Changes in the determinants of inflation in Australia

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1. Introduction

Low and stable inflation has been a feature of the Australian economy for the past decade. Australia's previous history of high and variable inflation encouraged many to discount the low inflation of the early 1990s as cyclical, even accidental.[2] As it turned out, low inflation has been maintained through a lengthy economic expansion and in the presence of various inflationary shocks. While a regime of inflation targeting has played a role in facilitating this outcome, inflation has been generally lower than expected, and certainly more stable. At the same time, inflation has been surprisingly subdued in a range of industrialised economies, including those without explicit inflation targets. A key question is whether these developments reflect a series of favourable shocks to prices or a more fundamental change in the inflation process.

It has been suggested that a more fundamental change in the inflation process might have occurred.[3] This view has gained currency because some types of shocks that previously had a conspicuous influence on inflation now appear to have much less influence. In the Australian case, this is best highlighted by the apparent change in the pass-through of exchange rate movements to final domestic prices. Since Australia is a small open economy, episodes of currency depreciation have usually generated an increase in inflation. But on two occasions during the 1990s, despite a sharp depreciation of the Australian dollar, and rising import prices "at the docks", growth in final retail import prices remained subdued, so that there was little effect on consumer price inflation.

The apparent reduction in exchange rate pass-through provides an example of a direct and visible change in pricing behaviour that has had a bearing on our recent inflation performance. However, other developments in the economy that have less direct or visible consequences for prices have also been at work. Over the past two decades in Australia, there has been a gradual but expansive programme of market liberalisation that extends from financial and product markets to labour markets. Its effects have now manifested themselves in a variety of ways. There has been an increase in domestic competition, a shift away from centralised wage setting towards a decentralised enterprise-based system, and an attendant rise in trend productivity growth. Each of these developments is conducive to achieving lower and more stable inflation, at least in the short to medium run, and may have reinforced the effects of reduced exchange rate pass-through.[4] Furthermore, these changes have occurred in an environment where financial markets demand disciplined behaviour of public policymakers.

This paper seeks to establish if a fundamental change in the inflation process has occurred in Australia. This task is challenging. There are many interactions between microeconomic conditions and macroeconomic management that influence inflation performance, but which are difficult to separately identify. The strategy adopted in this paper is to define the problem quite narrowly. We consider the inflation process in the context of a mark-up model, in which the domestic price level is set as a mark-up on unit costs of production. We then attempt to identify whether there has been a measurable change in the relationship between inflation and its main explanators. In other words, we are seeking direct evidence of a change in the inflation process. We do not address the more difficult

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[1] We are grateful to Adam Cagliarini and Sharon Wardrop for their technical assistance and to David Gruen for his helpful comments.

[2] Stevens (1999) provides an assessment of Australia's inflation experience over the 1990s.

[3] Bootle (1996) is a prominent example of this claim.

[4] In the long run, these developments are likely to lower the price level rather than the ongoing rate of inflation, which is determined by monetary policy.

and important question of whether the change in the inflation environment has altered the propagation of shocks in the economy in a way that reinforces price stability.

The paper is organised as follows. First, we present trends in inflation outcomes and show that inflation in the 1990s was unusually benign, but not dissimilar to that in other countries. Second, we explore developments in each of the key explanators of inflation, highlighting changes that are unusual or structural. Third, we seek to establish the importance of these changes by comparing the properties of a mark-up model of inflation estimated in different periods. In particular, we test whether the impulse to inflation from a given shock has changed through time. Finally, implications and conclusions are drawn.

2. Inflation performance

Australia's inflation performance over the past four decades is illustrated in Figure 1. Two measures of inflation are shown: the Treasury underlying series, which, until recently, was the main measure of core inflation in Australia, and the Statistician's new inflation series.[5] The shaded band indicates the current target of 2-3% inflation over the medium term that has been the objective of monetary policy since 1993. There are several striking features of the graph. When viewed over the longer run, inflation has been highly variable, so that the 1990s emerge as a period of unusual stability. Also striking is that since the 1970s, there has been a tendency for each cyclical peak in inflation to be lower than the one before it. Since the early 1990s, inflation has been maintained at a rate not witnessed for more than a generation. Furthermore, in the period since the adoption of the inflation target, it is clear that inflation has been below 2% for longer than above 3%.

Many of these features are not, however, unique to Australia. Comparing inflation performance in Australia with that in the OECD, it is clear that there is a fair degree of similarity (Figure 2).[6] The timing of most major swings in inflation is roughly coincident, reflecting some commonality of shocks, rough correlation of business cycles and broad similarities in the stance of monetary policy. A trend reduction in inflation since the 1970s is common to many countries. So too is the shift to a regime of low, stable inflation and the tendency for inflation outcomes to be either below target or in the lower part of tolerance intervals. However, until recently, inflation in Australia tended to be higher, on average, than in the OECD and subject to greater oscillations.

Stevens (1992) provides a detailed episodic analysis of inflation in Australia for the period 1950-91 and demonstrates that, as a small open economy, foreign shocks have played a prominent role in inflation outcomes. This is particularly evident during the 1970s, when there were several major commodity price shocks. Under a fixed exchange rate regime, higher world prices were transmitted to domestic prices directly, and indirectly through their effects on income. This partly explains why oscillations in inflation during the 1970s were higher in Australia than in the OECD generally. The adoption of a floating exchange rate (in 1983) has made it easier to insulate the economy from foreign shocks, but they remain a significant influence on domestic prices.[7] They explain much of the difference between Australian and OECD inflation during the mid-1980s, when, following a sharp fall in the terms of trade, Australia experienced a record depreciation of the currency.

While episodes of inflation in Australia have tended to be triggered by foreign shocks, domestic shocks have also played an important role, often amplifying the effects of external factors. In particular, outbreaks of wage inflation occurred in the early to mid-1970s, the late 1970s and early 1980s that

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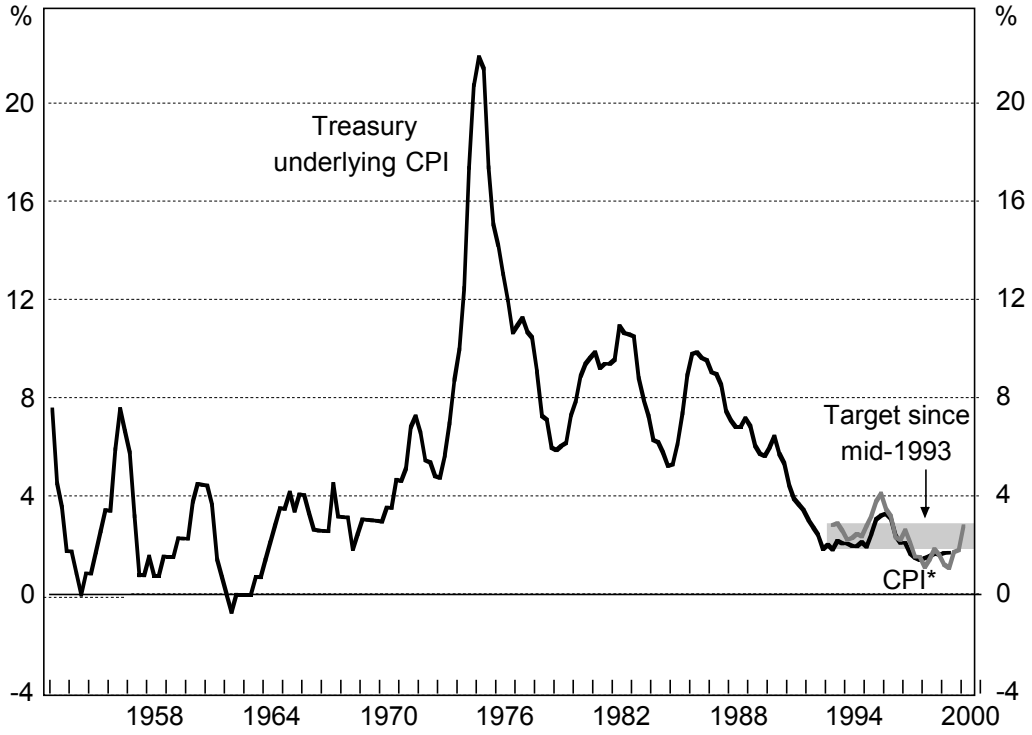
[5] Following a regular five-year review of the Consumer Price Index by the Statistician, the measurement of the CPI was changed from the outlays approach (in which interest charges were included) to the acquisitions approach (in which they are not). For a description of these and other data, see Appendix A.

[6] To permit a direct comparison with inflation in the OECD, CPI less interest is the measure of Australian inflation. (It peaks at a lower rate in the 1970s than our narrower measure of core inflation because it includes some items that experienced relatively low price rises in the September quarter 1974.)

[7] Gruen and Dwyer (1995) describe the mechanisms through which a terms-of-trade shock influences domestic prices under a fixed and a floating exchange rate and present empirical evidence of the relationship for Australia and how it has evolved.

were more pronounced than in other OECD countries.[8] These provided a powerful impulse to inflation, leading to a more exaggerated cycle in inflation in Australia than in most of the OECD.[9]

Figure 1: Inflation over the long run



* Excludes interest charge components where relevant.

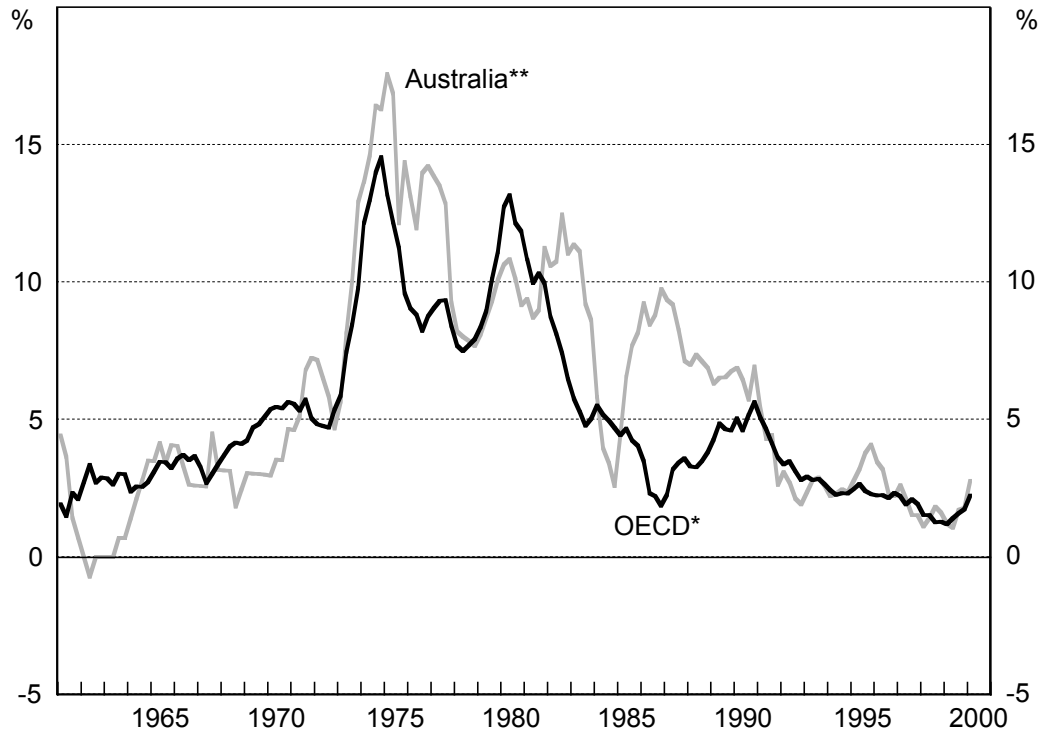
While Australian inflation has since fallen, and converged with that of other industrialised nations, the inflation process has remained subject to shocks. Volatile currency movements continue, as do fluctuations in wage growth, and there has been a pronounced and sustained upswing in real output. Certainly, the absolute size of these shocks has tended to be smaller in the past decade than previously. But notwithstanding this, the disturbances to inflation in Australia have been less than a casual reading of history would suggest. One very simple way of demonstrating this is to compare the variability of inflation with the variability of the inflationary shock. As Table 1 shows, the standard deviation of inflation fell significantly in the 1990s, while the standard deviation of import prices fell by a much smaller proportion, so that the ratio of the shock to the inflation outcome rose. A similar result can be found for the output gap and, to a lesser extent, wages in the manufacturing sector (often the wage leaders).[10] At face value, this points to an increased resilience of the inflation environment to shocks.

[8] The first reflected the government's intention to increase labour's share of income and establish "equal pay for equal work", while in the late 1970s labour secured wage rises outside the centralised system. In the early 1980s, formal centralised wage fixing was abandoned but coordinated union campaigns resulted in a generalised wage rise.

[9] In contrast, the Prices and Incomes Accord secured generalised wage restraint during the second half of the 1980s, which helped to counteract the inflationary consequences of prevailing external shocks.

[10] For aggregate wages, the relationship appears to be unchanged. The stability of this relationship may reflect the fact that much of a given rise in wages is an endogenous response to rising prices.

Figure 2: Inflation in Australia and the OECD



*Excluding Turkey.

** Excludes interest charge components where relevant.

Table 1

The variability of inflation and its explanators

	Pre-1990s	**1990s**
Standard deviation		
CPI	3.9	1.5
Import prices	8.7	5.5
Wages	4.9	2.3
Output gap	0.7	0.6
Standard deviation relative to that of the CPI		
Import prices	2.2	3.6
Wages	1.3	1.5
Output gap	0.2	0.4

Note: The pre-1990s period spans from the March quarter 1965 to the December quarter 1989. The CPI is less interest charges, import prices are the implicit price deflator for imports, wages are the average earnings of adult males in the manufacturing industry, and the output gap is calculated using a Hodrick-Prescott filter. Standard deviations of year-ended percentage changes in price and wage variables are presented.

So why does the experience of the past decade appear to be so different? The framework of inflation targeting has no doubt been helpful, providing a new price stability rule where others had broken down and an anchor to inflation expectations (Grenville (1997), Clarida et al (1998), Taylor (2000)).

Furthermore, it has encouraged policymakers to be more disciplined and forward-looking.[11] In doing so, it has demanded greater effort in forecasting inflation. But despite these efforts to account for influences on the inflation process, actual inflation has been surprisingly low.[12]

The extent of this surprise in Australia can be summarised by an Assistant Governor of our Bank. Commenting on the fact that inflation has been below target more often than above it, he says "I cannot recall anyone predicting this outcome when we set out on the track of having an inflation target: in fact, I cannot recall anyone even contemplating it as a serious possibility. The scepticism we faced for quite some time over whether we would be able to prevent a return to high inflation seems like another world now" (Stevens (1999), p 50).

Having highlighted the apparent increase in resilience to foreign and domestic shocks, in the following section we explore developments in some of the main influences on inflation, focusing on the experience of the past decade.

3. Influences on inflation

Inflation in Australia has typically been considered in the context of a mark-up model so that, in the long run, the domestic price level is a mark-up on total unit costs of production.[13] For an open economy, these costs include imported inputs to production as well as domestic inputs. Consequently, estimated mark-up models present us with a set of key variables, both foreign and domestic, that have played a significant role in explaining actual inflation outcomes. Prominent in this set are import prices, wages and productivity. We explore the behaviour of these variables over the 1990s and identify changes that are conducive to low and stable inflation.

3.1 Import prices

In recent years, import prices have contributed surprisingly little to consumer price inflation. This has invited claims of a structural change in the pass-though relationship that has increased the immunity of the inflation process to external shocks. The basis of these claims can be well summarised in Figure 3, which shows how import prices have moved during three episodes of currency depreciation. (The exchange rate index comprises the currencies of Australia's major trading partners, weighted by import shares. It is expressed in Australian dollars per unit of foreign currency so that a rise indicates a depreciation.)

In each episode of depreciation, import prices "at the docks" moved approximately in line with changes in the exchange rate. In the 1980s, these price movements at the docks were also translated into sharply rising retail import prices that provided considerable impetus to domestic inflation. In the early 1990s, however, import prices at the docks appeared to have a much smaller effect on retail import prices (measured here by the imported component of the CPI).[14] By the late 1990s, they appeared to have little or no effect on retail import prices so that, despite a significant depreciation, domestic inflation remained undisturbed.

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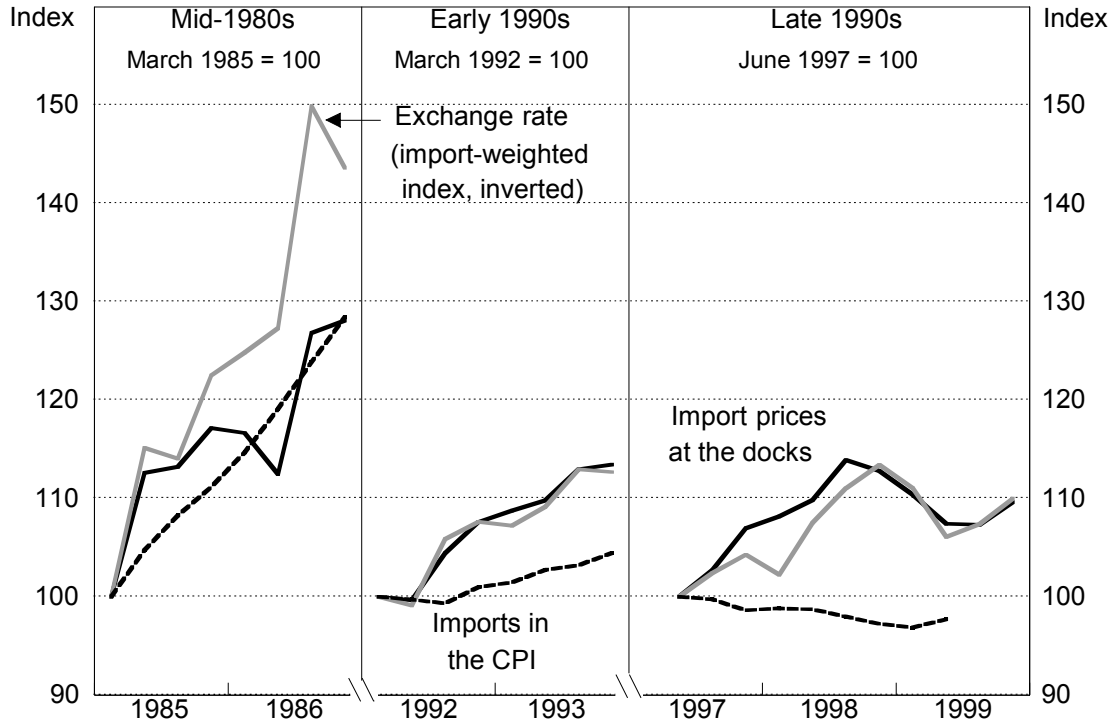
[11] These issues are explored comprehensively elsewhere (see Lowe (1997)). For a comment on how the target has conditioned Australian decisions on monetary policy specifically, see Stevens (1999).

[12] Internal Bank forecasts of inflation one and two quarters ahead have been well realised. In contrast, when forecasting over longer periods of six quarters, outcomes have, on average, been lower than expected. Although these forecasts are made with an assumption of no change in the exchange rate, when we revisit them, with the actual path of the exchange rate known, outcomes remain lower than predicted (by, on average, around ½ percentage point).

[13] See, for example, Cockerell and Russell (1995), de Brouwer and Ericsson (1995) and Beechey et al (2000).

[14] The imported component of the CPI was discontinued in June 1999 and replaced with a broader measure of tradables prices that is not directly comparable.

Figure 3: Import prices and the exchange rate



While these stylised facts provide a strong prima facie case of a change in the pass-through relationship, careful examination of events leads to more modest conclusions. In this section, we present estimates of the pass-through of changes in the exchange rate to import prices at the docks, or "first stage pass-through". We also present estimates of the responsiveness of final consumer prices to changes in import prices at the docks, or "second stage pass-through". In both cases, we pay particular attention to the experience of the 1990s.

3.1.1 First stage pass-through

First stage pass-through is, in essence, an application of the law of one price. In its absolute form, the law states that the price of a traded good should be the same in both domestic and foreign economies, when expressed in a common currency, and can be written as:

$$P = P^{*}E \tag{1}$$

where P is the domestic price of imports at the docks, P^{*} is the corresponding foreign price and E is the exchange rate (a basket of rates expressed in units of domestic currency per unit of foreign currency). The extent of first stage pass-through is represented by the elasticity of the domestic at the docks import price with respect to the exchange rate. It is complete when this elasticity is unity so that all of a change in the exchange rate is passed on to a change in the import price at the docks.

Since Australia is a small open economy, theory predicts that import price pass-through should be complete.[15] This prediction is usually borne out with aggregate import data (Dwyer et al (1993)).[16] For a given world price, changes in the exchange rate are fully passed on to changes in import prices at the docks. Furthermore, the typical finding is that first stage pass-through is completed rapidly, with

[15] Because in a small open economy importers face perfect elasticity of supply, foreigners will not adjust the foreign currency price of the import following a change in the exchange rate, so that the domestic price will move in exact proportion to the exchange rate.

[16] Although researchers examining pass-through of exchange rates to the prices of individual classes of goods find it to be incomplete (see, for example, Menon (1991) with respect to motor vehicles).

most of the adjustment occurring within one year.[17] However, a recent challenge to estimating the extent of first stage pass-through has arisen with the Asian financial crisis.

Most often, there is a high degree of co-movement between each of Australia's bilateral exchange rates so that most measures of an effective exchange rate move similarly, regardless of country coverage or weighting systems. But during the Asian financial crisis, the Australian dollar appreciated against the currencies of the troubled Asian economies and depreciated markedly against the major currencies, making the choice of effective exchange rate important. To assess the impact of these divergent currency movements on domestic import prices, it is necessary to properly control for changes in the foreign prices of goods exported from each trading partner. While bilateral exchange rates are readily available for all of Australia's trading partners, timely or reliable estimates of the relevant export prices are not. These are largely confined to the G7 countries.

Our approach is to view the G7 countries as price makers that set a notional world price for goods and services and estimate first stage pass-through using the currency and export prices of these G7 countries, rather than those of a broader group. In other words, our approach is to investigate whether $P = P_{G7}\ E_{G7}$.

In Appendix B, we present the estimated import price equation from the small model of the Australian economy presented in Beechey et al (2000). This import price equation is of the standard error correction type, but has two special features. These are designed to control for the fact that export prices from non-G7 countries may deviate from the notional world price. Beechey et al (2000) include a dummy variable to capture price undercutting by Asian exporters following the Asian crisis, and a time trend to capture the secular shift in Australia's imports towards lower-priced goods from non-G7 countries (particularly those in Asia). Incorporating these two variables into an otherwise conventional pass-through equation returns the results found in previous studies: changes in the exchange rate (and world prices) are completely passed through to changes in domestic import prices in the long run. Also consistent with earlier findings is the rapid adjustment to equilibrium, shown in Figure 4 by the response of import prices "at the docks" to a 1% depreciation.

In fact, this rapid adjustment has been a stable feature of the pass-through relationship, even during the 1990s. This is demonstrated by estimating the pass-through relationship recursively (that is, we estimate the equation up until the March quarter 1990 and successively re-estimate by extending the sample period by one quarter). The lines in Figure 5 trace the extent to which pass-through of a permanent 1% depreciation is estimated to have occurred by the quarter shown. Clearly, the path of adjustment towards long-run equilibrium has remained remarkably stable. In other words, the relative stability of inflation in Australia cannot be attributed to a reduction in exchange rate pass-through, at least at the first stage. This makes second stage pass-through central to assessments of the direct inflationary consequences of currency movements.

[17] And much of it after one quarter. See also Dwyer and Lam (1994).

Figure 4: First stage pass-through impulse response function

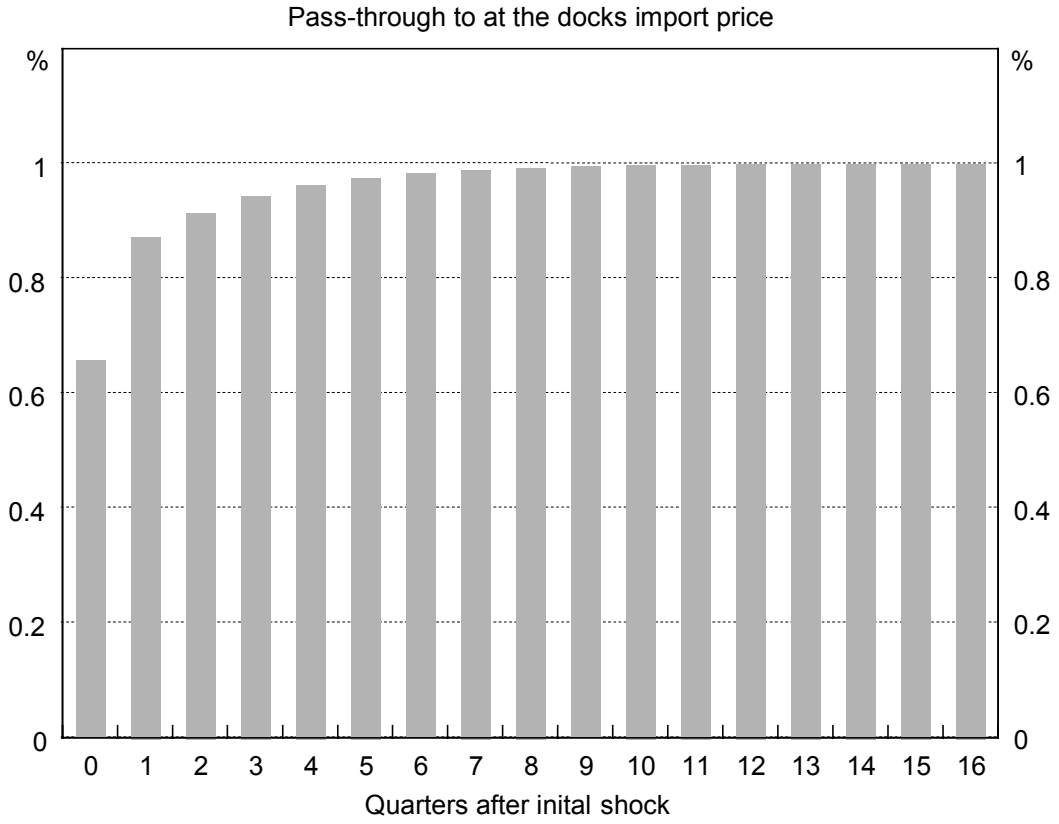
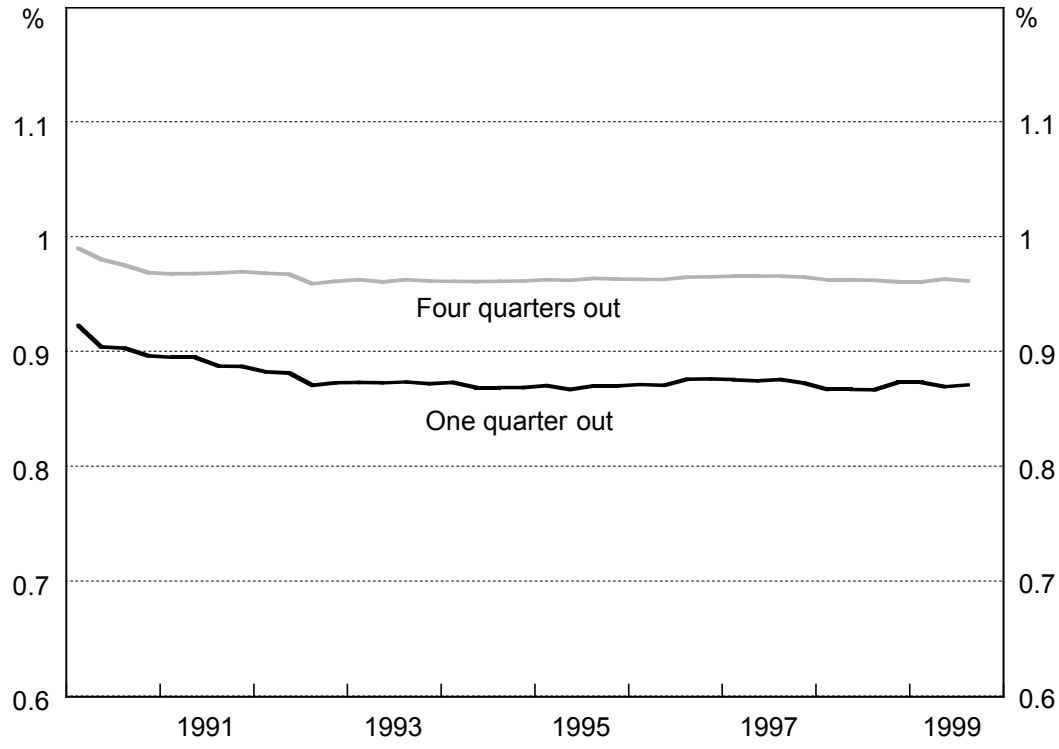


Figure 5: Stability of adjustment to an exchange rate shock



3.1.2 Second stage pass-through

If prices are set as a mark-up on costs, the price of the retail import will be determined by the cost of the import itself and the cost of domestic inputs used in the process of distribution and sale:

$$R = P^{\alpha} C^{(1-\alpha)} \lambda \tag{2}$$

where R is the retail import price, C is the cost of domestic inputs, λ is the mark-up and α is the share of the import in total costs.[18] In this framework, the extent of second stage pass-through is represented by the elasticity of a retail import price with respect to an at the docks price. Although the full increase in P (and C) will be passed on to R, the proportional change in R will be less than unity because the imported good is only one element in the total bundle of costs faced by the retailer. In other words, complete pass-through is defined by the share of the imported item in total costs. For Australia, this share appears to be around two thirds (Prices Surveillance Authority (1989), Dwyer and Lam (1994)).

This characteristic of second stage pass-through is important because, in popular discussion, when movements in retail import prices are observed to fluctuate by less than those at the docks, there has been a tendency to claim that pass-through is incomplete. This need not be so. Investigations of second stage pass-through in Australia that include the experience of the early 1990s have found it to be complete in the long run. That is, around two thirds of a change in import prices (equal to the estimated share of imports in total costs) is eventually passed on at the retail level. But adjustment is very slow, implying that distributors sometimes vary their mark-ups substantially and for considerable periods of time. Furthermore, Dwyer and Lam (1994) found that the mark-up is usually inversely related to changes in the exchange rate so that, in the short run, there is some tendency to absorb the effects of currency depreciation.[19]

We estimate the second stage pass-through relationship, with retail import prices modelled as a mark-up on landed import prices and unit labour costs; the mark-up is allowed to vary over the cycle.[20] Again, we use a standard error correction model, as detailed in Appendix C. Initially, we make no allowance for special factors that may have affected the pass-through relationship and our model yields broadly similar results to those in Dwyer and Lam (1994). The actual and fitted values from this basic model are illustrated in Figure 6. The model explains retail import prices reasonably well (even during earlier episodes of exchange rate shocks). However, since mid-1998, actual prices have been less than predicted.

Does this represent a change in the pass-through relationship or is it the result of special factors? In the Australian case, there would appear to be at least some role for special factors. Motor vehicles account for a substantial share of retail imports,[21] and their prices have been depressed by increased domestic competition in the automotive industry following the efforts of Asian suppliers to expand their share of the Australian market. This culminated in aggressive discounting of motor vehicles sourced from Asia, particularly during the Asian financial crisis.[22]

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[18] Assuming a Cobb-Douglas production function.

[19] However, Dwyer and Lam (1994) found that the inverse relationship between the mark-up and the exchange rate was less evident during the large depreciation of the mid-1980s. They concluded that the magnitude of the depreciation appeared to force many firms out of their "band of inaction" and pass on higher import prices much more quickly. So despite the fact that the experience of the mid-1980s was itself unusual, it has influenced popular expectations about the behaviour of retail import prices.

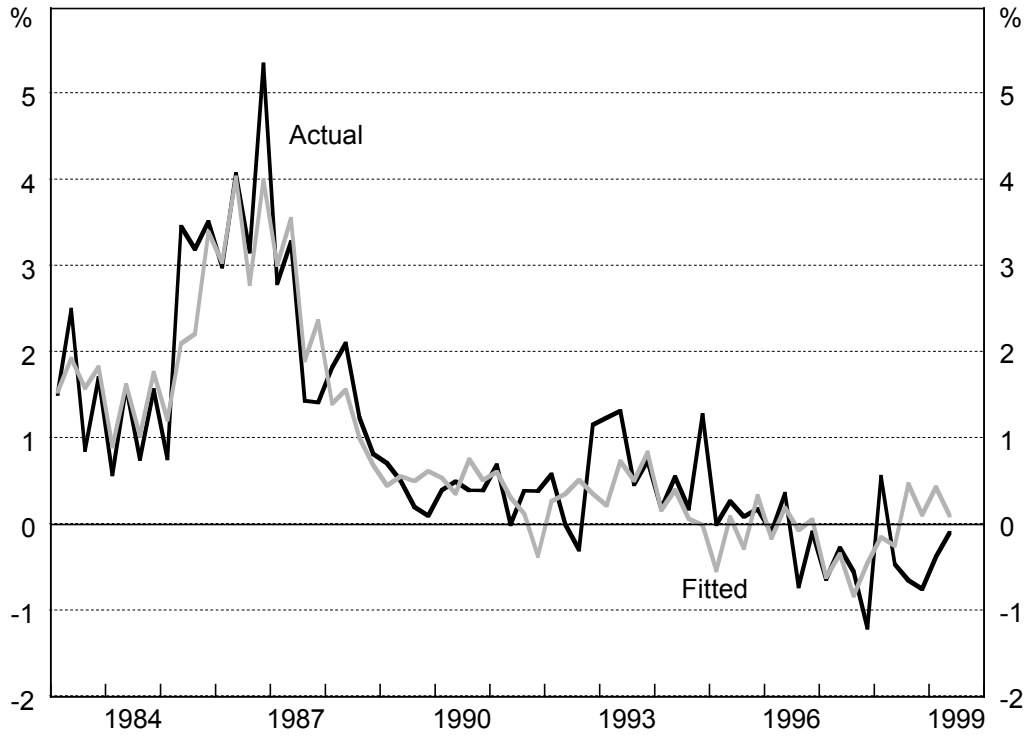
[20] In our model, domestic costs are represented only by unit labour costs rather than the more comprehensive cost index used by Dwyer and Lam (1994).

[21] With a weight of 16% in the imported component of the CPI.

[22] For a more detailed discussion, see Reserve Bank of Australia (1999).

Figure 6: Actual and fitted retail import prices

Quarterly percentage change



We model the second stage pass-through relationship excluding motor vehicles, also detailed in Appendix C. The results are summarised in Figure 7, which compares actual and fitted retail import prices. The extent of over-prediction has been reduced, so that the experience of the late 1990s now looks less unusual. But although the prediction error is not exceptionally large, it remains slightly more persistent than was previously the case. This persistence is statistically significant: only by employing a dummy variable (from the June quarter 1998) is the familiar second stage pass-through relationship restored.[23] Since these developments occur at the end of the sample period, it is difficult to determine whether there has been a temporary disturbance to the pass-through relationship, or a permanent change. Indeed, it is too soon to tell.

One interpretation is that there has been a temporary disturbance to the pass-through relationship, perhaps stemming from a widespread but short-lived discounting of goods sourced from Asia following the Asian financial crisis. Alternatively, there may be more pervasive forces at work that are placing sustained downward pressure on either the domestic costs involved with the distribution and sale of imports, or the mark-ups expected by retailers. These forces would imply a structural change in second stage pass-through and diminish the inflationary consequences of a given shock to import prices at the docks.

We can obtain some insights into the possible behaviour of the distributors' mark-up. Deviations of retail import prices from their long-run equilibrium, which are captured by the error correction term in our equations, imply a variation in the mark-up. We use the error correction term as a measure of the mark-up.[24] These terms, from both models, are plotted in Figure 8.

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[23] See Appendix C.

[24] The mark-up is $\lambda_t = r_t - (a)p_t - (1-a)c_t$, where *r* is the log of retail import prices, *p* is the log of landed import prices, *c* is the log of unit labour costs and *a* and *1-a* are the long-run elasticities reported in Appendix C.

Figure 7: Retail import prices, excluding motor vehicles

Quarterly percentage change

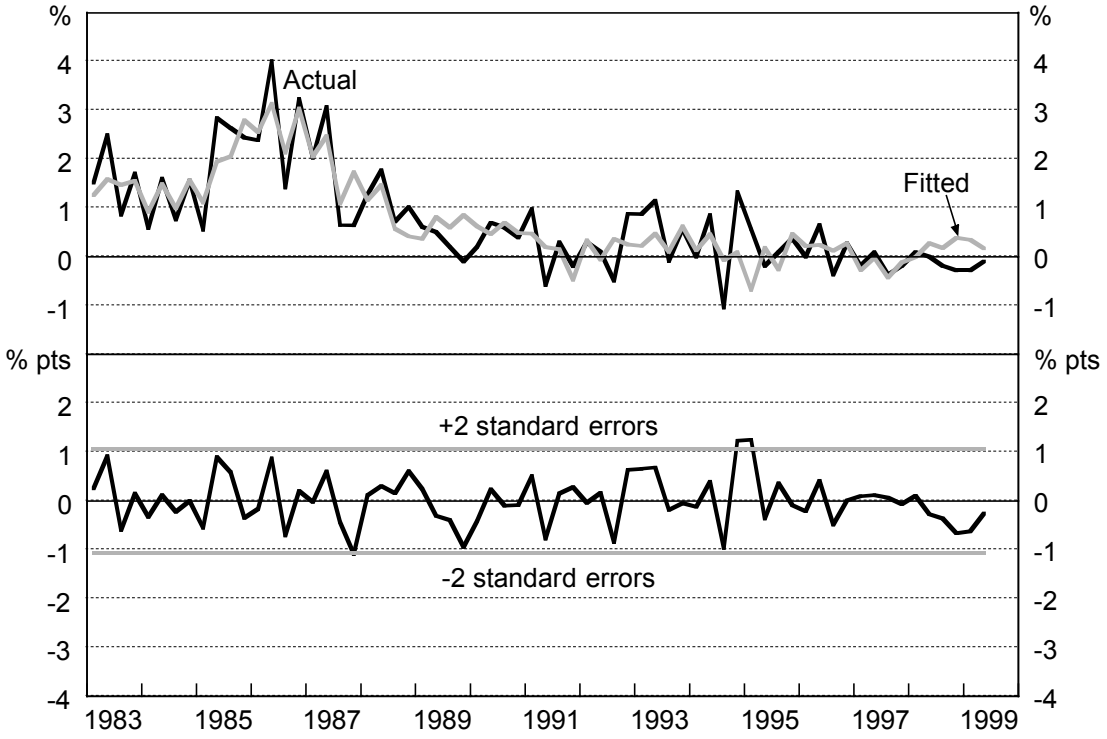
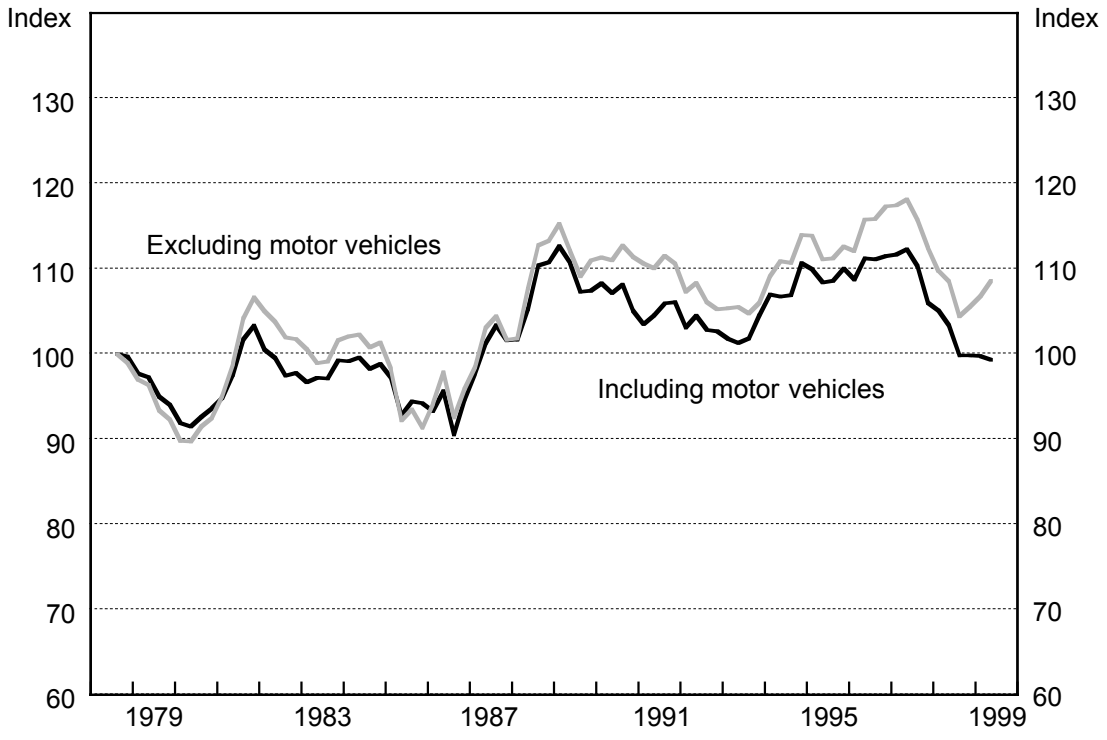


Figure 8: The importers' mark-up

September 1979 = 100



A protracted or unusually large change in the mark-up could suggest the possibility of structural change in the pass-through relationship. However, there is no suggestion of a downward drift in the mark-up during the 1990s. Neither is it clear that the mark-up is now established at a rate below historical norms. The two recent episodes of sharply falling mark-ups follow a period in which the mark-up was high.[25]

The recent behaviour of retail import prices has clearly been helpful for inflation. While the behaviour is unusual, it is too soon to tell whether it stems from temporary influences or is the result of a more fundamental change in the pass-through relationship.

3.2 Wage developments

Of all the influences on final prices, unit labour costs have the largest long-run effect. Furthermore, in the Australian experience, they are passed on more quickly than changes in other costs.[26] So, for a given rate of labour productivity, wage developments are central to inflation performance.[27] The 1990s witnessed significant changes in the wage setting system in Australia, which have implications for the propagation of wage shocks and thereby inflation.

For much of the last century, wage determination in Australia had two defining features: the bulk of wages were centrally determined, and they were indexed (either partially or fully) to the cost of living.[28] In the 1990s, however, there was a move towards enterprise-based agreements.[29] Consequently, at present, roughly 40% of employees are covered by enterprise agreements, 40% are covered by individual contracts and roughly 20% remain in the centralised system (DEWRSB (2000)).[30] The resultant changes in the process of wage bargaining served to undo some longstanding traditions, the first of which was the tendency to preserve wage relativities between workers.

The tradition of preserving wage relativities, known as “comparative wage justice”, had the result that an increase in wages in one sector was usually quickly transmitted to other sectors and resulted in a generalised wage increase. However, under the more recent decentralised system, there has been a greater tendency for wage rises in a given sector to be “quarantined” and not to lead to a generalised wage increase. The effects of this can be summarised by the coefficient of variation in industry wages, shown in Figure 9.[31] Variation in wage growth between industries appears to have increased in the 1990s. Consequently, the pockets of high wage growth during the mid-1990s did not become generalised, leaving aggregate wage growth at a rate consistent with low inflation.

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[25] Even though the mark-ups shown here are the error correction terms of our equations, a very similar pattern of mark-up behaviour in the 1990s can be found in independent estimates of the mark-up obtained by dividing earnings (before interest and depreciation) by sales, and measures of profitability recorded in surveys.

[26] See de Brouwer and Ericsson (1995) and Dwyer and Lam (1994). This may reflect perceptions that changes in wages are permanent while changes in other costs, such as those stemming from exchange rate fluctuations, are temporary.

[27] Indeed, proponents of purchasing power parity would argue that any shock to foreign prices will be associated with an offsetting currency movement so that domestic prices are unchanged. In this case, in the long run, domestic inflation should be determined by domestic costs, such as wages.

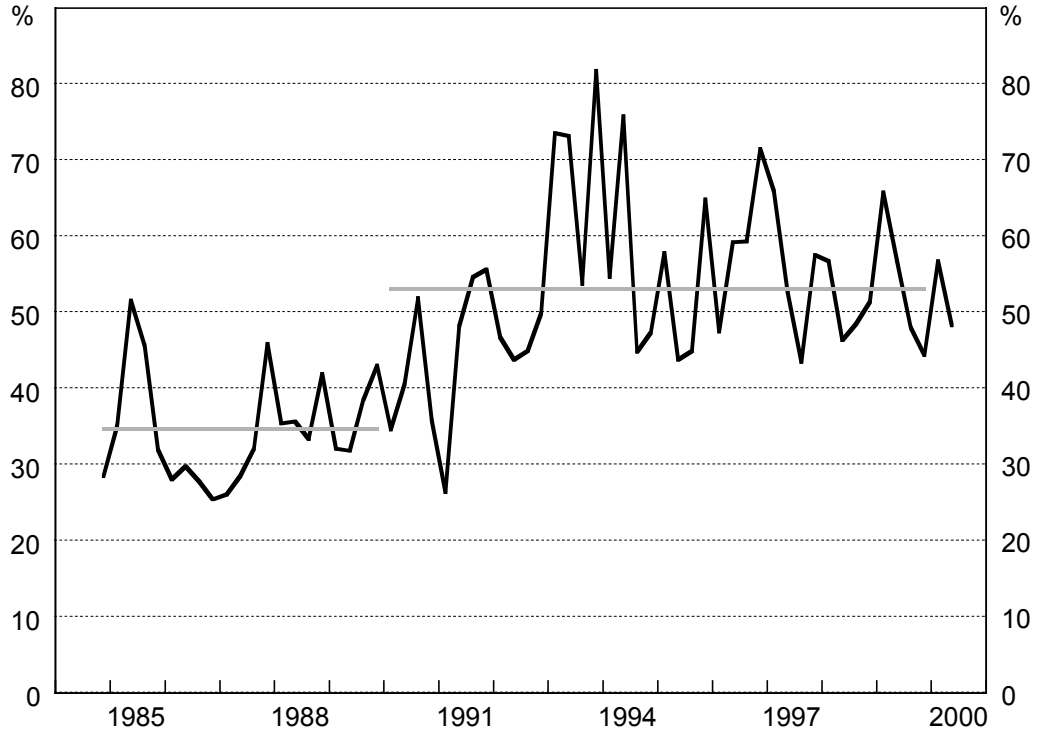
[28] This is, of course, a gross simplification. For a detailed discussion of the wage determination system in Australia, see Niland (1986) and for the period of the Prices and Incomes Accord between labour and the government that operated in the 1980s, see Lewis (1993).

[29] For a detailed discussion, see Wooden (2000).

[30] Workers who are unable to secure wage rises through enterprise bargaining receive “safety net” adjustments of their awards which are determined centrally by the Australian Industrial Relations Commission.

[31] A consistent series of industry-based wage data is not available for the run of years that we wish to consider. We are confined to using the average ordinary-time earnings of adults working full-time in each industry. These data are available from 1983. Before calculating the coefficient of variation, extreme wage changes (that are likely to reflect sampling problems) were trimmed from the distribution.

Figure 9: Coefficient of variation in annual industry wage growth



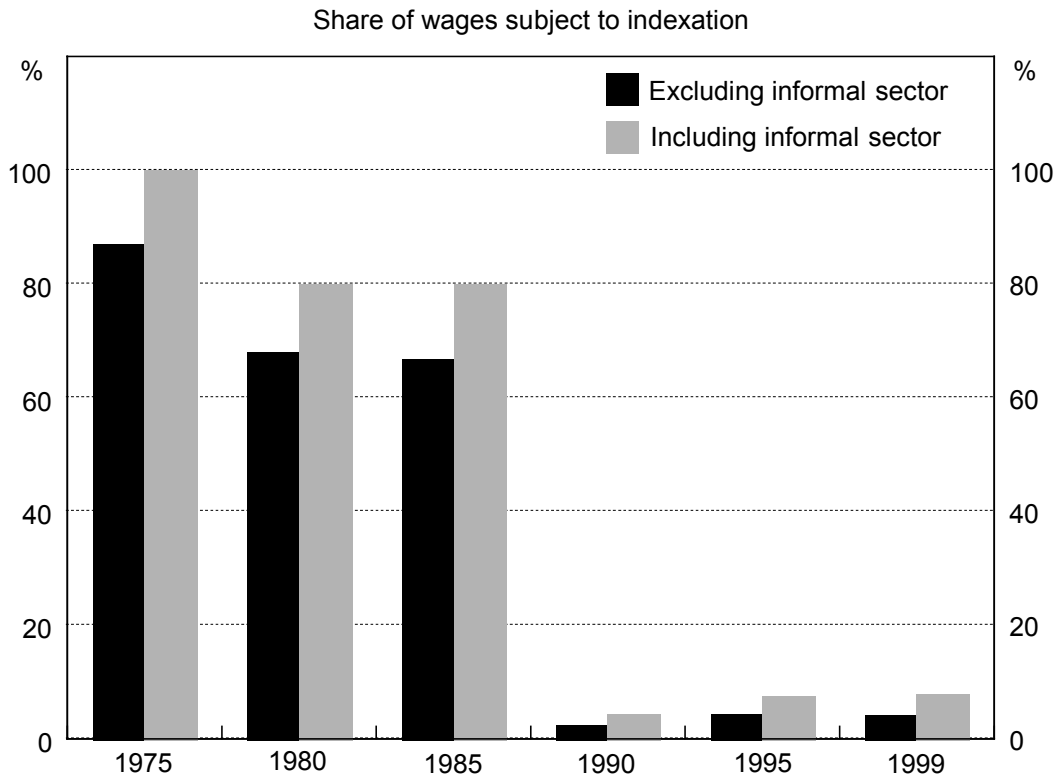
Note: The horizontal lines represent period averages.

Another important consequence of more decentralised wage bargaining is the reduced tendency for automatic indexing of wages to prices, removing a mechanism for the direct transmission of prices to wages. For much of the period of centralised wage determination, there was some form of regular indexation of wages to the cost of living (usually measured by the CPI). In the current system, though, indexation does not generally occur. Rather, it occurs if there is a cost of living adjustment clause in the enterprise agreement or a clause that permits wages to be renegotiated in the event of surprise inflation. However, relatively few enterprise agreements have explicit clauses of this nature. Indexing has, in effect, been replaced by incorporating expected inflation into initial wage demands.

A crude indication of the shift away from automatic wage indexation is given in Figure 10, which attempts to capture the extent to which wages are indexed to the CPI.[32] Two sets of estimates are presented. One set assumes that informal sector contracts (about which there is little published information) are not indexed. The second set assumes that informal sector contracts are indexed in the same way as other types of wage contracts. Regardless of the assumptions, though, there has been a clear regime change in the 1990s. No longer are the bulk of wages in the economy subject to automatic indexation. This diminishes the transmission of price shocks to wages and the potential for a wage-price spiral.

[32] For details about how these estimates have been derived, see Appendix A.

Figure 10: Indexation of wages to prices



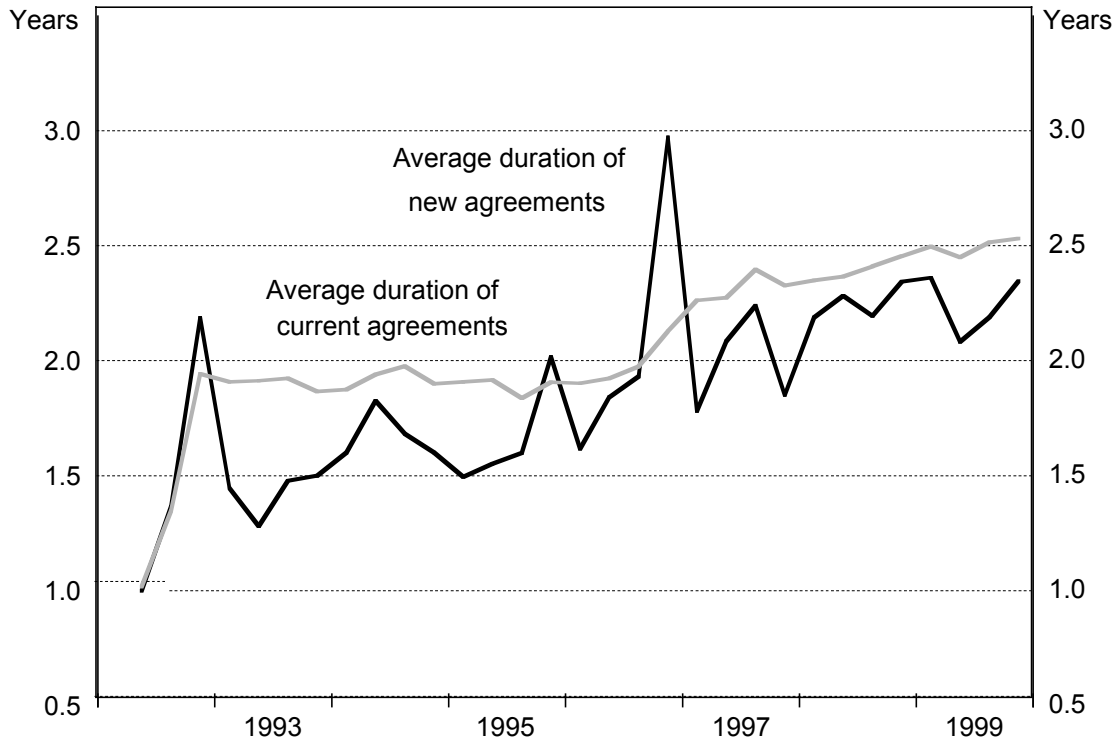
Along with these changes, there has been an increase in contract duration, which has imparted some inertia into the wage setting process. This is highlighted in Figure 11, which plots the average duration of formal federal enterprise agreements since the introduction of the new wage setting system. The duration of new federal agreements registered in each quarter and the duration of all currently active agreements are shown.[33] The general increase in duration is consistent with an environment of low and stable inflation; with lower uncertainty about inflation, agents are likely to revise contracts less frequently.[34] At the same time, the nominal rigidity introduced by longer contract duration means that wage changes may represent a more persistent shock to prices than previously. As it happens, in the second half of the 1990s, this shock was a small one, and so was helpful to the maintenance of low inflation.

The permanency of the regime change in wage setting arrangements can, however, be overstated. The economies of scale in bargaining are encouraging some labour market participants to seek more coordinated industry-wide bargaining rather than negotiating at the workplace level. If uncertainty about the future path of inflation increases, wage indexation may become fashionable again. And a reduction in macroeconomic stability may encourage more frequent resetting of wage contracts. But notwithstanding these possibilities, the containment of sectoral wage pressures, combined with an increase in the duration of contracts with modest rates of wage growth, has made it easier to maintain the low inflation outcomes of the 1990s.

[33] The Department of Employment, Workplace Relations and Small Business (DEWRSB) maintains a census of formal enterprise agreements in the federal jurisdiction.

[34] While reduced uncertainty about inflation reduces the need to revise contracts, under the new system of enterprise bargaining in Australia, increased contract duration is also a function of increased maturity in the bargaining process.

Figure 11: Duration of registered federal enterprise wage agreements



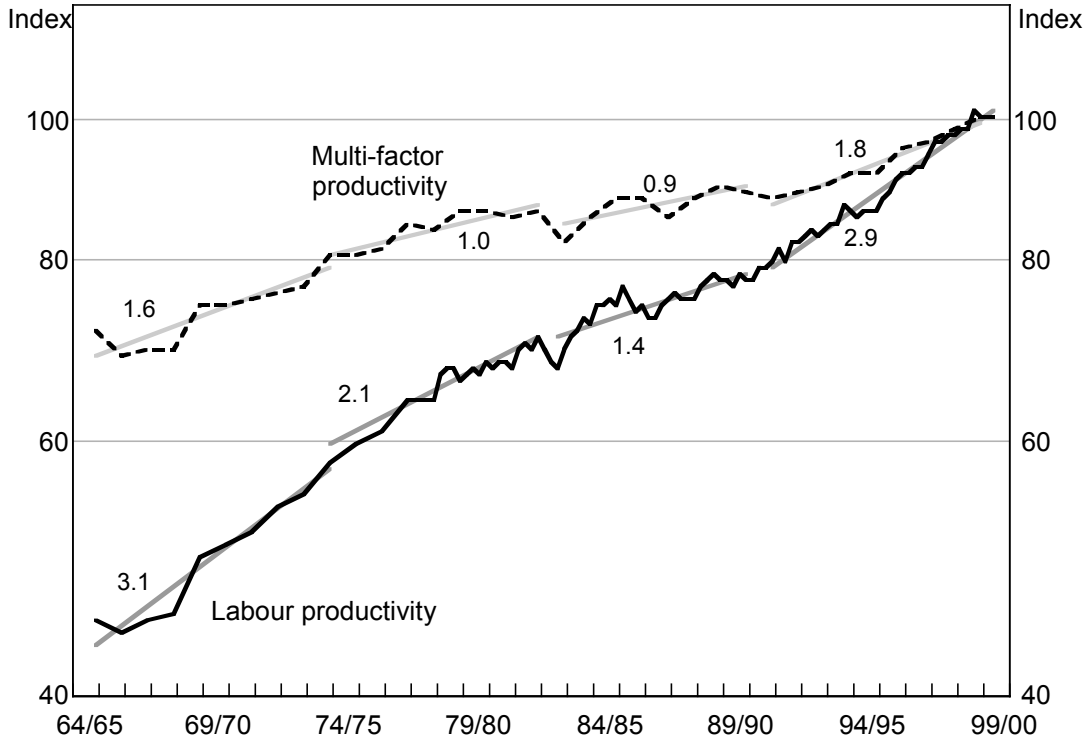
3.3 Productivity

Another important influence on inflation performance in the 1990s has been the sustained strength of labour productivity growth which, like inflation, has returned to rates not witnessed for more than a generation.

Figure 12 presents trends in market sector productivity since the mid-1960s, and is taken from Gruen and Stevens (2000). Measured productivity growth tends to vary during the course of a business cycle, as inputs are used more intensively when demand is increasing than when it is slowing. Consequently, we focus on average rates of productivity growth over entire economic expansions, depicted here by the trend lines.[35] Growth rates of both labour and multi-factor productivity are clearly faster than in the economic expansions of the previous two decades, while growth in multi-factor productivity now exceeds that in the 1960s. The pickup in labour productivity growth tends to attract most attention. However, the growth in multi-factor productivity (which abstracts from the effects of substitution between labour and capital) provides even more compelling evidence that there was an increase in the rate of technological progress in the 1990s.

[35] That is, from troughs to peaks in output. See Gruen and Stevens (2000) for a more detailed discussion.

Figure 12: Productivity in the market sector
1998/99=100, log scale



Workers do not appear to have captured all of the productivity gains in the form of higher real wages.[36] Consequently, the increase in trend productivity growth has been associated with low growth in unit labour costs, which has imparted a clear disinflationary impulse. In fact, in Australia over the past decade, the weakness in unit labour cost growth has resulted in a fall in labour's share of income, suggesting that the strength of productivity growth in the current expansion may not have been fully appreciated by wage negotiators.

While the trend increase in productivity has lowered growth in unit labour costs, it has also increased potential output in the economy, so that supply side constraints on prices are less binding. However, the extent to which this has occurred is difficult to determine. Assessments of potential output, and the attendant output gap, are better done in retrospect than in real time. There is the inherent "end point problem" involved in determining the trend rates of output growth from which we gauge potential, and a tendency for output data to be revised. Consequently, real-time assessments of output gaps are often wrong (Orphanides (2000)).[37] If there has been belated recognition of the strength of productivity improvements in the 1990s, actual output gaps may be wider than those that have informed policy decisions, playing a role in the surprisingly low inflation outcomes of recent years.

Although the structural improvement in productivity during the 1990s would appear to have been a helpful influence on inflation outcomes, it is less clear that its effects will be ongoing. High productivity is not a sufficient condition to achieve low inflation. Rather, it makes it easier to achieve low inflation once monetary policy is "committed to that end" (Gruen and Stevens (2000)).[38] And much depends on how the gains from productivity are distributed between prices, profits and wages. While the

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[36] Certainly, real wages (both real product and consumption wages) have grown at a rate less than trend productivity.

[37] For example, in the 1970s policymakers thought that output gaps were much larger than they actually were, because of belated recognition of a productivity slowdown (Orphanides (2000)).

[38] As Gruen and Stevens (2000) point out, the experience of the second half of the 1970s is a reminder of how high productivity can be associated with high inflation.

experience of the 1990s was one in which a significant share of the gains from higher productivity was reflected in lower prices, in another episode the distribution of gains may be quite different, and may carry different implications for inflation.

4. The inflation process

The 1990s witnessed changes in the behaviour of key explanators of inflation that have been conducive to low inflation. Some of this behaviour was unusual and some has been indicative of a more structural, although not necessarily permanent, change. Taken together, have these developments generated a change in the inflation process?

To answer this question, we first appeal to econometric evidence of structural breaks in a mark-up model of inflation for Australia. We refer to the inflation equation, detailed in Beechey et al (2000), in which prices are modelled as a mark-up on import prices and unit labour costs; the mark-up is allowed to vary cyclically with the output gap and is also influenced by oil prices.[39] (The equation has been estimated using an error correction specification.)

Beechey et al (2000) have examined the stability of this equation, focusing on whether a structural break is evident in the March quarter of 1993, which corresponds to the introduction of the inflation targeting regime. While their purpose was to test the relevance of the Lucas critique for the model, given the change in articulation of monetary policy objectives the same break point usefully defines the beginning of the current low-inflation episode. They found that a structural change in the inflation process in the post-break period is not indicated by standard Chow-type tests (on the significance of individual dummies or on their joint significance). However, this standard test of structural stability may mask useful details of changes in the way shocks to inflation are propagated.

An alternative insight into possible structural changes in the inflation process can be gleaned by examining the speed with which inflation responds to disequilibrium in the long-run relationship between prices and costs. The error correction specification of the inflation equation is helpful in this regard because it features a speed of adjustment parameter. We re-estimate the Beechey et al inflation equation over a slightly longer sample, and test the stability of the speed of adjustment parameter by using recursive estimation. (That is, we estimate the equation from the March quarter of 1985 up until the March quarter of 1990, and then successively re-estimate the equation over samples that have been extended by one quarter.)[40] The speed of adjustment parameter is plotted for each sample period in Figure 13.

A widely held view is that the low-inflation environment of the 1990s was accompanied by an increase in inertia in the inflation process. If so, we would expect to see a fall in the speed of adjustment. Within the bounds of our confidence interval, such a fall is possible. However, our point estimates of the speed of adjustment parameter were fairly stable during the 1990s.

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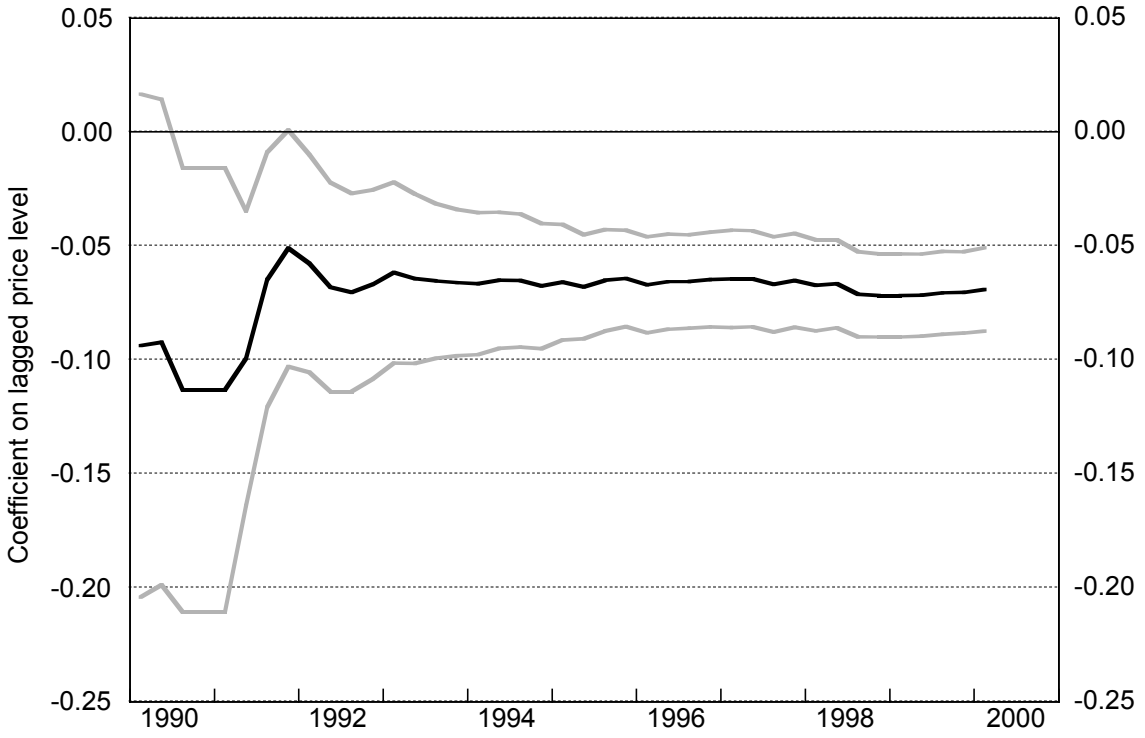
[39] See Beechey et al (2000) for a detailed discussion of the properties of this equation.

[40] See Appendix D. The start date for estimation of the inflation equation remains the March quarter of 1985 but our sample end point is more recent than that in Beechey et al (2000). Earlier start dates are often associated with structural instability that stems from the major shifts in labour's share of income in the mid-1970s and early 1980s.

Figure 13: Speed of adjustment



Note: The black line is the point estimate of the speed of adjustment parameter and the shaded lines represent the 95% confidence interval of this estimate.

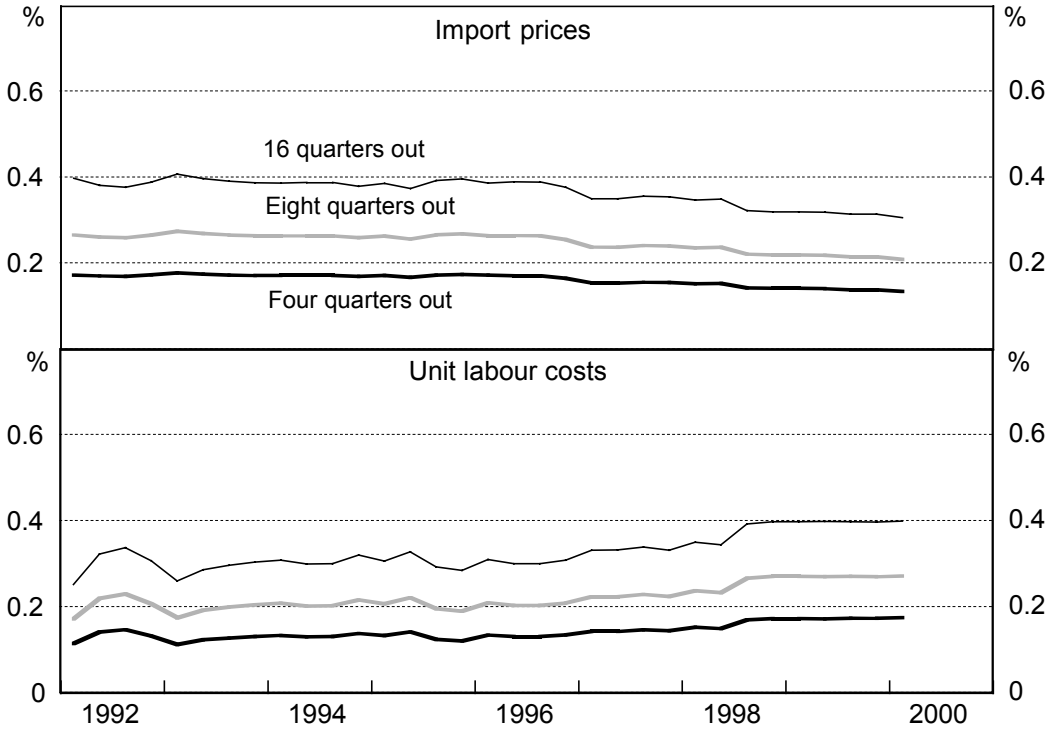
While the speed of adjustment parameter determines the eventual length of time taken to restore long-run equilibrium following a shock, the path of adjustment to equilibrium is also influenced by short-run dynamic terms. To examine this path of adjustment, we use impulse response functions. We identify the magnitude of the response to a shock that has occurred after a given number of quarters. By using recursive estimation, we identify whether this magnitude has changed through time. The top panel of Figure 14 presents results for a permanent 1% increase in import prices. Each line traces the extent to which adjustment is estimated to have occurred by the period shown. The bottom panel presents the corresponding results for unit labour costs.

Our estimation suggests that since the mid-1990s, there has been a slight downward drift in the degree of response of consumer price inflation to a shock to import prices. This is most evident over time horizons greater than four quarters. The corollary of this change has been a slight upward drift in the degree of response of inflation to a shock to unit labour costs.[41] In each case, the degree of change is not statistically significant. The confidence intervals around the point estimates in the early part of the sample overlap with those at the end of the sample, making it unlikely that any statistical test will reject the hypothesis of "no change" in the adjustment process.[42] The changes in point estimates that we observe would, however, be economically significant in the presence of large shocks to either import prices or unit labour costs.

[41] Linear homogeneity is accepted and imposed in the model. Therefore, a change in the estimated long-run response of consumer prices to a (permanent) import price shock is offset by an equal but opposite change in the response to a unit labour cost shock.

[42] To avoid clutter, the confidence intervals around each set of point estimates have not been drawn in Figure 14.

Figure 14: Response of consumer prices to shocks; stability of adjustment



Suppose that these point estimates of the degree of response to shocks capture actual changes in the nature of adjustment. Since the incentive to reset prices increases with the persistence of the shock to costs, one interpretation of the results is that, over the past decade, there has been a growing tendency for price setters to perceive import price shocks as transitory and unit labour costs shocks as persistent.[43] Such a change in responsiveness to shocks is consistent with low inflation outcomes because shocks to unit labour costs - that is, the more persistent of the shocks - were relatively small, especially during the second half of the 1990s.

Two of our tests of structural stability (the Chow-type test and the examination of the speed of adjustment parameter) fail to provide evidence of a change in the inflation process during the 1990s. Our third test, which focuses on the dynamics of adjustment to a shock, gives a much stronger suggestion that a change has occurred, although the results are not statistically significant. Ideally, to obtain a clearer picture, we would compare the degree of response to shocks in the 1990s with that in an earlier decade. In principle, this could be achieved by choosing an earlier start date for estimating our mark-up model of inflation and performing recursive regressions that, say, captured the experience of the 1980s. However, estimation of a mark-up model over longer samples is difficult, due to the major shifts in labour's share of income during the 1970s and 1980s.[44] Equations estimated over some longer samples display structural instability. Perhaps part of this instability reflects a change in the inflation process that we have not uncovered. But the popular view is that such change, should it have occurred, would be evident during the 1990s. Our results hint at some evolution of the inflation process over this period.

[43] See Taylor (2000) for a detailed analysis of the impact of perceived persistence of shocks in pricing behaviour.

[44] Given that labour's share of income is, in effect, the reciprocal of a mark-up. For a detailed discussion of the difficulty in estimating mark-up models in the presence of shifts in labour's share of income, see Cockerell and Russell (1995).

5. Conclusion

Inflation in the past decade in most industrialised countries, including those without inflation targets, has been surprisingly low. At issue is whether this outcome is the product of favourable shocks or a fundamental change in the inflation process.

We find that some of the determinants of inflation in Australia have undergone unusual or structural change in recent years, the effects of which have been clearly disinflationary. Consequently, an unexpectedly benign inflation environment has played an important role in the low inflation outcomes of the 1990s. We also find tentative evidence that, for some determinants, there has been a change in their relationship with inflation. These changes are not very statistically significant, and should be interpreted cautiously. They may, however, be economically significant. Furthermore, they appear to have been evolving throughout the past decade. This leaves open the possibility that some forces may be emerging that could help reduce the variability of inflation in response to shocks.

Despite this possibility of change, it cannot be said that the inflation process in Australia has become permanently more immune to shocks. The future may hold unhelpful influences on inflation. If these influences are large or persistent, inflation may not turn out to be as well behaved as it was in the 1990s. There remains an important role for monetary policy to anchor price expectations and convince the community that, while some variation in inflation is inevitable in the face of shocks, price stability will be quickly restored.

Appendix A: Data

Nominal exchange rate

Definition: Australian dollar against a nominal GDP-weighted average of G7 currencies. Indexed to 1980 = 100.

Source: Reserve Bank of Australia, unpublished data.

Import prices at the docks

Definition: Implicit price deflator for merchandise imports, excluding fuels and lubricants, civil aircraft and Reserve Bank of Australia imports of gold. Indexed to 1989/90 = 100.

Source: *National Income, Expenditure and Product*, ABS Cat No 5206.0.

Reserve Bank of Australia imports of gold data not publicly available.

Tariff rate

Definition: Customs duty receipts divided by the value of merchandise imports (excluding fuels and lubricants, civil aircraft and Reserve Bank of Australia imports of gold). Seasonally adjusted.

Source: Australian Customs Service.

Retail import price

Definition: Final price of items wholly or predominantly imported in the consumer price index.

Source: *Consumer Price Index; Effect of Change in Prices of Imported Items*,

ABS Cat No 6444.0.

Foreign export prices

Definition: Nominal GDP-weighted average of G7 export price indices. Indexed to 1990 = 100.

Source: Export price indices from Datastream.

Foreign consumer prices

Definition: Geometric import-weighted average of core consumer prices of G7 countries. Calculated as the ratio of nominal and real G7 import-weighted exchange rates. Indexed to 1989/90 = 100.

Source: Reserve Bank of Australia, unpublished data.

Oil price

Definition: Australian dollar price of West Texas Intermediate crude oil per barrel. Calculated using the US dollar price per barrel of West Texas Intermediate crude oil and the AUD/USD exchange rate. Indexed to 1989/90=100.

Source: Bloomberg, nearest contract price CL1 CMDTY.

Consumer price index (CPI)

Definition: Acquisitions consumer price index. Indexed to 1989/90 = 100.

Source: *Consumer Price Index*, ABS Cat No 6401.0.

Treasury underlying CPI

Definition: Consumer price index excluding selected items defined to be seasonal, volatile or non-market determined. Indexed to 1989/90 = 100.

Source: Commonwealth Treasury Department published in *Consumer Price Index*, ABS Cat No 6401.0.

Unit labour costs

Definition: Non-farm unit labour costs per hour per wage and salary earner. Indexed to 1989/90 = 100.

Total non-farm labour costs (wage and salary earners) per hour divided by productivity per hour in the non-farm sector.

Source: *National Income, Expenditure and Product*, ABS Cat No 5206.0.

Non-wage labour costs data obtained by special request from the ABS.

Industry wages

Definition: Average ordinary-time earnings of adults working full-time, by industry. These data are only available since 1983. For manufacturing wages used in Table 1, in the period prior to 1983, average total earnings for all adult males are used.

Source: *Average Weekly Earnings*, ABS Cat No 6302.0.

Type of wage contract

Definition: Awards are determinations of federal or state industrial tribunals that apply to workers in their jurisdiction. Enterprise agreements are those wage contracts negotiated collectively at the enterprise or workplace level that are registered with the Australian Industrial Relations Commission. Awards and registered collective agreements are said to comprise the "formal" sector. All other wage contracts are defined as "informal".

Sources: *AWIRS95*, *AWIRS90*, *Award and Agreement Coverage Survey* (1999), *Award Coverage in Australia*, ABS Cat No 6315.0.

Indexation of wages to prices

Method: In each period, the share of the wage contracts eligible for indexation is identified and then multiplied by the degree of indexation. Initially, only wage contracts in the formal sector (about which there is more data) are considered eligible for indexation. Subsequently, assumptions are made about the possible extent of indexation in the informal sector.

Formal sector:

From 1975 to 1985, only awards are considered eligible for indexation. Awards as a share of wage contracts are multiplied by the rate of indexation awarded in the national wage case of that year to give a measure of the extent to which all wage contracts are indexed.

From 1990, with the cessation of wage indexation in national wage cases, only those enterprise agreements with indexation clauses are considered eligible for indexation. For simplicity, full indexation is assumed.

Informal sector:

From 1975 to 1985, non-award contracts comprise the informal sector. In each period, these contracts are assumed to receive the same rate of indexation as that prevailing in the formal sector.

From 1990, the informal sector comprises wage contracts other than awards and registered collective enterprise agreements. In each period, it is assumed that the share of informal wage contracts subject to indexation is the same as that for enterprise agreements with indexation clauses. For simplicity, full indexation is assumed.

Sources: *AWIRS95*, *AWIRS90*, *Award and Agreement Coverage Survey* (1999), *Award Coverage in Australia*, ABS Cat No 6315.0, national wage cases summarised in Plowman (1986) and ACTU (1996).

Output gap (economy wide and retail)

Definition: Potential output less actual output. Potential output is obtained by smoothing actual output with a Hodrick-Prescott filter. To avoid "starting point problems", the filter is commenced five years before the beginning of the estimation period for the output gap.

Source: *National Income, Expenditure and Product*, ABS Cat No 5206.0.

Appendix B: First stage import price equation

The first stage pass-through relationship is estimated from the March quarter of 1985. Results from an error correction equation are shown below. In the equation, linear homogeneity is accepted and has been imposed.

Table B1

Explaining import prices[1]

(estimated from 1985 Q1 to 1999 Q3)

	Coefficient	Std error
Independent variable		
Constant	153.2712	40.2754***
Import prices (lag 1)	– 0.3345	0.0889***
World prices (lag 1)	0.3345	0.0889***
Exchange rate (lag 1)	– 0.3345	0.0889***
Change in the exchange rate (lag 0)	– 0.6572	0.0303***
Change in the exchange rate (lag 1)	– 0.0998	0.0462**
Change in world prices (lag 0)	0.5669	0.2115***
Change in world prices (lag 1)	0.3887	0.2113*
Trend[2]	– 0.1077	0.0261***
Dummy 1998 Q2-1999 Q3[3]	– 2.7964	0.6993***
Long-run elasticities		
World prices	1	
Exchange rate	– 1	
Adjusted R^2	0.9199	
Residual autocorrelation LM(4)		{0.0715}
Breusch-Pagan heteroscedasticity test		{0.0022}
Jarque-Bera normality test		{0.0302}
Linear homogeneity[4]		{0.9843}

[1] The equation is from Beechey et al (2000). ***, ** and * represent significance at the 1, 5 and 10% levels. Numbers in braces {} are p-values. All variables in log-levels are multiplied by 100 (so growth rates are in percentages). Given the evidence of heteroscedasticity, the standard errors reported are White heteroscedasticity-consistent standard errors. [2] The trend captures the shift in imports towards lower-priced goods from non-G7 countries. [3] The dummy captures price undercutting by Asian exporters following the Asian crisis. [4] Linear homogeneity implies that the coefficients of the world price and exchange rate are 1 and -1, ie the PPP restriction holds.

Appendix C: Second stage import price equation

The second stage pass-through relationship is estimated from the September quarter of 1978 to the June quarter of 1999, after which the retail import price series is discontinued. Results from error correction equations are shown below. The first table presents results for the case in which motor vehicles are included in the retail price of imports. The second table presents results for the case in which they are excluded and a dummy is imposed from the June quarter of 1998 to control for the effects of the Asian financial crisis. In both cases, linear homogeneity is accepted and has been imposed.

Table C1

Explaining import prices[1]

(estimated from 1978 Q3 to 1999 Q2)

	Coefficient	**Std error**
Independent variable		
Constant	– 16.6578	3.7844***
Retail import prices (lag 1) – Unit labour costs (lag 1)	– 0.0834	0.0166***
Landed import prices (lag 1) – Unit labour costs (lag 1)	0.0541	0.0088***
Change in retail import prices (lag 2)	0.4261	0.0996***
Change in retail import prices (lag 3)	– 0.0014	0.0858
Change in retail import prices (lag 4)	0.2352	0.0972**
Retail output gap (lag 2)	0.0017	0.0004***
Long-run elasticities		
Unit labour costs	0.3509	0.0939
Landed import prices	0.6491	0.0939
Adjusted R2	0.8048	
Residual autocorrelation LM(4)		{0.0664}
Breusch-Pagan heteroscedasticity test		{0.2251}
Jarque-Bera normality test		{0.2143}
Linear homogeneity[2]		{0.2672}

[1] ***, ** and * represent significance at the 1, 5 and 10% levels. Numbers in braces {} are p-values. All variables in log-levels are multiplied by 100 (so growth rates are in percentages). [2] Linear homogeneity implies that the long-run elasticities on unit labour costs and landed import prices sum to unity.

Table C2

Explaining retail import prices, excluding motor vehicles[1]

(estimated from 1978 Q3 to 1999 Q2)

	Original		With dummy variable	
	Coefficient	**Std error**	**Coefficient**	**Std error**
Independent variable				
Constant	–15.3484	3.5867***	–15.5766	3.5026***
Retail import prices (lag 1) – Unit labour costs (lag 1)	– 0.0583	0.0196***	– 0.0652	0.0194***
Landed import prices (lag 1) – Unit labour costs (lag 1)	0.0506	0.0109***	0.0561	0.0110***
Change in retail import prices (lag 2)	0.2657	0.0957***	0.2365	0.0944**
Change in retail import prices (lag 3)	0.0207	0.0830	– 0.0140	0.0826
Change in retail import prices (lag 4)	0.3021	0.0939***	0.2841	0.0921***
Retail output gap (lag 2)	0.0015	0.0004***	0.0016	0.0003***
Dummy 1998 Q2-1999 Q2			– 0.5589	0.2616**
Long-run elasticities				
Unit labour costs				
Landed import prices	0.1315	0.1669	0.1396	0.1439
	0.8685	0.1669	0.8604	0.1439
Adjusted R2	0.7399		0.7522	
Residual autocorrelation LM(4)		{0.3884}		{0.1421}
Breusch-Pagan heteroscedasticity test		{0.9904}		{0.9131}
Jarque-Bera normality test		{0.5714}		{0.6600}
Linear homogeneity[2]		{0.5983}		{0.8968}

[1] ***, ** and * represent significance at the 1, 5 and 10% levels. Numbers in braces {} are p-values. All variables in log-levels are multiplied by 100 (so growth rates are in percentages). [2] Linear homogeneity implies that the long-run elasticities on unit labour costs and landed import prices sum to unity.

Appendix D: Inflation equation

The inflation equation is estimated from the March quarter of 1985. Results from an error correction equation are shown below. In the equation, linear homogeneity is accepted and has been imposed.

Table D1

Explaining consumer prices[1]

(estimated from 1985 Q1 to 2000 Q1)

	Coefficient	Std error
Independent variable		
Constant	– 0.4277	0.3879
Consumer prices (lag 1)	– 0.0690	0.0091***
Unit labour costs (lag 1)	0.0391	0.0135***
Landed import prices (lag 1)	0.0299	0.0061***
Unit labour cost growth (lag 0)	0.0467	0.0308
Landed import price growth (lag 0)	0.0363	0.0139**
Oil price growth (lag 1)	0.0075	0.0030**
Output gap (lag 3)	0.1699	0.0270***
Change in the output gap (lags 0,1,2)[2]	0.0848	0.0345**
Dummy 1990 Q4[3]	0.9766	0.3041***
Dummy 1991 Q1	– 1.3333	0.3033***
Dummy 1999 Q1	– 0.4824	0.2721*
Long-run elasticities		
Unit labour costs	0.5662	0.1296
Landed import prices	0.4338	0.1296
Adjusted R2	0.8670	
Residual autocorrelation LM(4)		{0.3810}
Breusch-Pagan heteroscedasticity test		{0.1439}
Jarque-Bera normality test		{0.5399}
Linear homogeneity[4]		{0.1819}

[1] The equation is an updated version of that in Beechey et al (2000). ***, ** and * represent significance at the 1, 5 and 10% levels. Numbers in braces {} are p-values. All variables in log-levels are multiplied by 100 (so growth rates are in percentages). [2] The restriction that the coefficients on each lag are equal is accepted and imposed. [3] The dummies allow for large but short-lived spikes in oil prices. [4] Linear homogeneity implies that the sum of the coefficients of unit labour costs and landed imported prices is equal to the absolute value of the coefficient of consumer prices.

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