Commodity Prices and the Dynamics of Inflation in Australia∗

by

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1. Introduction

Explanations of inflation tend to emphasise domestic market conditions, particularly labour market institutions and the strength of demand for domestic output relative to productive capacity. In the present paper we examine an additional influence on the inflationary process, namely the prices of primary commodities. Our approach is to incorporate primary product prices into a structural model of pricing that is developed from the pricing analysis of Michal Kalecki.

Kalecki (1971) treats the cost of finished goods as determined by both the prices of primary commodities used as raw materials and the wage rates of industrial labor. He then argues that primary commodity prices have a stronger positive relationship to the business cycle than do wage rates, so the ratio of primary commodity prices to wage rates is pro-cyclical. Further, prime costs are marked up to determine finished goods prices, implying cyclical variation in the real wage rate and distribution of income.

We employ Kalecki’s pricing analysis to consider the implications for the dynamics of inflation arising from the cyclical behaviour of primary product prices. Our particular concern is that the pro-cyclical movement in primary commodities relative to wage rates can set off a wage-price spiral for finished goods through the resulting pressure on the nominal wages of industrial workers. Of course, this scenario can also work in reverse, as Beckerman and Jenkinson (1986) suggest in explaining the fall of the rate of inflation in the UK in the early 1980s. The general issue is whether, and to what extent, shocks to nominal commodity prices impact on the aggregate price level as well as on the relative price of primary commodities and manufactured goods.
We examine this possibility by estimating an econometric model of the inflationary process in the Australian economy over the period since the float of the Australian dollar in 1984.

Kalecki develops his pricing analysis for the case of a closed economy, so we extend his framework two ways to apply it to the open Australian economy. First, we allow the price of competing foreign products to affect prices of domestic finished goods, following Bloch (1996) in treating the degree of monopoly for domestic products as influenced by the relative price of domestic and competing foreign products. Second, we introduce an exchange rate equation to provide a link between foreign and domestic prices. Bloch (1991) shows that this is particularly important in the case of Australia, as primary commodities have been so dominant in Australian exports that the Australian dollar is generally considered to be a “commodity currency”. We therefore need to establish whether the Australian dollar price of raw materials follows the worldwide pattern or deviates due to offsetting fluctuations in the exchange rate.

Our estimating model is described in Section 2, which also contains a discussion of the predicted impacts for key variables. The data, estimation method and empirical results are discussed in Section 3. Finally, Section 4 presents conclusions and discusses the implications for economic policy in Australia.

2. Modelling Commodity Prices and Australian Inflation

Markets for primary commodities are notoriously volatile, arising from the interaction of inelastic demand (for both price and income) and variable supply. They are also
prone to periods of boom and bust of significant magnitude (see Sapsford and Morgan, 1994 for an overview). Maizels (1992) demonstrates how volatile prices have been in the 1980s. Sugar, for example, has seen world market prices vary between 2.5 and 41 US cents per pound, while coffee has ranged between 60 and 303 cents per pound. “Hard” commodities have not been insulated from this volatility either, with aluminium prices varying between 42 and 162 cents and copper between 58 and 159 cents. While only a limited sample, it is illustrative of the more general experience of price uncertainty and variability in primary commodity markets.

Kalecki (1971) treats primary commodity prices as determined by supply and demand forces in world markets. He also notes that primary commodities are used as raw materials to the manufacturing process so that demand increases with industrial production. A strong pro-cyclical movement is shown in Figure 1, where the movement in OECD industrial production is shown along with movement in the IMF index of primary commodity prices over the period from 1984, quarter 2, through 1998, quarter 4. Also, noticeable in Figure 1 is the substantial volatility in primary commodity prices.

*** Inset Figure 1 near here ***

In Bloch and Sapsford (1991-92), we expand this treatment to include other influences on the demand and supply of primary commodities and to treat primary commodity prices as determined in world markets. World demand increases with the prices received for manufactured products and with the prices of substitute inputs in
manufacturing production, particularly with the manufacturing wage and the rental
price of capital. The world supply of primary products in the long run depends on the
cost of production, which in turn reflects technology, wage levels and capital costs in
primary production. Due to the long lead time for many primary commodity
production projects, primary commodity production is generally subject to capacity
constraints in the short to medium run, implying upward sloping supply functions,
which shift with changes in productive capacity due to investment or technical
progress.

A short-run world pricing equation for primary commodities in which we treat
capital as a quasi-fixed input to production can be written in general form as:

\[
pc = f[X, \, px, \, w, \, r, \, \varepsilon, \, TC]
\]  

In (1), \(pc\) is the world price of the primary commodity expressed in US dollar terms.
\(X\) and \(px\) are measures of total world industrial production (given by the sum of \(X_j\)
over all countries) and the average price at which this product is sold in the various
countries, respectively. \(w\) and \(r\) are average measures across manufacturing and
primary production for the wage rate and cost of capital, respectively, with the
average taken across countries (given ideally by an appropriately weighted average of
the \(w_j\) and \(r_j\) individual country wage rates and capital costs, respectively). \(\varepsilon\) is a
disturbance term for the influence of supply shocks (such as droughts, floods and
earthquakes). Finally, \(TC\) is an index of productive capacity across primary
producers.
Pro-cyclical movement in primary commodity prices is expected in (1), as the primary commodity demand moves in the same direction as industrial production and the short-run supply curve is upward sloping. By similar argument, prices of industrial products are expected to have a positive influence on primary product prices. Positive impacts of wages and capital costs are also expected, as these increase either the production cost of primary commodities or the price of substitute inputs in the manufacturing process. Finally, a negative impact is expected for increases in capacity due to investment and technical progress, which increase short-run commodity supply.¹

Australia’s foreign exchange rate is linked to primary product prices through their influence on her terms of trade. Bloch (1991) finds that Australia, as a substantial net exporter of primary commodities, has terms of trade that move directly with the price of primary commodities on world markets. The path of the IMF primary commodity price index and the value of Australian currency expressed in terms of Australian dollars per US dollar are shown in Figure 2. Inverse movement in the indexes is particularly noticeable from the beginning of the period through 1989 and again from 1996 onwards.

Gruen and Wilkinson (1994) find some evidence that the Australian dollar moves directly with Australia's terms of trade (after controlling for the influence of interest rate differentials). Further, Blundell-Wignall and Gregory (1990) argue that
increases in Australia’s terms of trade require appreciation of the real exchange rate to achieve product market equilibrium. Thus, the nominal exchange rate expressed as Australian dollars per unit of foreign currency is expected to move inversely with commodity prices, after controlling for domestic and foreign price levels. Our equation for estimating the determinants of Australia's foreign exchange rate includes primary commodity prices, along with the domestic price level, foreign price level and other macroeconomic variables used in monetary and portfolio balance theories of the determinants of exchange rates. Our estimating equation is of the general form:

\[ E_{A,j} = f[p_{c}, p_{x_{A}}, p_{x_{j}}, Z_{A,j}], \] (2)

In (2), \( E_{A,j} \) is the foreign exchange rate expressed as Australian per unit of the currency of the jth country, \( p_{x_{A}} \) is the Australian domestic price level, \( p_{x_{j}} \) is the domestic price level in country j and \( Z_{A,j} \) is a vector of other variables, such as interest rates, affecting the exchange rate between Australia and country j. Due to the importance of the US dollar in international transactions, especially transactions in primary commodities, we limit our focus to the exchange rate between the Australian and US currencies.

Our direct interest is in the determinants of the aggregate price level in Australia. Primary commodity prices have a potential influence through the use of these commodities as raw materials in manufacturing, as well as entering directly as final products in the food sector. Kalecki (1971) treats the prices of finished goods as determined by marking up unit prime cost, where unit prime cost consists of unit labour cost and unit materials cost. Bloch and Olive (1999) find that prices in
Australian manufacturing industries are very closely related to domestic production costs. However, they also find that in industries with high concentration, output prices increase with prices of competitive foreign products when the market share of competitive imports is high and that output prices increase with the level of aggregate output (real GDP) when the market share of competitive imports is low. This implies that for high concentration industries, the degree of monopoly increases with either the price of competing foreign products or real GDP. Thus, we allow for the aggregate price level in Australia to be affected by prices of competitive foreign products and real GDP, as well as by input prices that affect production costs.

We estimate a pricing equation for finished goods, combining the factors that affect the degree of monopoly with those that affect unit prime cost. The variables affecting the degree of monopoly are real GDP and the price of competitive foreign product, while unit prime cost depends on the wage rate, the price of primary commodities and time as a proxy for technology. The estimating equation is of the general form:

\[ p_{xA} = f[X_A, p_{xA,j}, p_{cA}, w_A, T], \]  

In (3), \( X_A \) is a measure of aggregate production in Australia (measured by real GDP), while \( p_{x\text{A},j} \) is a measure of the average price of competitive foreign products as expressed in Australian dollars. \( w_A \) and \( p_{cA} \) are measures of the nominal wage rate in Australia and of the price of primary commodities expressed in Australian currency,
respectively. $T$ is time, which we use as a proxy for technology available for manufacturing in Australia.\textsuperscript{2}

Wage rates are generally given more prominence in discussions of the determinants of inflation than are primary commodity prices. We explicitly include wages in our model of inflation through a Phillips-curve relationship of the variety commonly used in Australia (see Gruen \textit{et al.}, 1999), so that the wage rate equation is explicitly in log difference form, except for the unemployment variable, as follows:

$$\Delta \log(w_A) = f[\Delta \log(p_{x_A}), U_A, \Delta \log(p_{c_A}), \Delta \log(T_{W_A})] \quad (4)$$

In (4), $U_A$ is the Australian unemployment rate and $T_{W_A}$ is an index of the productivity of labour in Australia (either proxied by time or measured by labour productivity).

Blanchard and Katz (1999) discuss the difference between the type of Phillips curve relation in (4), excluding primary commodity prices and labour productivity, and a ‘wage curve’ in which the level of the wage rate is a function of the level of unemployment and the level of the reservation wage. They show that the two are consistent provided that (a) neither the expected real wage nor the reservation wage in the ‘wage curve’ is a function of labour productivity and (b) the reservation wage in real terms moves exactly with lagged real wages. We test below to determine whether labour productivity and primary price terms add to the explanatory power of our wage rate equation. If not, the estimated Phillips curve may be taken as also representing an underlying ‘wage curve’
3. Some Empirical Evidence

The previous section specifies a four-equation model consisting of equations describing the determination of world primary commodity prices, equation (1), Australia’s exchange rate, equation (2), Australia’s domestic aggregate price level, equation (3), and Australia’s wage rate, equation (4). This section reports the results that are obtained when this model is estimated against quarterly data spanning the time period from the first quarter of 1984 through to the final quarter of 1998. We restrict our attention to the period after the Australian dollar was floated in December 1983, to focus on the inter-relationship between movements in prices in international commodity markets and the value of the Australian dollar in international currency markets, as a central element of our model. Blundell-Wignall and Gregory (1990) show clearly that the inflationary impact of terms of trade movements changed dramatically after 1983 when the Australian dollar moved from an adjustable peg to a managed float.

For purposes of estimation we take the world price of the primary commodity (pc), the Australian exchange rate vis a vis the US dollar (EAj, where j denotes the USA) as well as Australia’s prices and wage rates (pxA and wA, respectively) as endogenously determined. The remaining variables of the model are each treated as exogenous. These remaining variables are the world finished goods production (X), average world wage level (w), average world capital cost (r) [proxied by US interest rates], productive capacity in primary production (TC) [proxied by time], domestic price level in the outside world (pxj) [proxied by the US GDP deflator], the vector of
‘other’ macroeconomic variables affecting the Australian-US dollar exchange rate 
\( (Z_{Aj}) \), Australian real GDP \( (X_A) \), the rental price of capital in Australia \( (r_A) \) [proxied 
by Australian interest rates], technological capacity in the production of finished 
goods within Australia \( (T) \) [proxied by time], the Australian unemployment rate \( (U_A) \) 
and labour productivity in Australia \( (TW_A) \).³

The world primary commodity price series analysed in this section is obtained 
from the International Monetary Fund, International Financial Statistics (IFS) 
database. This series provides an index of the prices of 33 internationally traded 
primary commodities expressed in US dollars. Our proxy for world production of 
finished products is the OECD index of industrial production and is obtained from its 
Main Economic Indicators database. The remaining series employed are obtained 
mainly from the DX database, supplemented in the case of some of the domestic 
variables by data collected from Australian Bureau of Statistics and Reserve Bank of 
Australia sources, or the IFS. Full details relating to both the sources and definitions 
of the series used may be found in the Data Appendix.

Testing the variables of a model for stationarity prior to regression analysis is 
now well established as an essential component of econometric practice. The results 
that are obtained when the Dickey-Fuller and Augmented Dickey-Fuller (both with 
and without trend) tests are applied to the variables of our model lead us to reject, for 
each variable expressed in growth rate form as the first difference of natural 
logarithms, the null-hypothesis of a unit-root.⁴ In essence, these results indicate that 
the levels of the logarithms of the various variables discussed above are each I(1) 
variables.
Since each of the variables entering the right hand side of the world primary commodity price equation (1) is exogenous, unbiased estimates of the parameters of this equation can, in principle, be obtained by a suitable single equation method of estimation. As indicated above, our proxy measure for world production of finished products (X) is the OECD’s index of industrial production. In light of the unit-root test results described above, our model is estimated with all variables specified in logarithmic first-difference form, with the consequence that each estimated parameter may be straightforwardly interpreted as an estimate of the relevant elasticity. As regards equation (1), this particular specification for the estimating equation has the additional implication that when TC is proxied, as is frequently the case, by a time trend then its coefficient corresponds directly to the intercept that is estimated from the equation expressed in logarithmic first-difference form. Our measure of the cost of capital in world primary production (r) is the US 10 year bond rate (as obtained from the IMF’s IFS database). Since we are working with quarterly seasonally unadjusted data a set of three seasonal dummies is introduced into the analysis, corresponding to the first through third quarters of the year (denoted hereafter by SD1, SD2 and SD3, respectively).

The results that are obtained for equation (1) are set out as (1.1) in Table 1. We allow for possible lagged effects in the determination of world primary commodity prices using the ‘general-to-specific’ methodology. The results of this exercise lead us to choose both the current value and a one-quarter lag on the world industrial production variable, but only the current value of the capital cost variable. This exercise also reveals no evidence that the world wage level, w, or the world aggregate
price level, px (whether proxied by the US GDP deflator or the US producer price index), exerts any current or lagged effect on world primary commodity prices. Due to the presence of autocorrelation, this equation is corrected using the exact AR(2) Newton-Raphson iterative method, which converges after five iterations.\(^5\)

*** Insert Table 1 near here ***

In terms of both its overall degree of fit and the signs of its various estimated parameters, this estimated equation provides an encouraging degree of support for the simple model of price determination in the world market for primary commodities presented above. Estimated coefficients of both world finished goods production, X, (measured by OECD industrial production) and the world cost of capital, \(r_{US}\) (proxied by the US 10 year bond rate), are correctly signed and significantly different from zero at conventional levels.

Considering both current and lagged effects, our estimates imply an elasticity of world primary commodity prices with respect to OECD industrial production over the study period of 0.89 (significantly different from zero at the 5 percent level). This estimated elasticity compares to the estimate of 1.46 reported by Bloch and Sapsford (2000, p. 474) for the longer period 1948 through to 1993. The difference between these two estimates is consistent with the view expressed by some analysts (e.g. Winters and Sapsford, 1990) that at the global level, primary commodity prices in the 1980s were less sensitive to fluctuations in the level of world industrial production than in earlier periods.\(^6\) The estimated elasticity with respect to the cost of capital is
equal to 0.21 (also significant at the 5 percent level). Our estimates also reveal the presence of a distinct seasonal pattern in world primary commodity prices, with a significant increase being evident in the first quarter of the year, accompanied by a fall of roughly equivalent magnitude in the third quarter.

The results that are obtained when the Australian exchange rate equation (2) is estimated are summarised as (1.2) in Table 1. In view of the endogeneity of both the primary commodity price (pc) and Australian domestic price level (pxA) variables, equation (2) is initially estimated using the generalised instrumental variable (GIVE) technique. In this equation, the Australian GDP deflator measures the domestic price level, while the US domestic price level (pxj, with j = USA) is measured by the US GDP deflator.

Experiments utilising the GIVE technique conducted over a range of alternative specifications, yield no evidence to suggest that movements in either the Australian or US price levels exert any significant impact on the exchange rate between their two currencies. This finding is consistent with the evidence in Olekalns and Wilkins (1998), who find that purchasing power parity applies to the Australian exchange rate only over the long run. The results in (1.2) are obtained with the two price level variables omitted on the grounds of their insignificance.

For the purpose of the current exercise we consider only short-term and long-term interest rates for both the US and Australia as possible components of the Z vector. Long-term rates are used as proxies for inflation expectations, while short-term rates are used as proxies for financial market intervention by the monetary authority in each country. In the particular specification reported in (1.2), the interest rate
variables for each country are entered separately, so that the separate effects exerted by domestic and foreign (US) interest rates may be isolated. The long-term interest rate variables employed in (1.2) are the 10-year Australian bond rate and US long-term Treasury bond rate, denoted by \( r_A \) and \( r_{US} \), respectively. The corresponding short-term rates are the 13-week Australian Commonwealth note rate and the 3-month US Treasury note rate (for constant maturity), denoted by \( i_A \) and \( i_{US} \), respectively.

To allow for possible lags in the influences on Australia’s exchange rate a range of alternative lag lengths are applied in the context of the ‘general-to-specific’ technique. The results of this exercise indicate the existence of significance at two quarters for the \( pc \) term, three quarters on the US short-term interest rate, two quarters on the Australian short-term interest rate, and both the current value and the one-quarter lag on the Australian long-term interest rate.\(^9\) Once the price level variables and the current value of commodity price level are omitted, there are no current endogenous variables on the right-hand side of our chosen specification and we estimate equation (1.2) using a single-equation method. Finally, diagnostic tests on ordinary least squares regression results lead us to adopt a one-period moving average adjustment scheme.\(^{10}\)

The parsimonious model reported in (1.2) reveals that primary commodity prices lagged two quarters exert the hypothesised negative effect on Australian dollar per US dollar exchange rate (implying appreciation of the Australian dollar following an increase in primary commodity prices). The elasticity of \(-0.4836\) suggests that the Australian dollar in the period since the float exhibits the characteristics of a commodity currency, once the influences of foreign and domestic interest rates are
included in the specification. However, the elasticity value indicates slightly less than half of the change in world commodity prices is offset by a change in the value of the Australian dollar, so that prices of primary commodities expressed in Australian dollars are still pro-cyclical with world industrial production.\textsuperscript{11}

Both short-term and long-term interest rates in Australia and the US are shown to significantly influence the value of the Australian dollar in (1.2). Evidence of overshooting is found for the adjustment of the exchange rate to changes in the long-term Australian interest rate, but there is no evidence of dynamics found for the US interest rate. The direction of the net influence for each long-term rate is as expected for measures of inflationary expectations, with a higher Australian rate associated with depreciation of the Australian dollar and the US long-term rate having the opposite effect. The opposite direction of impact is expected for short-term interest rate variables as measures reflecting the impact of monetary policy. This is what we find, namely that the Australian dollar appreciates with an increase in Australian short-term interest rates but depreciates with an increase in US rates.\textsuperscript{12}

Experiments conducted with estimation of equation (3), describing the determinants of Australia’s aggregate price level, using the GIVE technique suggest that the rate of growth of Australia’s domestic price level (proxied by the GDP deflator) over the post-float period is significantly and positively related to growth in real output, $X_A$ (proxied by GDP at constant prices), growth in nominal wages, $w_A$, and growth in primary commodity prices denominated in Australian dollars, $p_{cA}$. However, our initial results provide no evidence that either the rental cost of capital in Australia or the average price of competing foreign products expressed in Australian
dollars (proxied by the US GDP deflator multiplied by the prevailing rate of exchange between the two dollars) exert a significant effect, so these variables are excluded.

To allow for the possible existence of lags in the impact of the remaining variables on the domestic price level, a range of alternative lag lengths are applied in the context of the ‘general-to-specific’ technique. The results obtained when the model is re-estimated after exclusion of non-significant lag terms are reported in (1.3). Since the particular specification reported in (1.3) contains no current endogenous variables on its right hand side, it is legitimately estimated by OLS rather than GIVE.

The various diagnostic statistics for (1.3) provide no evidence of serial correlation, heteroscedasticity, non-normality or functional form misspecification problems. The results suggest that growth in Australia’s domestic price level is positively and significantly related to growth in real GDP lagged one quarter, but negatively and significantly related to real GDP lagged three quarters. This is arguably consistent with the existence of an endogenous lagged supply response of the cobweb variety.

In addition, the results in (1.3) indicate that the effect of growth in nominal wages, $w_A$, is distributed over a four-quarter period commencing with a one-quarter lag, with all four of the lag coefficients correctly signed and significant at the five percent level. The sum of the wage coefficients indicates a full impact elasticity of approximately 1.0 (1.0064 to be exact) within five quarters. This implies that a one percent increase in nominal wages leads to a one percent increase in the GDP deflator within five quarters, so that domestic producers are restoring fixed mark-ups on changes in unit labour costs due to wage changes over the five-quarter period.$^{13}$
Simple dynamics on the primary commodity price term denominated in Australian dollars, \(pc_A\), indicate that this variable exerts the expected positive effect on the price level at both three and four quarter lags at the five percent significance level.\(^{14}\) The full impact elasticity of primary commodity prices on inflation, as indicated by the sum of the lagged coefficients of the primary product price, is approximately .12 within five quarters.

Equation (1.4) reports GIVE estimates of the parameters the Australian wage equation (4). Once again the diagnostics show no evidence of serial correlation, functional form misspecification, non-normality of errors or heteroscedasticity. In contrast to Gruen et al. (1999), who estimate a Phillips curve type formulation for quarterly Australian data covering the longer period 1965, quarter 2, through 1997, quarter 4, our results provide no evidence of a significant unemployment term over the post-float period, so this variable is omitted from the estimated specification reported as (1.4).\(^{15}\) Despite its parsimonious nature, (1.4) reveals that movements in Australia’s domestic price level (as proxied by movements in the GDP deflator) exert a positively signed and significant effect on movements in average weekly earnings. The estimated coefficients of the seasonal dummies suggest the presence of a seasonal pattern according to which average weekly earnings rise (fall) significantly during the first (second) quarter of the year.

Although correctly signed, the primary commodity price variable (expressed in Australian dollars) fails to achieve significance. Likewise, despite experimentation with a range of alternative proxy measures for labour productivity, we could find no evidence to suggest that this variable exerted a significant effect on the rate of growth
of Australian nominal wages over the post December 1983 period. We retain the intercept as a proxy for the time trend in labour productivity and the primary product price variable in (1.4) to test the conditions proposed by Blanchard and Katz (1999) under which a Phillips curve relationship can also be interpreted as a wage curve. These conditions are satisfied, as we are unable to reject the null hypothesis that each coefficient is equal to zero. However, as noted above we are unable to find any significant impact on wage rates for the unemployment variable, implying that both the Phillips curve and the wage curve are vertical.16

4. Conclusions

We examine the impact of primary commodity prices on inflation in Australia. We begin with the observation that commodity prices are highly volatile. This has potentially complex implications for Australia, given her position as a commodity exporting country. Primary commodity prices have a positive impact on the aggregate price level through the use of commodities as raw materials in industrial production. However, the Australian dollar may behave as a ‘commodity currency’ and appreciate (depreciate) with increases (decreases) in commodity prices, thereby offsetting the direct effect of changes in commodity prices on the cost of production.

We estimate a system of four equations for determining in turn: a price index of primary commodities on world markets, the foreign exchange rate for the Australian dollar in terms of US dollars, the GDP deflator in Australia and average weekly earnings in Australia. We find that primary commodity prices are strongly procyclical with world industrial production, explaining part of their overall volatility. We
also find that this volatility impacts on the value of the Australian dollar (relative to the US dollar) through the type of relationship to commodity prices expected for a ‘commodity currency’, although the long-run elasticity of the Australian dollar to commodity prices is substantially less than one (about equal to one half). Thus, primary product prices expressed in Australian dollars are shown to move pro-cyclically with world industrial production.

Our results for determining the aggregate price level in Australia show a positive and significant impact of primary commodity prices (expressed in Australian dollars). We estimate an elasticity of the GDP deflator with respect to primary commodity prices equal to 0.12, so that a 10% increase in primary products prices directly leads to an extra 1.2% inflation in overall prices. In addition, we find a positive, although statistically insignificant coefficient, for primary commodity prices in the earnings equation of .03, so that there may be a small additional impact of commodity prices through wages. Both these effects are enhanced through a positive feedback mechanism between wages and prices. In particular, we estimate an elasticity of wages with respect to current aggregate prices equal to 0.98 and an elasticity of aggregate prices with respect to various lagged values of wages equal to approximately 1.0, implying an extremely strong wage-price spiral that can continue virtually indefinitely once shocked by a change in commodity prices.

The strength of the wage-price spiral found in our results has very great consequences for Australia’s inflationary experience. The high degree of volatility in primary commodity prices is only partially offset by changes in the exchange rate for the Australian dollar as a ‘commodity currency’. This means that the Australian
inflation rate is subjected to substantial shocks through the Australian dollar price of primary commodities that feed through, albeit with a lag and only partially, to the rate of inflation in the GDP deflator. Given the strength of the price-wage spiral found in our results, there is no endogenous dampening force to dissipate the force of this shock over time. Without a reversal in commodity prices or a change in the rate of growth of domestic GDP, our results suggest that a rise (or fall) in inflation caused by such a commodity price shock will be sustained indefinitely. This means that the ultimate impact on the price level grows without bounds.

It is not surprising therefore that Australia’s rate of inflation has been highly unstable during the period of our study, nor that the Australian government was moved to engineer ‘the recession we had to have’ in the early 1990s in order to bring inflation under control. Of course, our results suggest that the downturn in commodity prices that began in mid 1989 and was not accompanied by the usual depreciation of the Australian dollar would have led to a slowing in the rate of inflation, even without the pain and suffering of a recession.

In closing it is worth speculating on the implications of our findings for other industrialised countries, particularly those that are importers rather than exporters of primary commodities. Changes in primary commodity prices can be expected to lead to changes in the currency value for such countries that are opposite to those experienced in Australia, for example a commodity price boom would lead to a depreciation of the currency. The domestic currency price of primary commodities would then magnify the change in world prices. The potential magnitude of an inflationary (or deflationary) shock is then especially great. Of course, there is no
guarantee that the strength of the wage-price spiral would be as great as what we find for Australia. Examination of the impact of primary commodity prices in other countries is the subject of our continuing research. We are particularly interested in determining the extent to which the slowing in global inflation over the period since 1990 can be attributed to the downward movement in commodity prices shown in Figure 1 and Figure 2.
DATA APPENDIX

World price of the primary commodity (pc)

Australian primary commodity prices in AUS (pcₐ)
*Source:* Reserve Bank of Australia Index of Primary Commodity Prices, DX Database.

Australian exchange rate *vis a vis* the US dollar, expressed as AUD$ per US$ (Eₐ,US)
*Source:* DX Database.

Australian price level (pxₐ)
*Source:* Australian GDP Deflator, DX Database.

Australian wage rates (wₐ)
*Source:* Average Weekly Earnings, DX Database.

World finished goods production (X)
*Source:* OECD Index of Industrial Production, OECD Main Economic Indicators.

World wage level (w)

World/US capital cost and long-term interest rate (rₚₚ)
*Source:* US 10-year Treasury Bond Rate, IFS Database.

World/US short-term interest rate (iₚₚ)
*Source:* US 3-month Treasury Bill Rate (constant maturity), IFS Database.

Domestic price level in the outside world (pxₐ,US)

Australian real GDP (Xₐ)
*Source:* GDP at constant prices, DX Database

Australian capital cost or long-term interest rate (rₐ),
*Source:* Australian 10-year Bond Rate, DX Database

Australian short-term interest rate (iₐ),
*Source:* Australian 13-week Commonwealth Note Rate, DX Database

Australian unemployment rate (Uₐ)
*Source:* Australian Bureau of Statistics Database
Labour productivity in Australia (TW_A)  
Source: DX and Australian Bureau of Statistics Databases.

References


Figure 1: OECD industrial production and IMF primary commodity prices (US$); indices – 1984Q2=100
Figure 2 – A$/US$ exchange rate and IMF commodity prices; indices – 1984Q2=100
### Table 1

**Primary Commodity Prices and Inflation in Australia 1984Q2 - 1998Q4**

<table>
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**Notes:** Figures in parenthesis are absolute ‘t’ ratios. LM₁ denotes the Lagrange multiplier test for serial correlation, LM₂ denotes Ramsey's RESET test of functional form, LM₃ denotes the Jarque-Bera test for residual normality, while LM₄ denotes the Lagrange multiplier test for heteroscedasticity. On the relevant null-hypothesis these test statistics are distributed as χ² with 4, 1, 2 and 1 degree of freedom respectively.
Financial support of from the Australian Research Council is gratefully acknowledged, as is research assistance from Michael Dockery. Previous versions of this paper were presented to seminars at Curtin University of Technology, University of Adelaide, University of New South Wales, Australian National University and the Industry Economics Conference at the University Melbourne. Helpful comments have been received from participants at these sessions and are gratefully acknowledged. However, all remaining errors and omissions are the full responsibility of the authors.

1 Both the cost of capital and productive capacity appear in the short-run price equation when firms make only partial adjustment to the equilibrium capital stock in the short run, so that capital is a quasi-fixed input to production. This approach is applied to the specification of short-run cost functions in manufacturing industries in the US, Canada and Japan by Morrison (1992) and is particularly appropriate in primary production given the long lead times required of primary production projects such as new mines, oil fields and irrigation schemes.

2 See Bloch and Sapsford (1991-92) for a more detailed derivation, which does not, however, allow for variables influencing the degree of monopoly.

3 It should be noticed that the price of primary commodities expressed in Australian dollars (pcA) is given, by construction, as the product of the world price expressed in US dollars (pc) and the exchange rate prevailing at the time in question between the Australian and US dollars (E_{A,j}, where j denotes the USA). Since both of these individual ‘components’ of pcA are treated as endogenously determined, pcA is to be treated likewise. The price of competing foreign products expressed in Australian dollars (pc_i) is similarly the product of two components (within USA) and E_{A,j}. 

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(where j again denotes the USA). This variable is also treated as endogenous in the following analysis as it comprises the product of an exogenous variable (px\textsubscript{j}) and an endogenous variable (E\textsubscript{A,j}).

4 The full set of test results is available from the authors upon request.

5 The estimated autoregressive error specification is as follows:

\[ U(t) = 0.2749 \, U(t-1) + 0.3083 \, U(t-2) + \varepsilon \]
\[(2.22) \quad (2.49)\]

where \( U(t) \) denotes the error corresponding to time \( t \), \( \varepsilon \) denotes a disturbance term and the figure in parenthesis is the ‘t’ ratio based on the asymptotic standard error. The log-likelihood ratio test of the AR(1) specification versus the (unadjusted) OLS specification yields a Chi-square value, with one degree of freedom, equal to 9.794, whilst the AR(2) versus AR(1) test yields a Chi-square value, with one degree of freedom, equal to 5.034.

6 The greater volatility of primary commodity prices in the 1980s, as noted by Maizels (1992), plausibly was due to supply-side shocks or alteration in the protection of primary commodities, rather than the influence of demand-side shocks. Maizels notes a number of supply-side developments and increases in protection by agricultural commodity importers, when explaining the volatility of primary commodity prices in the 1980s.

7 The estimated elasticity with respect to capital costs was found to be similar when this equation was re-estimated with the US long-term Treasury Bond rate as an alternative measure of capital cost.
The wage cost variable \( w \) is dropped from the estimated equation, as we could find no evidence of significance for this term using the data series employed in our earlier study (Bloch and Sapsford, 2000). This may reflect the poor quality of data on wages in developing countries that account for the bulk of production of agricultural primary commodities. Alternatively, the capital-intensive nature of most mining and energy commodity production might give capital costs a greater impact than labour costs.

It should be noted that once these lags are imposed, only the third-quarter seasonal dummy variable approaches significance; hence the exclusion of the dummies for the first and second quarters from the specification estimated as (1.2).

The estimated moving average error specification is as follows:

\[
U(t) = E(t) - 0.3559 E(t-1)
\]

\[ (1.91) \]

where \( U(t) \) denotes the error at time \( t \), \( E \) denotes the error term before applying the moving average and the figure in parenthesis is the ‘\( t \)’ ratio based on the asymptotic standard error. The coefficient of the lagged error is significant at the six percent level.

Bloch (1991) finds a powerful impact of the terms of trade between primary commodities and manufactured goods on the value of the Australian dollar using annual data over a period mostly preceding the float. The results reported in (1.2) are more consistent with those in Gruen and Wilkinson (1994), who find that Australia’s real exchange is most strongly influenced by the differential in long-run interest rates, rather than the terms of trade, during the post-1983 period of a floating exchange rate.

The lags that we find for the impact of short-term rates are consistent with exchange rates responding to monetary policy following their influence on the
respective domestic economy rather than through a direct effect on foreign exchange markets.

13 This implies that the mark up on unit prime cost actually rises when nominal wages rise. This evidence of a rising mark up following a nominal wage increase contrasts with a decreasing mark up following real wage increases found by Bloch and Madsen (2001) in a study of mark ups and employment across Australian industrial sectors. One possible reason for the difference in results is that mark ups at the industrial sector level are subject to the competitive influence of prices in other domestic industries. In contrast, we find no significant role for competing foreign prices in influencing the aggregate price level in the present study, suggesting that there is no influence on the corresponding aggregate mark up.

14 Bloch and Sapsford (1997 and 2000) find evidence to suggest that primary commodity prices lagged one year exert a significant positive effect on the prices of finished goods averaged over all OECD countries during the post 1948 period.

15 This finding is not altogether unusual in the Australian context. Gruen et al. (1999) point out that the Australian evidence is perhaps to be expected to be less revealing of a Phillips curve type (inverse) unemployment effect given the fact that Australian wage data reflect, in addition to pressures generated by the forces of excess demand or supply in the labour market, various institutional factors associated with centralised wage bargaining. It is perhaps worth noting that estimation of specifications of equation (4) by ordinary least squares does, however, yield a correctly signed and, according to standard OLS hypothesis testing techniques, significant unemployment term. However, the analysis of this paper suggests that such findings are invalid. The
estimators in question are inconsistent, by failing to allow Australia’s domestic prices and primary commodity prices to be endogenous within the wage equation.

16 Dungey and Pitchford (2000) note difficulties in identifying a unique relationship between the unemployment rate and inflation from data for Australia over recent decades. Our results cast further doubt on the existence of an Australian NAIRU (the non-accelerating inflation rate of unemployment). However, as in the results of Dungey and Pitchford, we find that output growth significantly impacts on the rate of price increase in the results reported in (1.3). This means the inflation rate responds positively to economic activity, as measured by the rate of growth of output, rather than responding to labour market conditions, as measured by the unemployment rate.