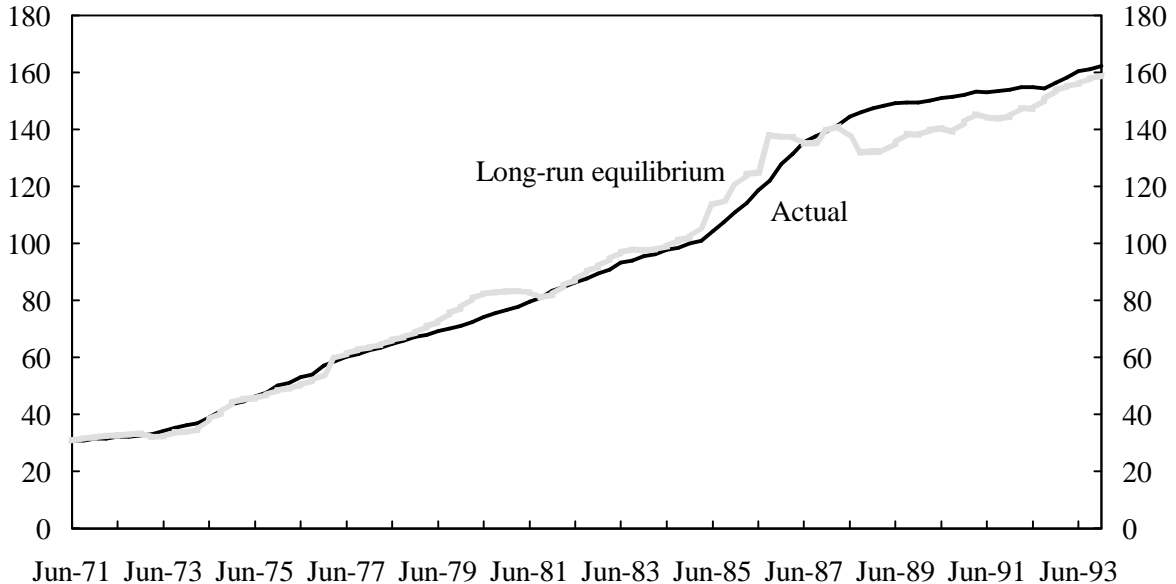**Figure 4: Deviations from Second Stage Equilibrium**



Figure 5 shows the estimated dynamic response of retail import prices to a 1 per cent change in the landed import price during episodes of appreciation and depreciation. Two key results emerge that have important implications for the mark-up. First, the pass-through of changes in the landed import price to changes in

the retail price is very slow. It takes about four years before most of the estimated long-run price effect is realised.[31] Such slow pass-through implies considerable variation and persistence in the mark-up.

Second, it appears that there is an asymmetry in the speed of response of retail import prices to changes in their landed price. Pass-through of changes in the landed price is slower during appreciations (when such prices fall) than during depreciations (when such prices rise). From this we can infer a corresponding asymmetry in the response of the mark-up to changes in the exchange rate; it increases more quickly during appreciations than it falls during depreciations.

Figure 6 shows the estimated dynamic response of retail import prices to a 1 per cent increase in the cost of domestic inputs. The profile of adjustment is different to that when the landed import price changes. Although a small speed of adjustment parameter ensures that it takes a long time to reach equilibrium, a sizeable proportion of a change in costs is passed on to retail import prices early in the adjustment process. Consequently, variations in the cost of domestic inputs have less influence on the importers' mark-up than changes in the landed import price. This suggests that distributors of imports may perceive changes in domestic costs to be permanent.[32] Changes in over-the-docks import prices, on the other hand, may be seen as transitory, especially given the extent to which they are driven by a volatile exchange rate.

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[31] In fact, this result is striking in its similarity to that found by de Brouwer *et al.* (1994) with respect to the speed of pass-through of aggregate import prices to a measure of the general price level.

[32] Certainly, it is plausible for them to think that an increase in unit labour costs is permanent, given the infrequency with which such costs fall. Unit labour costs comprise the largest share of the cost of domestic inputs.

**Figure 5: Second Stage Dynamics -
Import Price Impulse Response Function**
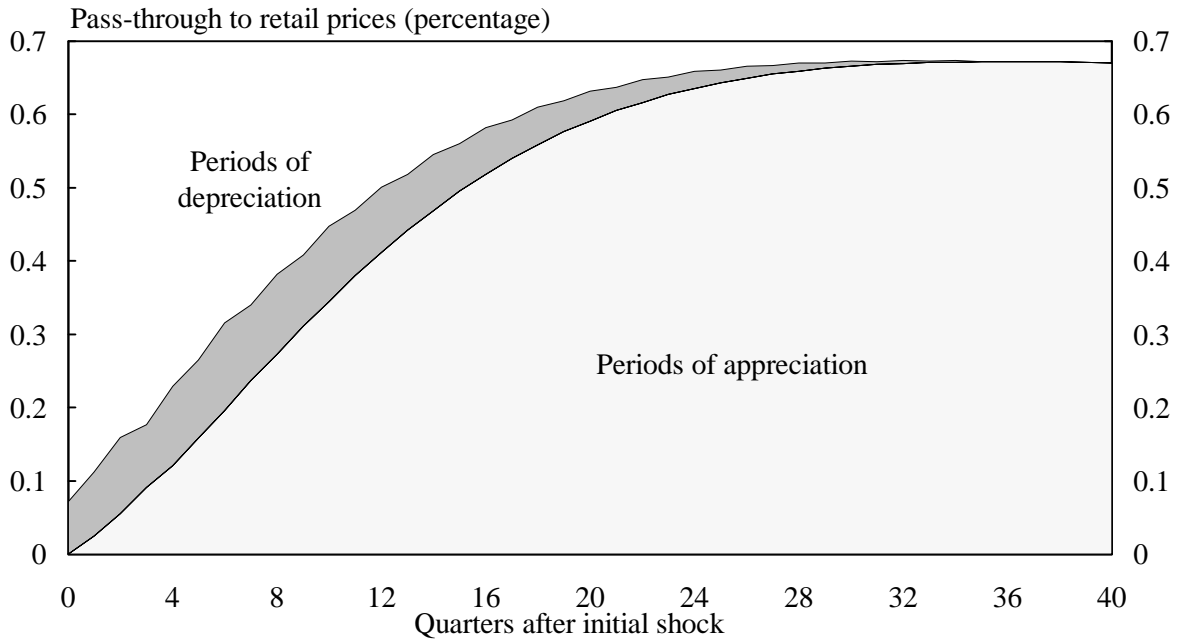


**Figure 6: Second Stage Dynamics
Domestic Cost Impulse Response Function**
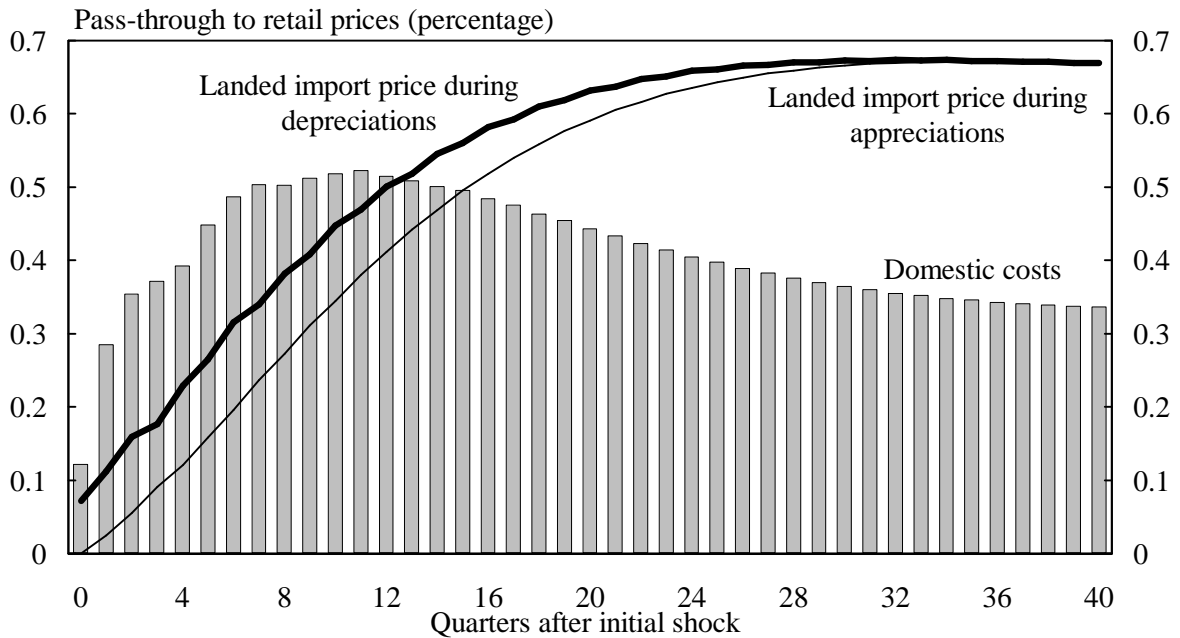
## 6.3    Combined Pass-Through

The first and second stages of price adjustment, described above, can now be combined to trace the final impact of an exchange rate change on retail import prices.  It has been shown that, in the long run, a 1 per cent change in the exchange rate leads to a 1 per cent change in the free-on-board price of an import.  In turn, a 1 per cent change in the landed price of an import leads to an 0.66 per cent change in its retail price, in the long run.  Thus, assuming that all other costs incurred by the domestic importer are independent of the exchange rate, pass-through of a 1 per cent change in the exchange rate to retail import prices is, in the long run, also about 0.66 per cent.  However, to the extent that international freight is an imported service, its price will be affected by the exchange rate, so that combined pass-through is slightly more than this estimate.

This long-run impact is substantial.  The short-run impact, however, is not. Although changes in the exchange rate are passed on quickly to over-the-docks prices, these prices are, in turn, passed on only very slowly to those at retail outlets. In addition to such slow pass-through, the adjustment is asymmetric, with the pass-through of landed import prices during appreciations being slower than during depreciations.  In fact, as implied by Figure 5, the influence of the exchange rate is so greatly dissipated by the slowness of price adjustment at the second stage that it takes, in the event of depreciation, two years before half of the estimated pass-through is realised.  Pass-through is even slower in the event of appreciation. Clearly, the inflationary consequences of exchange rate fluctuations hinge on price adjustment at the second stage, in particular the way in which local distributors elect to vary their mark-ups in response to a given shock.

The nature of price adjustment at the second stage has permitted a number of inferences about the behaviour of the mark-up in response to given shocks.  We observe that changes in the costs of imported or domestic imports are not immediately passed on to retail import prices and so infer that the mark-up has changed.  The error-correction mechanism, therefore, contains information with which a measure of the importers' mark-up can be constructed.  In the next section, such a measure will be presented.

## 7.    A MEASURE OF THE MARK-UP

Central to the empirical analysis in the preceding section is an assumption that the mark-up follows a stationary process. This assumption of stationarity permits us to take advantage of all known variables and estimated long-run relationships to construct a measure of short-run variations in the mark-up as deviations from their long-run equilibrium. Specifically, from equation (9) it follows that:

$$l_t = \frac{R_t}{(P_L)_t^{\hat{a}} C_t^{\hat{p}}} \tag{11}$$

where $\hat{a}$ is 0.66 and $\hat{p}$ is 0.34, and the mark-up is stationary by construction.[33]

The resultant series exhibits both significant variation and persistence as illustrated in Figure 7. The persistence is in keeping with the notion that price adjustment by firms is not costless; it can involve menu costs that reduce the frequency with which firms are prepared to adjust prices (Ball and Mankiw 1992). The oscillations are in keeping with shocks to the cost of imported or domestic inputs.

Oscillations in the mark-up occurred around a trend decline until the September quarter 1986, after which there was a sharp increase in the mark-up. In fact, by late 1988 the mark-up reached a record high in the period for which it has been estimated. Certainly, perceptions of a disproportionate rise in importers' mark-ups precipitated an inquiry by the Prices Surveillance Authority (PSA 1989).[34] Subsequently, the mark-up has drifted down, but it remains at a level higher than has been evident for most of the period shown.

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[33] In fact, $l = r - 0.66pl - 0.34c$ is simply the error-correction term from the cointegration analysis in the previous section.

[34] Public perceptions that the sharp appreciation of the late 1980s, and the associated fall in free-on-board import prices, was not being passed on to consumers, resulted in the PSA inquiry.

**Figure 7: The Importers' Mark-up**
(June 1971=100)
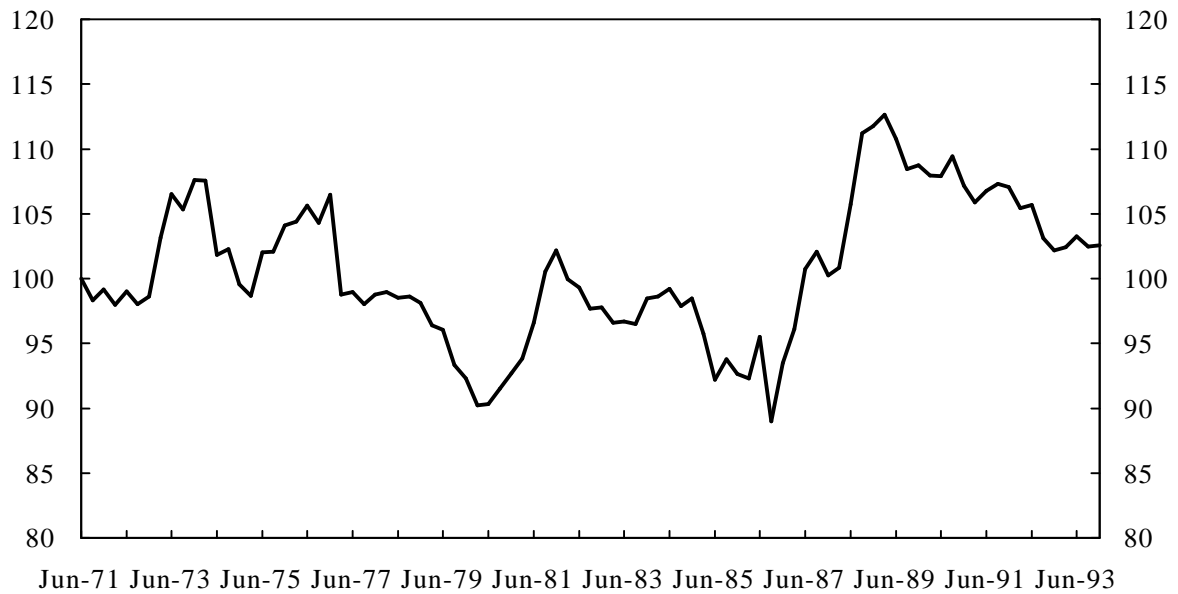


**Figure 8: The Mark-up and the Exchange Rate**
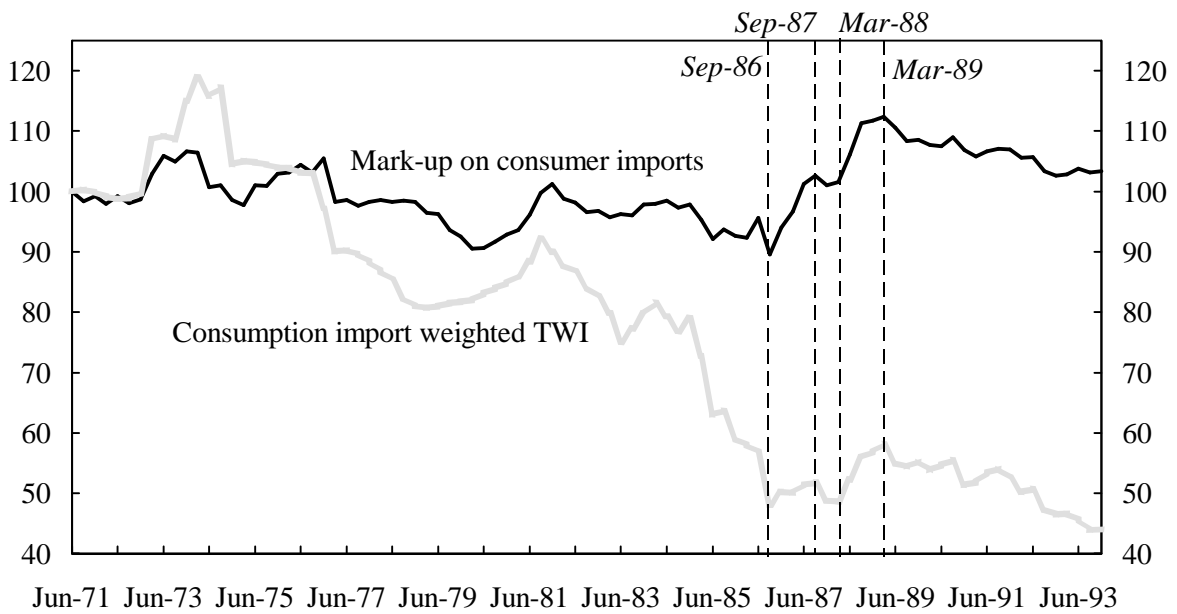
Given that the mark-up moves to offset the impact of changes in the cost of imported and domestic inputs, of interest is the behaviour of the mark-up during periods when major changes in such costs have occurred. For example, changes in the cost of the imported input - the largest component of total costs - have been primarily associated with episodes of exchange rate movement. Consequently, we shall focus on the behaviour of the mark-up during these episodes.

We expect that retailers increase their margins during times of appreciation, and decrease them during times of depreciation, so as to offset the changes in the free-on-board price that result from such currency movements. As shown in Figure 8, changes in the mark-up are, in general, positively correlated with changes in the exchange rate. However, at times, the strength of this correlation has been weakened. For instance, during the historic depreciation from the December quarter 1984 to the September quarter 1986, the mark-up fell by significantly *less* than did the exchange rate; in fact, the fall in the mark-up was not exceptional when compared with that in other episodes of depreciation. In the period of appreciation that immediately followed, the mark-up rose by *more* than the exchange rate. Indeed, in the late 1980s importers appear to have taken an opportunity to substantially increase their mark-up.

The mechanics of these changes in the mark-up are depicted in Figure 9 where episodes of major exchange rate movement are identified. During the sharp depreciations (from December 1984 to September 1986, late 1987 and recently) it is clear that over-the-docks import prices rose dramatically, driving up the total costs faced by local distributors. A significant share of this increase in costs was passed on to retail import prices. Consequently, despite our general finding of very slow pass-through, the mark-up was, on these occasions, squeezed by no more than in most other periods in which it has fallen.[35]

Conversely, the appreciations (from September 1986 to September 1987 and from March 1988 to March 1989) led to a decrease in the total costs faced by retailers that was driven by a fall in the free-on-board price of imports. Retailers chose not to lower the retail prices, but instead increased their mark-up to a record high level.

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[35] An outcome facilitated by the subdued movement in the cost of domestic inputs during these episodes.

A number of factors might have contributed to this especially large increase. Corresponding to a lengthy period of depreciation in the first half of the 1980s, there was a protracted fall in the mark-up. Given that we expect the mark-up to return to a long-run equilibrium, some reversal of the fall was inevitable as retailers sought to "catch up" on accumulated losses. However, the mark-up appears to have increased beyond such "catching up". This outcome raises several important questions about its recent behaviour.

**Figure 9: Retail Import Price and Total Cost for Imported Consumer Goods**
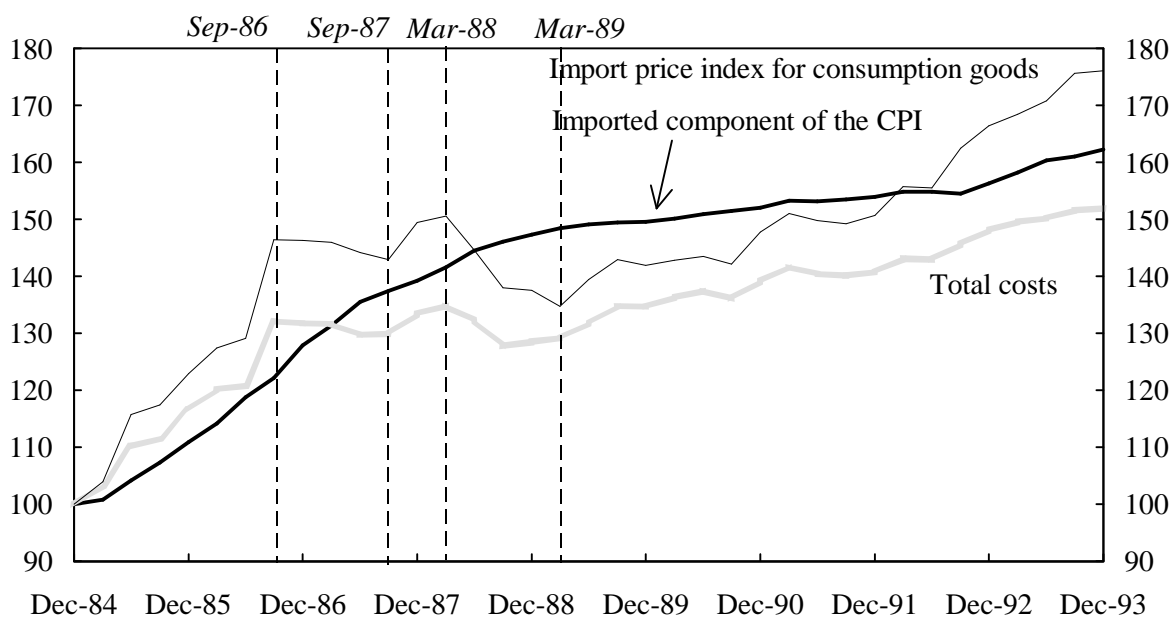


A popular view is that, in the short run, given downward stickiness in final retail prices, the mark-up responds asymmetrically to changes in the exchange rate; that is, the increase in the mark-up during appreciations is greater than the fall in the mark-up during depreciations (PSA 1989). The second stage results reported in the previous section lent support to this view by demonstrating asymmetry in the response of changes in the retail import price to changes in their landed price during periods of appreciation and depreciation.

However, an important aspect of the asymmetry result is that exchange rate depreciations have often been precipitous, whilst appreciations have been less steep. Given that price adjustment for firms is not costless, they tend to be more responsive to large shocks than to small ones (Ball and Mankiw 1992). For

example, the historic depreciation of the mid 1980s may have forced firms out of their "band of inaction" so that pass-through of total costs was higher than would otherwise have been the case, containing the fall in the mark-up. Alternatively, during the subsequent and less dramatic appreciation, firms may have remained within their band of inaction and failed to pass on the reduction in total costs that stemmed from such appreciation, permitting a disproportionate rise in the mark-up.

Nonetheless, it is by no means clear that the extent of the rise in the mark-up during the late 1980s is attributable solely to an asymmetric response to exchange rate movement. One might expect a role for domestic demand conditions. During the late 1980s, actual output exceeded potential creating an opportunity for firms to increase their mark-up with little fear of loss of customers (Benabou 1992). Certainly, the PSA (1989) concluded that the appreciation, combined with buoyant economic conditions, allowed firms to recover lost margins. In our estimation of second stage pass-through, though, the output gap proved to be insignificant. This is not to say that domestic demand conditions are irrelevant to the mark-up. Rather, in our model, there is no statistical indication that the output gap is important. (The information afforded by it may well be swamped by that contained in more volatile exchange rate movements.)

At issue, however, is the future direction of the mark-up, and the attendant pressure on inflation, as Australia's economic conditions change. Given prospective currency appreciation and consolidation of economic recovery, it is of interest whether a situation will re-emerge that is reminiscent of the late 1980s. In this regard, there are several important differences between the present environment and that which prevailed in the late 1980s.

The first of these differences is the prevailing level of the mark-up. As importers emerged from the mid-1980s depreciation, there was a clear motivation to recover lost margins. In contrast, as importers emerge from the recent episode of depreciation, the motivation for "catch up" is less evident. This is because the mark-up was established at such a high base in the late 1980s.

The second difference in the present environment compared with that in the late 1980s stems from the process of microeconomic reform which has now reached greater maturity. Consequently, there is an increased focus on competition. We

might expect that importers will be more inclined to preserve viable margins by reducing cost rather than increasing final prices.[36]

The third difference, which is relevant in the case of depreciation, is the prevailing rate of inflation. Ultimately, the extent to which retailers can alter their mark-ups is governed by the scope for changing the relative prices of final goods. When the prices of domestically produced goods are increasing rapidly, as was the case in the second half of the 1980s, the scope for raising retail import prices is considerable. If, however, domestic inflation is low, relative price changes are conspicuous. Certainly, if the price of a domestic substitute has not changed, the scope for altering the corresponding retail import prices is limited. Thus, a continuance of Australia's low inflation can impose an exigency in this regard.

## 8.    SUMMARY AND CONCLUSIONS

In Australia's contemporary history, episodes of currency depreciation have tended to be accompanied by an increase in inflation (Stevens 1992). Consequently, strong expectations were formed that the depreciation of the early 1990s would generate inflationary pressures. The "missing" import price inflation has invited an examination of exchange rate pass-through. Most investigations of exchange rate pass-through have focussed on the transmission of the exchange rate to import prices over the docks. However, it is the retail price of an import, and not that over the docks, that directly enters measured inflation. Thus understanding the second stage of price adjustment as imports are distributed to local markets is central to any assessment of the inflationary consequences of currency depreciation.

This paper has measured exchange rate pass-through at both the first and second stage. It has shown that changes in the exchange rate are quickly transmitted to the prices of consumption imports over the docks. First stage pass-through is fast and unambiguously complete. Second stage pass-through is also complete but, because of the existence of domestic costs, the retail import price does not move by the same proportion as the over-the-docks price, even in the long run. Furthermore, the adjustment process is very slow.

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[36] Such an effect would, however, be difficult to separate from the discipline imposed by low domestic inflation on importers seeking to alter the price of imports relative to substitute goods.

In popular discussion of second stage pass-through, when movements in retail import prices are observed to fluctuate by less than those over the docks, there has been a tendency to interpret these movements as incomplete pass-through. However, if the long-run elasticities represent cost shares, the elasticity of the retail import price with respect to that over the docks *cannot* be unity. It must instead reflect the value of the import as a share of total costs, and so be *less than unity*. Consequently, complete pass-through at the second stage entails less than proportional movement. The second stage results accord with this notion and suggest that the share of the landed import price in total costs is about 66 per cent.

In the short run, however, adjustment is slow and the rate of pass-through is clearly much less than this cost share would imply. Thus, by any standards, second stage pass-through is incomplete for sustained periods. This occurs because importers' mark-ups are varied to insulate consumers from changes in the cost of the import, such as result from exchange rate fluctuations. In fact, persistent variations in importers' mark-ups lead to slow adjustment at the second stage, thereby dissipating the inflationary consequences of currency depreciation.

**APPENDIX 1: DATA**

All data series are quarterly from 1971:2 to 1993:4.

**(a) Retail Prices of Imported Consumption Goods**

For the years in which it is available, the retail import price is represented by "items wholly or predominantly imported" in the CPI. Because the sample size was insufficient for econometric analysis, a proxy was constructed and spliced with the actual series to provide additional observations. This was done by removing expenditure classes from the All-groups CPI that were thought not to contain a significant proportion of imports. The remaining expenditure classes were then combined (with the same relative contributions as in the All-groups CPI) to form the proxy series of retail import prices.[37]

Changes in the proxy series match closely those of the published series. However, during the major currency depreciation of 1985/86, the rate of change in the proxy is consistently lower than that of the actual series. Given that the series is spliced prior to this episode, and that exchange rate movements were less volatile before the float, it is contested that tests of pass-through are not biased towards rejecting completeness.

Sources:  1984:4 to 1993:4, ABS, Catalogue No. 6444.0
             1970:1 to 1984:4, ABS, Catalogue No. 6401.0

**(b) Prices of Consumption Imports Over the Docks**

A free-on-board import price is used. For the period from 1982:3, the ABS import price index (IPI) for consumption goods is used. Prior to this, the IPI was compiled by the RBA. Because the RBA only published price series for major commodity groupings, an IPI for consumption imports was constructed by removing commodity

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[37] Sub-groups and expenditure classes which form the proxy are: processed fruit and vegetables; clothing, except for dry cleaning and shoe repairs; appliances; household textiles; household utensils and tools; motor vehicles; tyres and tubes; alcoholic drinks; personal care products; books, newspapers and magazines; and recreation goods.

groups which did not contain predominantly consumption goods.[38]   The relative weights of the remaining items were maintained.   It should be noted that the construction of these two series are not identical and therefore they are not strictly comparable.

Sources:   1981:3 to 1993:4, ABS, Catalogue No. 6414.0
            1970:1 to 1981:3, RBA, *Bulletin.*

## (c) World Export Prices for Consumption Goods

The world price series is represented by an index of the foreign currency prices of exports of consumption goods from 17 of Australia's major trading partners. Changes in the world price, from which index values are inferred, are calculated as:

$$\dot{W}_t = \sum_i (w_i \times \dot{P}_t^i) \qquad\qquad (A1.1)$$

where $\times$ denotes proportional change; $w_i$ is the average share of consumption goods imported into Australia from 1981:3 to 1986:2 from country $i$ relative to other countries in the sample; and $P_t^i$ is an index of export price of consumption goods in country $i$.[39]

The weights used in the construction of the index are shown below, together with those derived using total imports.  Because data on the value of imports classified by commodity and country of origin are not readily available, four-digit Australian Standard Industrial Classification (ASIC) data were used.  Industries which were considered to be engaged in the production of consumer goods were identified and

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[38] Items excluded were: crude materials, inedible; mineral fuels and lubricants; chemicals; machinery except electric; electric machinery apparatus and appliances; and transport equipment.

[39] The index is a weighted sum of percentage changes in the foreign price series so as to minimise the error that results from using weights based on the proportion of expenditure on consumption imports (rather than volumes).

their exports included[40]; these goods account for about 35 per cent of Australia's total merchandise imports during the period. Comparing the weights with those based on total exports it can be seen that a larger proportion of our consumption imports are from Asian countries.

**Table A1.1: Country Weights**

| Country | Type of trade weight | |
| --- | --- | --- |
| | Consumption imports | Total imports |
| Japan | 0.257 | 0.259 |
| USA | 0.244 | 0.268 |
| UK | 0.075 | 0.088 |
| Singapore | 0.059 | 0.031 |
| Taiwan | 0.059 | 0.038 |
| Germany | 0.055 | 0.076 |
| New Zealand | 0.045 | 0.044 |
| Hong Kong | 0.043 | 0.026 |
| Italy | 0.032 | 0.033 |
| France | 0.026 | 0.026 |
| Rep. of Korea | 0.025 | 0.017 |
| Netherlands | 0.017 | 0.016 |
| Canada | 0.014 | 0.027 |
| Switzerland | 0.013 | 0.013 |
| Malaysia | 0.013 | 0.012 |
| Sweden | 0.013 | 0.019 |
| Belgium | 0.008 | 0.008 |

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[40] Industries included are: ASIC 2124, 2125, 2131, 2132, 2140, 2153, 2161-2163, 2173-2176, 2185-2190, 2351, 2354, 2356, 2441, 2442, 2451, 2452, 2454, 2459, 2460, 2541, 2542, 2632, 2643, 2762, 2763, 2765, 2766-2768, 2770, 2850, 2864, 3161, 3231, 3245, 3341, 3343, 3351-3353, 3452, 3461, 3462, 3473, 3474, 3481-3483, 3485, 3487.

Where possible, a price series for consumer exports was used. For countries where consumer export prices could not be obtained, the index for total exports was used.[41]

Sources for prices: Bank of Japan, *Economic Statistics Monthly*; US Department of Labor, *Monthly Labor Review*; UK, Central Statistical Office, *Monthly Digest of Statistics*; Taiwan Directorate-General of Budget, *Monthly Bulletin of Statistic*; The Bank of Korea, *Economic Statistics Yearbook*; Statistics Canada, *Canadian Economic Observer*; IMF, *International Financial Statistics*.

Source for weights: Department of Foreign Affairs and Trade, unpublished.

## (d) Effective Exchange Rate

An effective exchange rate is calculated as a geometrically weighted average of the bilateral exchange rates between Australia and the 17 countries represented in the world price index. The weights used are identical to those used in the construction of the world price index. The index is calculated as:

$$E_t = 100 \times \prod_{j=1} \left[ \frac{A_{jt}}{A_{j0}} \right]^{w_j} \tag{A1.2}$$

where: $\prod$ is the product operator; $A_{jt}$ is the number of Australian dollars per unit of foreign currency at time $t$; $A_{jo}$ is the number of Australian dollars per unit of foreign currency for country $j$ in the base period; and $w_j$ is the weight of country $j$.

## (e) Costs Faced by Importers and Retailers

Five major cost items were considered; these include: unit labour costs, international freight, domestic transport, taxes on international trade and other expenses. While these clearly do not cover all costs incurred in bringing an import to the retail outlet, those that are excluded (such as rental and charges for utilities) account for a relatively small share and fluctuate less frequently.

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[41] These countries are: Singapore, Germany, New Zealand, Italy, France Netherlands, Switzerland, Malaysia, Sweden and Belgium. They together account for about 30 per cent of consumption imports during the weighting period.

*Labour Costs:* Nominal, non-farm unit labour cost was used. This accounts for wages, salaries and supplements, plus payroll tax less employment subsidies, plus fringe benefits tax. Source: Treasury, "Economic Round-up"

*International Freight:* The price of international freight is estimated using the implicit price deflator for shipment debits in the balance of payments. Prior to September 1974, a measure of the implicit price deflator was obtained by dividing the value of shipment debits at current prices, by the value of imports at constant prices. Source: ABS, Catalogue No. 5302.0

*Domestic Freight:* The Australian Bureau of Agricultural and Resource Economics' index of freight outward incurred by farmers (from the farm to the docks or store) is used. Source: ABARE, "Indexes of Prices Received and Paid by Farmers"

*Taxes on International Trade:* An average tariff was calculated as the value of customs duties as a proportion of the value of imports. Source: ABS, Catalogue No. 5206.0 and 5302.0

*Other Expenses:* Other expenses nominated in a survey of retail business operations and industry performance. Source: ABS, Catalogue No. 8140.0.

**(f) Cost Shares**

Estimates of the cost shares used in the construction of the cost index incurred by domestic importers are obtained from PSA survey results and from various ABS sources.[42]

The table below shows estimates of the value of each of the four additive costs as a proportion of turnover. These estimates are obtained from ABS and PSA surveys of the retail industry, and ABS census information about the cost structure of manufacturers. These shares of turnover are then rescaled so that they sum to unity.

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[42] Australian Bureau of Statistics (ABS) publications: the *Manufacturing Census*, *Retail Survey* and *Business Operations and Industry Performance*.

**Table A1.2: Apportioning Costs for Retail Importers**

| Item | Proportion of | |
| --- | --- | --- |
| | Turnover / retail price | Cost index |
| Unit labour cost[43] | 0.15 | 0.62 |
| International freight[44] | 0.04 | 0.17 |
| Domestic freight[45] | 0.03 | 0.13 |
| Other expenses[46] | 0.02 | 0.08 |
| Total | 0.24 | 1.00 |

The most important cost faced by an importer of consumption goods is, of course, the landed price of the import. Evidence to a PSA inquiry (PSA 1989, p.74) suggests that the free-on-board price represents between 30 to 50 per cent of the *final retail price*. Taking the middle of this range, and assuming a mark-up factor of 1.20, it can be seen that the free-on-board price represents approximately $50(\approx 40 \times 1.20)$ per cent of *per unit costs* faced by an importer. With an average tariff of 10 per cent, the *landed price* would account for about $55(=50 \times 1.10)$ per cent of total per unit costs. This value is of a similar magnitude to our estimate of the limit of second stage pass-through.

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[43] According to the ABS, *Manufacturing Census 1989-90*, wages and salaries represent approximately 15 per cent of turnover.

[44] The PSA (1989) suggests that international freight is equal to roughly 10 per cent of the free-on-board price of a consumption import, and that the free-on-board price accounts for approximately 40 per cent of the retail price. It follows that international freight is about 4 per cent of the retail price.

[45] Outward freight and motor vehicle expenses account for approximately 3 per cent of turnover in the ABS, *Manufacturing Census 1989-90*.

[46] From the ABS, *Business Operations and Industry Performance*, and estimated to be approximately 2 per cent of sales.

**APPENDIX 2: TIME SERIES PROPERTIES OF THE DATA**

Each of the series used in estimating cointegrating relationships was tested for non-stationarity using the Augmented Dickey-Fuller test (Said and Fuller 1984). The null hypothesis of this test is non-stationarity. The following procedure was adopted. Initially equation A2.1 was estimated for each time series $y_t$.

$$\Delta y_t = a + bt + (r-1)y_{t-1} + \sum_{i=1}^{8} g \Delta y_{t-i} + e_t \qquad \text{(A2.1)}$$

Eight lags of the dependent variable were included to eliminate autocorrelation; the lags were then sequentially removed until the minimum number of lags required to avoid autocorrelation was reached.

The joint hypothesis, $b = 0, r - 1 = 0$, was then tested. The results of this test are shown in the first column of table A2.1. Where the hypothesis was rejected, a test was conducted to see whether the series is integrated around a deterministic trend; thus the hypothesis $r - 1 = 0$ was tested. These results are shown in the second column below.

If the initial joint hypothesis was accepted, equation A2.1 was re-estimated with a constant but no trend. The null of a unit root and no drift was then tested ($a = 0, r - 1 = 0$). If this hypothesis was rejected, we tested whether the rejection was due to a significant drift term, stationarity, or both. This was done by testing for a unit root given a drift. The results, reported in Tables A2.1, suggest that the series are all integrated of order one.

**Table A2.1: Results of Unit Root Tests**

| Null hypothesis: | (a) Unit root & no trend | (b) Unit root given trend | (a) Unit root & no drift | (b) Unit root given drift |
|---|---|---|---|---|
| Variable | | | | |
| **First stage pass-through** | | | | |
| $p$ | 2.579 | ~ | 4.673 | ~ |
| $e$ | 4.640 | ~ | 2.202 | ~ |
| $w$ | 11.763** | -2.392 | ~ | ~ |
| $\Delta p$ | 8.211* | -3.841* | ~ | ~ |
| $\Delta e$ | 7.400* | -3.601* | ~ | ~ |
| $\Delta w$ | 16.219** | -5.455** | ~ | ~ |
| **Second stage pass-through** | | | | |
| $r$ | 6.873* | -2.669 | ~ | ~ |
| $pl$ | 2.380 | ~ | 4.351 | ~ |
| $c$ | 4.098 | ~ | 6.775* | -2.797 |
| $\Delta r$ | 9.854** | -4.157** | ~ | ~ |
| $\Delta pl$ | 10.607** | -4.315** | ~ | ~ |
| $\Delta c$ | 12.422** | -4.689** | ~ | ~ |

Notes: * indicates significance at the 5 per cent level and ** at the 1 per cent level.

(a) Critical values are tabled in Perron (1988).

(b) Critical values from Fuller (1976).

**APPENDIX 3: TESTS OF EXOGENEITY**

This appendix addresses the issue of exogeneity in the estimation of first-stage pass-through. For the single-equation framework to be valid, it is necessary that the contemporaneous import-weighted exchange rate and the world price are exogenous to changes in the import price. In particular, the exchange rate and the world price have to be weakly exogenous, so that the error-correction term enters only the import price equation.[47]

To ensure that this is the case, tests of Granger causality were carried out in a vector autoregressive (VAR) model. This is actually a stronger test of exogeneity than required; Granger non-causality implies *strong* exogeneity.

A fourth order VAR on the differences was estimated and the results of Granger causality tests are presented in the table below. Sufficient lags were included to eliminate autocorrelation.

**Table A4.1: Granger Causality Results**

| Null hypothesis | Test statistic $F(4,73)$ (significance) | Comment |
|---|---|---|
| Changes in the *import price* do not Granger-cause changes in the *exchange rate* | 1.969 (0.108) | Exchange rate is strongly exogenous |
| Changes in the *import price* do not Granger-cause changes in the *world price* | 0.767 (0.550) | World price is strongly exogenous |

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[47] For a discussion of the different concepts of exogeneity, see Ericsson (1992).

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