Commodity Prices and the Dynamics of Inflation in Commodity-exporting Nations: Evidence from Australia and Canada*

by

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ABSTRACT

A commodity price boom is under way. What does this boom mean for countries with substantial net commodity exports? In particular, can a commodity price boom be expected to increase inflationary pressure on the domestic economy?

Because primary commodities are standardized and traded globally, price increases impact on all countries given the prevailing foreign exchange rates. This creates upward pressure on finished goods prices, as the direct costs of production, including raw material costs are marked up to determine finished goods prices. The behavior of finished goods prices then depends on domestic movement in wage rates, labor productivity and price-cost margins.

Both the Australian and Canadian dollars are viewed as "commodity currencies", implying co-movement of the exchange rate with the commodity prices. In particular, currency appreciation with rising commodity prices can offset the impact of global commodity prices on domestic raw material costs. Thus, an exchange-rate equation is included in our small structural model for inflation determination in Australia and Canada. The full model includes equations for the world price of primary commodities, the foreign exchange rate, the domestic price of finished goods and domestic industrial wages. We estimate this model using quarterly data covering 1960 through 2001. The results show evidence that the world commodity price boom increases inflation in both Australia and Canada, albeit with an influence that is moderated by the partially offsetting impact of exchange rate appreciations (depreciations) during commodity price booms (busts).

Introduction

Explanations of inflation tend to emphasize monetary policy or domestic market conditions, particularly labor market institutions and the strength of demand for domestic output relative to productive capacity. We examine an additional influence on the inflationary process, namely prices of primary commodities. We incorporate primary product prices into a structural model of pricing, where the domestic cost of finished goods is determined by prices of both primary commodities used as raw materials and the wage rates of industrial labor. Prime costs are marked up to determine finished goods prices. The cyclical behavior of finished goods prices then depends on domestic cyclical movement in wage rates, labor productivity and price-cost margins as well as in world cyclical movements in primary commodity prices.

Previous research, Bloch et al (2004), examines the influence of primary commodity prices on inflation in each of three major industrialized countries: Japan, UK and US. We estimate a system of equations in which the key dependent variables are world commodity prices, the domestic inflation rate for finished goods and the rate of domestic industrial wage inflation. These estimates allow us to identify common elements in the inflation dynamics of three of the leading industrialized countries.

We find that world commodity prices move pro-cyclically with the growth rate of world industrial production. Further, in each country, world commodity price changes expressed in domestic currency and domestic wage changes have a positive, but less than proportional, relation to finished goods inflation. In each country, there is also a positive, but less than proportional, impact of finished goods inflation on the rate of wage growth. Thus, we find evidence of a feedback mechanism associated with the wage-price spiral in each country, with a common impetus to upward and downward movements in the spiral coming from worldwide commodity price movements.

The previous research leads us to consider inflation as a global phenomenon related to the world business cycle, because primary commodity prices are determined in world markets and, yet, are used as raw materials in the production process in all industrialized countries. In the present paper, we extend our analysis to consider the circumstances of two smaller industrialized countries that are substantial net exporters of primary commodity products, namely Australia and Canada.

In dealing with smaller industrial countries that are substantial exporters of primary commodities, we extend our framework in two ways. First, we allow the price of competing foreign products to affect prices of domestic finished goods. Following Bloch (1974) or Kardasz and Stollery (1998) for Canada and Bloch (1992) for Australia, the price set by domestic import-competing producers is positively related to the price of competing foreign products.

As a second extension, we introduce an exchange rate equation to provide a link between foreign and domestic prices. Bloch and Sapsford (2005) show 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”. Canadian dollars are also often viewed as a “commodity currency”. We therefore need to establish whether the Canadian and Australian dollar price of raw materials follows the worldwide pattern, or rather deviates from this pattern due to offsetting fluctuations in the exchange rate. Thus, an exchange-rate equation is included in our small structural model for inflation determination in Australia and Canada.

The full estimating model applied to Australia and Canada includes equations for the world price of primary commodities, the foreign exchange rate, the domestic price of finished goods and domestic industrial wages. We estimate this model using quarterly data covering 1960 through 2001. The results show evidence that the world industrial production cycle influences prices for both Australia and Canada, albeit an influence that is moderated by the partially offsetting impact of exchange rate appreciations (depreciations) during commodity price booms (busts).

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

Modeling commodity prices and inflation

Markets for primary commodities are notoriously volatile, arising from the interaction of inelastic demand (for both price and income) and supply. They are also prone to periods of boom and bust of significant magnitude (see Sapsford and Morgan, 1994 for an overview). Cashin and McDermott (2002) argue that the volatility of commodity prices is so great as to dominate any trend movement.

Primary commodities are used as raw materials in the manufacturing process, so that demand increases with industrial production. Figure 1 shows the rates of change in OECD industrial production and in the IMF index of primary commodity prices over the period from 1960 to 2001. The price index is expressed in US dollars as this the dominant currency for trading primary commodities on world markets. The rises and declines occur at similar times, but there is substantially greater volatility in primary commodity prices. For this reason, changes in industrial production are shown on a much narrower scale in Figure 1 than are changes in commodity prices. This allows for a much clearer depiction of the coincidence in the cyclical movements.

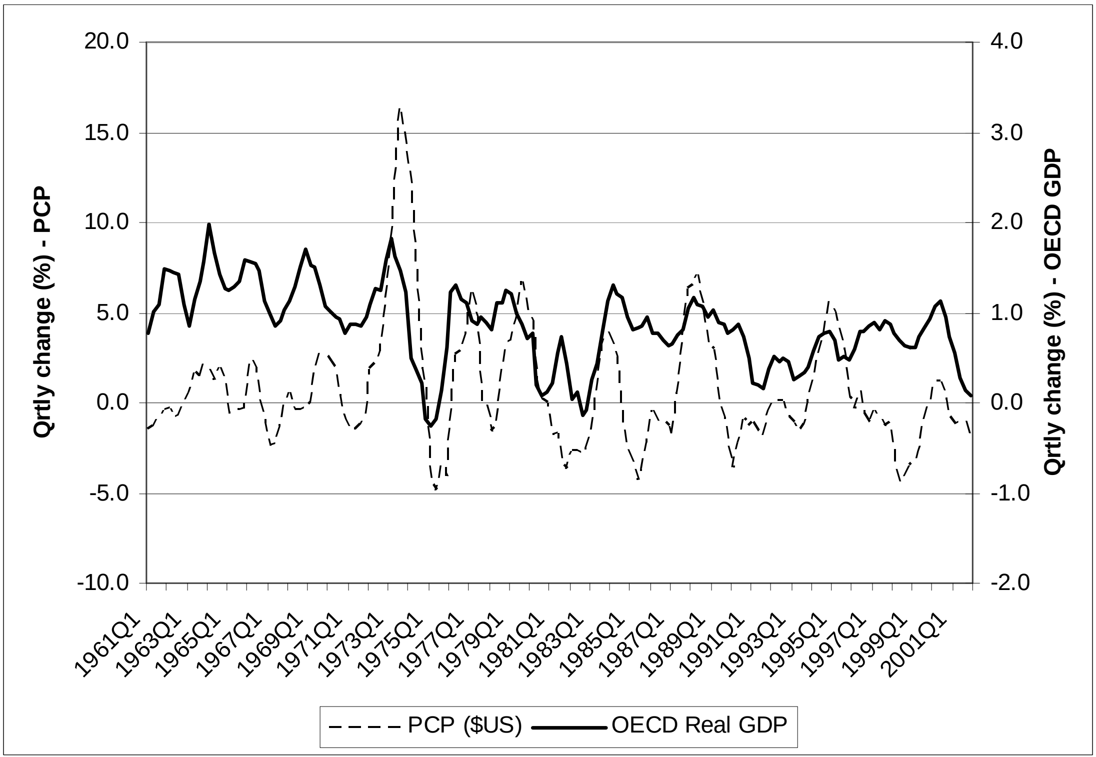

Figure 1: Primary Commodity Prices and OECD Real GDP: 1960-2001
Quarterly changes (four-quarter moving average) ($US)

Bloch and Sapsford (2000); Bloch, Dockery and Sapsford (2004); and Bloch et al (2004) include factors other than world industrial production as impacting on the demand and supply for primary commodities. In particular, demand increases with prices of substitute inputs, labor and capital, and with the prices received for manufactured products. The supply of primary commodity production is subject to capacity constraints in the short to medium run, but grows over time with investment in productive capacity and with technical progress. Here, we extend the analysis to also allow for influences of interest rates on the supply of primary commodities, operating through investment in productive capacity, through arbitrage between spot and futures markets or through impacting the rate of exploitation of non-renewable resources in the production of primary commodities.[1]

A general reduced-form equation for the world price of primary commodities is:

$$pc = f[X, px, w, r, T, \varepsilon] \qquad (1)$$

In (1), pc is the world price index of the primary commodity expressed in US dollar terms. X, px, w are measures of total world industrial production (given by the sum of Xi over all countries), the average price at which this product is sold in the various countries, and the average wage of industrial workers, respectively. Also, r is a measure of the long-term or short-term interest rate on world markets and T is time, which is our crude proxy for the productive capacity summed across primary producers. Finally, ε is a disturbance term for the influence of supply shocks (such as droughts, floods and earthquakes).

Pro-cyclical movement in primary commodities prices is expected in (1). Prices of industrial products and industrial wages are also expected to have a positive influence on primary product prices. A negative impact is expected for increases in capacity due to investment and technical progress, which increase short-run commodity supply. Only the impact of interest rates is ambiguous, as there are offsetting impacts on demand as a substitute input (positive) and on supply altering the timing of production and inventory decisions (negative).

Foreign exchange rates can be linked to primary product prices through their influence on the terms of trade. Bloch (1991) finds that Australia, as a substantial net

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[1] Hotelling (1931) demonstrates that optimal depletion of a non-renewable resource equalizes the rate of interest with the rate of increase in unrealized resource rents at the margin.

exporter of primary commodities, has terms of trade and an exchange rate that move directly with the price of primary commodities on world markets.[2] The path of the IMF primary commodity price index and the value of Australian currency expressed in terms of US dollars per Australian dollar are shown in Figure 2 for the period that the Australian dollar has been floating, since 1984. Closely parallel movements are clearly evident throughout the period and the amplitudes are similar. A corresponding chart for Canada is shown in Figure 3 for the period that the Canadian dollar has been floating, since 1970Q2. While the peaks and troughs are clearly related, the amplitude of the commodity changes far exceeds that of the exchange rate changes.

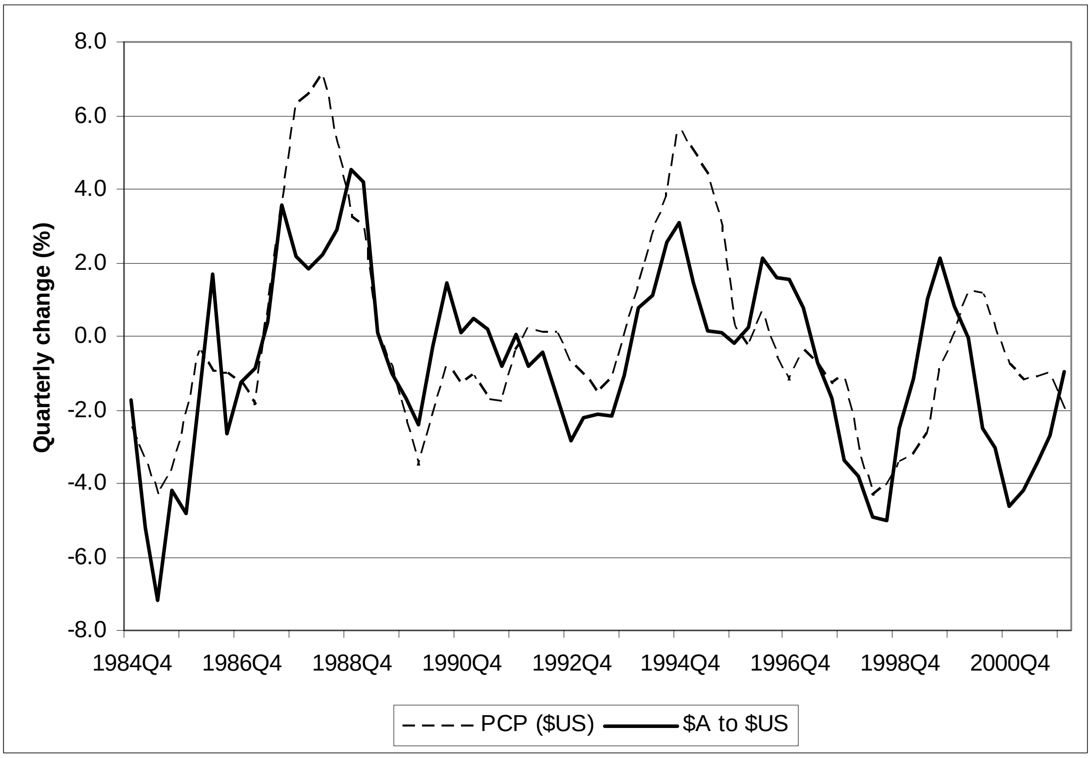

Figure 2: IMF Primary Commodity Price Index and US dollar per Australian dollar exchange rate: 1984Q1-2001Q4 - Quarterly changes (four-quarter moving average)

[2] Further evidence of an impact of the terms of trade on the value of the Australian dollar is given by Gruen and Wilkinson (1994), who 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.

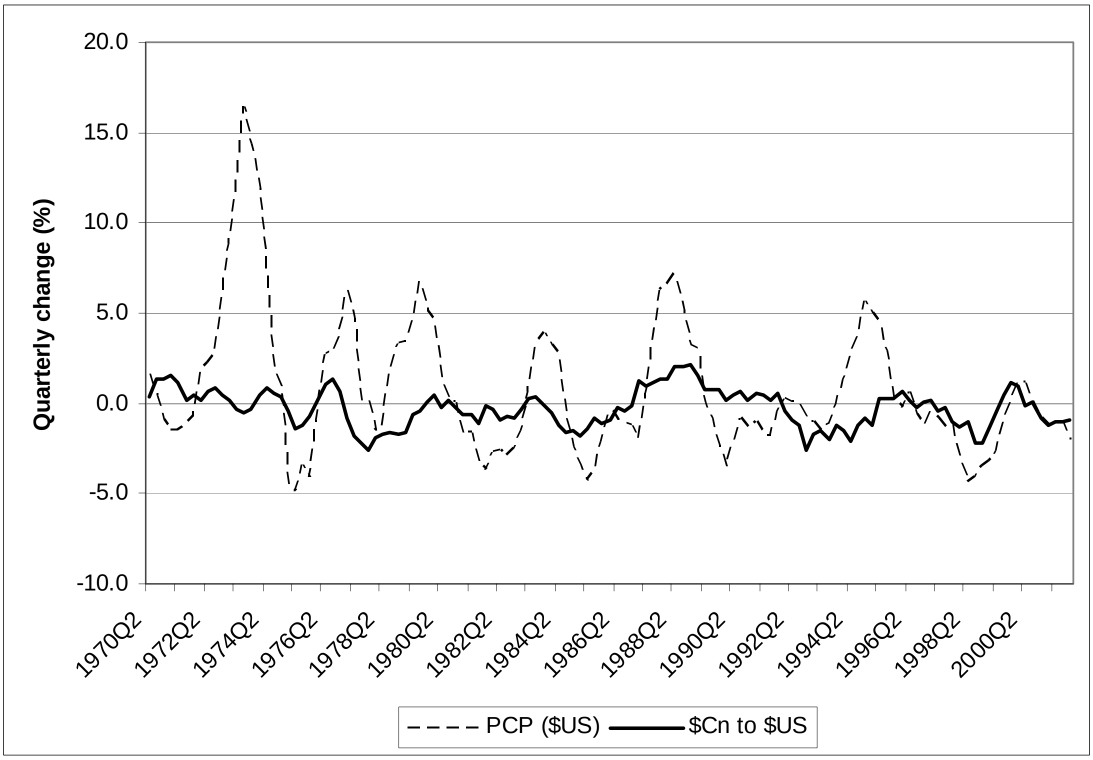

Figure 3: Primary Commodity Prices and US dollar per Canadian dollar exchange rate: 1970Q2-2001Q4 - Quarterly changes (four-quarter moving average)

Our equation for estimating the determinants of foreign exchange rates for Australia and Canada 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:

$$Ei = f[pc, pxi, pxus, Zi], \qquad (2)$$

In (2), Ei (i = au or cn) is the foreign exchange rate expressed as Australian or Canadian dollars per US dollar, as the US dollar is the dominant currency for trading primary commodities as well as the dominant trading partner for Canada and a major trading partner for Australia. pxi (i = au or cn) is the Australian or Canadian domestic price level, pxus is the US domestic price level and Zi (i = au or cn) is a vector of other variables, such as interest rates, affecting the exchange rate between Australia or Canada and the US.

Our direct interest is in the determinants of the aggregate price level in Australia and Canada. Direct production costs are important, including wages and primary commodity prices used as raw materials in manufacturing, as well as entering directly as final products in the food sector. Further, Bloch (1974) along with Kardasz and Stollery (1998) find evidence that prices and profit margins of manufactured goods in Canada increase with prices of competing goods in the US, at least in highly concentrated industries, while Bloch (1992) finds related evidence for Australian manufacturing. Thus, we allow for the aggregate price level to be affected by prices of competing foreign products, specifically prices in the US as the US is Canada's dominant trading partner and a major trading partner for Australia, as well as by input prices that affect production costs. We also allow for the possibility that direct production costs or the profit margin are cyclical.

The estimating equation is of the general form:

$$pxi = f[Xi, pxusi, pci, wi, T], \tag{3}$$

In (3), Xi (i = au or cn) is a measure of aggregate production (measured by real GDP) in either Australia or Canada, while pxusi is a measure of the average price of competitive foreign products from the US expressed in local currency. Wi and pci (i = au or cn) are measures of the nominal wage rate in Australia or Canada and of the price of primary commodities expressed in either Australian or Canadian currency, respectively. T is time, which we use as a proxy for technology available for manufacturing.

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. In particular, we allow the level of wages to be influenced by slack in labor markets, labor productivity and the cost of living, with a separate role for primary commodities given our interest in their role in the inflation process. A general equation is the form:[3]

$$wi = f[pxi, Ui, pci, T] \tag{4}$$

In (4), Ui (i = au or cn) is the domestic unemployment rate and time (T) to capture trend growth in domestic labor productivity).

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), the foreign exchange rate, equation (2), the domestic aggregate price level, equation (3), and the domestic industrial 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 1960 through the final quarter of 2001, although some regressions are for shorter periods due to data availability or other factors.

For purposes of estimation we take the world price of primary commodities (pc), the exchange rate *vis a vis* the US dollar (Ei), as well as domestic prices and wage rates, pxi and wi, respectively, where i = au, cn as endogenously determined. The remaining variables of the model are each treated as exogenous. These remaining

[3] If the relation is in the form of a Phillips-curve of the variety commonly used in Australia (see Gruen *et al*., 1999), the wage rate equation is in log difference form, except for the unemployment variable, which is in levels

variables are the world finished goods production (X), average world wage level (w), average world capital cost (rus) [measured by US 10 year Treasury constant maturity yield], time (T), US domestic price level (pxus) [measured by the US producer price index], domestic real GDP (Xi, where i = au, cn), the domestic capital cost (ri, where i = au, cn) [measured by the Australian and Canadian 10 year government bond yield, respectively], and the domestic unemployment rate (Ui, i = au, cn).[4]

The world primary commodity price series analyzed 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 industrial production volume index for industrialized countries from that same source. The remaining series employed are obtained mainly from the Datastream database. Full details relating to both the sources and definitions of the series used are given 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 Dickey-Fuller and Augmented Dickey-Fuller (both with and without trend) tests are applied to all the variables in our model. Based on these tests, variables are entered as the first difference of their logs with the exception of the domestic unemployment rate for Canada, which is stationary in levels.[5]

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[4] It should be noticed that the price of primary commodities expressed in Australian or Canadian dollars (pcau or pccn) 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 or Canadian dollar and the US dollar (Eau or Ecn, respectively). Since both of these individual 'components' are treated as endogenously determined, pcau or pccn is to be treated likewise. The price of competing foreign products expressed in Australian or Canadian dollars (pxus,au or pxus,cn), is similarly the product of two components pxus and the relevant exchange rate. Thus, the price of competing foreign products is also treated as endogenous in the following analysis.

[5] The ADF test fails to reject the hypothesis of a unit root for the first difference of the logs of the US and Canadian price and wage indices. However, the first difference of the log of each of these variables displays an upward trend over period from 1960 to the late 1970s, followed by a declining trend from

3.1 Primary commodity prices

The results that are obtained for estimation of (1) using the first differences in the log of the world commodity price index as the dependent variable in Table 1. We allow for up to four lags on all the variables indicated in (1), with insignificant lags and variables excluded using the 'general-to-specific' methodology. We begin with OLS estimation in Model 1.1. Diagnostic tests on the resulting equation indicate critical problems, including strong evidence of autocorrelation, heteroscedasticity, non-normality of residuals and functional misspecification.

Table 1: World Commodity Price Equation – regression results

	Model 1.1 OLS		Model 1.2 AR(1)	
	coefficient	t-statistic	coefficient	t-statistic
INTERCEPT	-0.0143	-3.45	-0.0140	-2.85
DLX	0.9326	3.39	0.8984	3.47
DLX(-1)	0.7340	2.64	0.7709	2.91
DLPXUS	1.3977	6.56	1.2983	5.77
DLRUS(-1)	-0.1093	-2.15	-0.1151	-2.35
DLIUS(-4)	-0.0831	-2.06	-0.0861	-1.83
SD3	-0.0202	-3.10	-0.0196	-3.52
AR Process				
U(t-1)			0.2875	3.89
Observations	168		168	
R-Squared	0.408		0.456	
R-Bar-Squared	0.386		0.432	
F-statistic [probability]	18.464	[0.000]	19.167	[0.000]
DW-statistic	1.409		1.974	
Diagnostics	Probability [Chi-sq]	Probability [F- statistic]		
A: Serial Correlation[a]	0.002	0.002		
B: Functional Form[b]	0.000	0.000		
C: Normality[c]	0.016	na.		
D: Heteroscedasticity[d]	0.001	0.001		
Likelihood Ratio test (AR v. OLS)			χ^2 14.016	Probability 0.000

Notes: Chi-square and F-statistic figures given for the diagnostics are the probability values. a: Lagrange multiplier test of residual serial correlation; b: Ramsey's RESET test using the square of the fitted values; c: Based on a test of skewness and kurtosis of residuals; d: Based on the regression of squared residuals on squared fitted values.

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around 1980. Perron (1989) has shown that many tests for unit roots incorrectly conclude the presence of a unit root when there is a structural break in the series, and intuitively it is unlikely that the price or wage series are I(2).Thus, we conclude the test results are flawed and enter the US and Canadian inflation and wage variables in the regressions below as first difference of their logs. Detailed results of the unit root tests are available from the authors on request.

To address the problem of serial correlation, an autoregressive model (AR 1) is estimated with results shown for Model 1.2. The Durbin-Watson statistic of 1.97 for this model suggests elimination of serial correlation. There is also a considerable improvement in the adjusted R-squared results and the likelihood ratio test shows the AR1 model is preferred to OLS.

Considering both current and lagged effects, the estimates for Model 1.2 imply an elasticity of world primary commodity prices with respect to OECD industrial production over the study period of 1.7 (significantly different from zero at the one percent level), with the estimates not much different in the OLS results (Model 1.1).[6] Changes in producer prices have an almost proportional affect on primary commodity prices (the coefficient of the producer price variables is significantly greater than zero, but not significantly greater than one at the five percent level), which suggests it is the real commodity price rather than the nominal price that is affected by the world business cycle. The estimates for Model 1.2 also reveal the presence of a significant negative impact of long-term and short-term interest rates, which suggests an impact of resources exhaustion or commodity arbitrage as opposed to substitution between capital and primary commodities in production. Finally, a distinct seasonal pattern in world primary commodity prices is indicated, with a significant fall in prices in the third quarter.

3.2 Exchange rate equations

We have data on all the variables in all models for Australia from 1973Q1 to 2001Q4 and for Canada from 1960Q1 to 2001 Q4. However, the currencies of each of these

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[6] This estimated elasticity compares to an estimate using annual data of 1.46 by Bloch and Sapsford (2000, p. 474) for the period 1948 through to 1993.

countries were pegged to the US dollar in the early years of the sample period. We estimate exchange rate equations for each country over the period after the move to flexible exchange rates. For Australia this is from 1984Q2, while for Canada it is from 1970Q2. In Table 2, we show the estimation results for regressions in the general form of (2) for the period from these start dates up to 2001Q4.

Table 2: Exchange rate – regression results for Australia and Canada

	Australia 1984Q2 – 2001Q4 Model 2.1 GIVE[c]		Canada 1970Q2 – 2001Q4 Model 2.2 GIVE[d]		Canada 1970Q2 – 2001Q4 Model 2.3 AR	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
INTERCEPT	0.0090	1.36	0.0016	0.71	0.0039	1.95
DLPCi	-0.9582	-5.01				
DLPCi (-1)			-0.0862	-3.11	-0.0718	-2.52
DLPXus			-0.4245	-2.17		
DLPXi			0.5355	1.90		
DLPXi (-1)	0.5624	1.24				
DLPXi (-2)	-1.2691	-2.62				
DLPXi (-3)	0.5374	1.16				
DLRus (-2)	0.3067	3.48				
DLRi (-2)	-0.2196	-3.44				
DLIus (-4)	-0.3161	-4.33				
DLIi	0.1363	3.31	0.041	3.66	0.0517	5.24
DLIi (-1)			-0.027	-2.60	-0.0270	-2.74
DLIi (-4)	0.2038	4.45			-0.0181	-1.84
AR Process						
U(t-1)					0.3923	4.81
Observations	71		168		168	
R-Squared	0.4867[b]		0.3093[b]		0.3145	
R-Bar-Squared	0.4110[b]		0.2808[b]		0.2862	
F-stat [probability]	6.43	[.000]	10.83	[.000]	11.10	[.000]
DW-statistic	2.02		1.33		1.98	
Diagnostics[a]	Chi-Square	Probability	Chi-Square	Probability	Chi-Square	Probability
A: Serial Correlation	1.67	0.796	18.48	0.001	na	
B: Functional Form	4.74	0.029	0.89	0.347	na	
C: Normality	0.52	0.771	0.15	0.929	na	
D:Heteroscedasticity.	0.04	0.842	0.80	0.370	na	
Likelihood Ratio test (AR v. OLS)					19.924	0.000

Notes: a: see notes to Table 1. b: the reported statistics are the corresponding GR-squared and GR-bar-squared c: Instruments used are INTERCEPT, DLPCau(-1), DLPXau(-2), DLRus, DLRus(-2), DLRau(-2), DLIus(-4), DLIau, DLIau(-4), DUau(-2); d: Instruments used are INTERCEPT, DLPCcn(-1), DLPXus(-1), DLPXcn(-1), DLPXcn(-2), DLIcn, DLIcn(-1), DUcn(-1) DUcn(-2), DUcn(-3).

Given potential endogeneity between the domestic price level and the exchange rate, results are generated using generalized instrumental variable estimation (GIVE) in Model 2.1 and Model 2.2 for Australia and Canada, respectively. The domestic price level variable and the primary commodity price variable, which is treated as an endogenous variable in the results in Table 1, are each instrumented by their one-period lags. The results for Canada indicate a high level of serial correlation, so the regression is re-estimated using auto-regressive estimation (AR). The current domestic and US price levels are dropped from the regression due to potential endogeneity. The estimated coefficients of the other variables are not much changed from the corresponding GIVE estimates.

The dependent variable in the regressions in Table 2 is the first difference of the log of the number of dollars of local currency that can be purchased per US dollar. Hence, a negative (positive) coefficient indicates an appreciation (depreciation) of the local currency and the coefficient of the independent variables can be interpreted as elasticities. Our special concern is with the impact of world primary commodity prices. The negative and significant coefficient of the current world commodity price the indicates it is appropriate to think of both the Australian and Canadian dollars as 'commodity currencies'. The value of each appreciates with increases in world commodity prices, although the effect is clearly much stronger for Australia. This is as expected given the heavier concentration of Australian exports on primary commodities (particularly coal, wheat and iron ore) or lightly processed primary commodities (alumina, wool and meat).

In addition to primary commodity prices, exchange rates in both Australia and Canada are affected by interest rates. For Canada only short-run domestic interest rates have an impact, with increase leading to an immediate depreciation of Canadian dollar partially offset by a lagged appreciation. This opposite to expectation for interest rates as an attractor of capital flows, but consistent with the short-run interest rates serving as an indicator of expected inflation.

For Australia, the coefficients for both the current short-run interest rate and the four-quarter lag suggest an interpretation as with Canada, that short-run rates serve as an indicator of inflationary expectations. Both estimated coefficients are larger and more significant than in Canada, suggesting a more sensitive foreign exchange market. The four-quarter lag of the US short-run rate has a negative impact, roughly equal in magnitude to the sum of the two corresponding Australian coefficients. Thus, it seems to be the interest-rate differential that impacts on the exchange rate, at least after some lag.

The interest-rate differential also seems to drive the impact of long-run interest rates on the Australian / US exchange rate. Increases in Australian long-term interest rates lead to an appreciation of the Australian dollar against the US with a two-quarter lag, while increases in the corresponding US rate lead to depreciation. These coefficients suggest that funds flow to the country with the highest rates, pushing up the exchange rate for that currency.

For Canada, there is evidence of a purchasing-power-parity impact of domestic and US prices, at least in the GIVE estimates. Increases in Canadian prices lead to depreciation of the Canadian dollar, with US prices having an opposite and almost equal effect. No impact of US inflation could be detected for the Australian exchange rate and the impact of Australian domestic inflation is of weak significance and with offsetting signs for various lags.

3.3 Domestic inflation equations

We estimate results for the full period of data available for each country, as the choice of exchange rate regime is not expected to have great impact on the domestic inflationary process. Thus, the estimates are based on data from 1973Q1 to 2001Q4 for Australia and from 1960Q1 to 2001Q4 for Canada. The dependent variable in each equation is the first difference of the log of the domestic price index, which provides a measure of inflation and each coefficient of an independent variable (all in first differences of logs) provides an estimate of the elasticity of the price level with respect to the particular variable.

Estimation for both Australia and Canada is carried out GIVE due to the presence as explanatory variables of other endogenous variables from our system, specifically the domestic wage rate and the price of primary commodities converted into domestic currency. However, the original estimates for Canada in Model 3.2 indicate the evidence of significant serial correlation and functional form misspecification. We find that by adding a time trend to the equation in Model 3.3, the likelihood tests show no evidence of either serial correlation or misspecification but there is evidence of significant hetroscedasticity.[7] Results for the single Australian regression, Model 3.1, and the two Canadian regressions are reported in Table 3.

Primary commodity prices converted into domestic currency and wages both impact positively and significantly on prices in both Australia and Canada, although with different relative magnitudes. Summing over the various lags, inflation rises by about nine tenths of the percentage increase in wages in Australia, but only by about one third (Model 3.2) to one half (Model 3.3) in the case of Canada. In contrast a percentage increase in primary commodity prices in Australia leads to only about an

[7] The positive time trend indicates accelerating inflation, given that the dependent variable is a measure of the rate of inflation. This is implausible in the long run, but reflects a rising trend rate of inflation over much of the sample period.

increase of 0.06 in inflation, while it leads to an increase of about 0.13 (Model 3.2) or about 0.25 (Model 3.3) in Canada.

Table 3: Domestic Price Equation – regression results for Australia and Canada

	Australia 1973Q1 – 2001Q4 Model 3.1 GIVE[c]		Canada 1960Q1 – 2001Q4 Model 3.2 GIVE[d]		Canada 1960Q1 – 2001Q4 Model 3.3 GIVE[e]	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
INTERCEPT	0.0015	0.54	-0.0009	-0.85	-0.0138	-3.42
DLXi	-0.2415	-2.18				
DLPXUSi	-0.0742	-0.0742	0.2662	8.92		
DLPXUSi (-1)					0.1436	3.47
DLPXUSi (-3)					0.0929	2.22
DLPXUSi (-4)			0.1528	5.78	0.0735	1.66
DLPCi	0.0619	2.32	0.0213	1.70	0.2111	7.93
DLPCi (-1)			0.0382	3.04		
DLPCi (-2)			0.0429	3.56		
DLPCi (-3)			0.0330	2.88		
DLPCi (-4)					0.0480	2.72
DLWi	0.9576	4.27	0.1657	2.41	0.5005	4.27
DLWi (-2)	-0.2524	-1.98	0.1264	2.36		
DLWi (-3)	0.2053	2.49				
DLRi			0.0280	2.75		
DLRi (-1)			0.0233	2.19		
SD1			0.0041	2.58	0.0050	2.40
SD2					0.0073	3.18
SD3					0.0147	5.23
TIME					0.00004	2.10
Observations	116		164		168	
R-Squared[b]	0.4468		0.7721		0.6715	
R-Bar-Squared[b]	0.4164		0.7556		0.6506	
F-statuistic [prob]	9.31	[0.000]	46.80	[0.000]	14.80	[0.000]
DW-statistic	2.24		1.44		1.88	
Diagnostics[a]	Chi-square	Probability	Chi-square	Probability	Chi-square	Probability
A Serial Correlation	5.89	0.208	17.01	0.002	5.18	0.268
B: Functional Form	0.002	0.959	15.59	0.000	0.07	0.785
C: Normality	3.23	0.199	1.13	0.569	0.95	0.621
D: Heteroscedasticity.	1.93	0.165	2.88	0.090	24.4	0.000

Notes: a: see notes to Table 1. b. the reported statistics are the corresponding GR-squared and GR-bar-squared c: Instruments used are INTERCEPT, DLXau, DLPXUSau, DLPCau, DLWau(-1), DLWau(-2), DLWau(-3). d: Instruments used are INTERCEPT, DLXcn, DLPXUScn, DLPXUScn(-4), DLPCcn, DLPCcn(-1), DLPCcn(-2), DLPCcn(-3), DLWcn(-1), DLWcn(-2), DLRcn, DLRcn(-1), Ucn, Ucn(-1), Ucn(-2), Ucn(-3), Ucn(-4), SD1. e: Instruments used are INTERCEPT, DLPXUScn, DLPXUScn(-1), DLPXUScn(-3), DLPXUScn(-4), DLPCcn(-1), DLPCcn(-4), DLWcn(-1), DLWcn(-4), Ucn, SD1, SD2, SD3, TIME.

The US producer price index converted at the current exchange rate, is used as a measure of the price of competing imports for both Australia and Canada. Inflation in this measure has opposite estimated impacts on inflation in the two countries, with a coefficient of about -0.07 in the Australia, but between +0.31 and +0.42 in Canada. It's not surprising that Canadian prices are more heavily influenced by US prices, given the much stronger trading relationship, but the difference in sign is surprising.

Output growth is negatively related to inflation in Australia, but has no significant relationship to inflation in Canada. Bloch, et al (2004) find a negative influence of output growth on inflation for three major industrialized countries, US, UK and Japan. The interpretation of the relationship given there is that there are pro-cyclical variations in productivity, lowering direct production costs, or counter-cyclical variations in gross profit margins. In either event growth is deflationary and contributes to an improvement in the country's international competitiveness. The size of the deflationary effect for Australia in Model 3.1 is comparable to that found for the US and UK and bigger than that found for Japan.

There is some evidence of a positive impact of capital cost increases on price inflation in Canada, but only in Model 3.2 without the time trend. There also is some evidence of seasonality for inflation in Canada. None of the capital-cost variables or seasonal dummies is found to have any significant impact on inflation in Australia.

3.4 Wage equations

As with the domestic price equations, we estimate wage equation results for the full period of data available for each country, so the estimates are based on data from 1973Q1 to 2001Q4 for Australia and from 1960Q1 to 2001Q4 for Canada. Also, as with the price equations, the dependent variable in each equation is a first difference of the log of a variable, but now an industrial wage index rather than the domestic price index. This means the dependent variable is a measure of wage inflation and each coefficient of an independent variable (all in first differences of logs) provides an estimate of the elasticity of the wage level with respect to the particular variable.

Table 4: Wage Equation – Regression results for Australia and Canada

	Australia 1973Q1 – 2001Q4 Model 4.1 GIVE[c]		Canada 1960Q1 – 2001Q4 Model 3.2 GIVE[d]	
	coefficient	t-tatio	coefficient	t-ratio
INTERCEPT	0.0006	0.22	0.0239	9.49
DLPXi	1.5258	3.22		
DLPXi(-1)			0.3020	4.28
DLPXi(-2)	0.2619	2.22		
DLPXi(-3)			0.2472	3.42
DLPXi(-4)	-0.5663	-1.86		
Ui			0.0061	5.06
Ui(-1)			-0.0040	-5.46
Ui(-4)			-0.0037	-4.69
DLPCi	-0.0836	-1.78		
DLPCi(-4)			-0.0263	-1.65
SD3			-0.0096	-5.71
Observations	116		164	
R-Squared[b]	0.4211		0.5962	
R-Bar-Squared[b]	0.4003		0.5781	
F-statistic [probability]	12.51	[.000]	27.78	[.000]
DW-statistic	2.51		1.81	
Diagnostics[a]	Chi-square	Probability	Chi-square	Probability
A: Serial Correlation	2.68	0.612	6.39	0.171
B: Functional Form	6.53	0.011	0.67	0.412
C: Normality	1.33	0.514	13.62	0.001
D: Heteroscedasticity.	6.10	0.014	0.05	0.827

Notes: a: see notes to Table 1; b. the reported statistics are the corresponding GR-squared and GR-bar-squared c. Instruments used are INTERCEPT, DLPXau(-1), DLPXau(-2), Uau(-2) , UA(-3) , SD3, DLXau(-1). d: Instruments used are INTERCEPT, DLPXcn(-1), DLPXcn(-3) , DLPCcn(-1), DLPCcn(-4), Ucn(-1), Ucn(-2), Ucn(-3), SD2, SD3.

The dominant influence on wage inflation in the results in Table 4 is price inflation for both Australia and Canada. For Australia, the results suggest a full pass through of price inflation into wage inflation, with the sum of the coefficients of current and lagged price inflation coefficients equal 1.22 but not significantly different from 1.0. For Canada, the estimated impact is substantially smaller at 0.55, which is significantly less than 1.0.

Noticeably absent from significant influences on wage inflation in Australia is the unemployment rate. Other specifications or estimations methods do occasionally return a statistically significant coefficient of unemployment variables. However, the magnitude of impact is generally small and often offsetting over various lags, as is the case for Canada in Model 4.2. The net coefficient over up to a four-quarter lag is minus 0.0016, suggesting that increasing the unemployment rate by six percentage points, such as from four percent to ten percent, would reduce the inflation rate by one tenth of a percent per quarter.

Commodity price inflation has a small negative impact on wage inflation in both Australia and Canada. As commodity price inflation is already included directly and indirectly in the price inflation measure, this might simply reflect an overweighting of commodity price inflation in overall price inflation.

4. Conclusions

We examine the impact of primary commodity prices on inflation in Australia and Canada as commodity exporting countries. Commodity prices are highly volatile and are dependent on the world business cycle. This has potentially complex implications for commodity exporting countries. Primary commodity prices have a positive impact on the aggregate price level through the use of commodities as raw materials in industrial production. However, a ‘commodity currency’ might appreciate (depreciate) with increases (decreases) in commodity prices, thereby offsetting the direct effect of changes in commodity prices on the cost of production.

We find that primary commodity prices are strongly pro-cyclical with world industrial production. We also find that this impacts on the value of the Australian and Canadian dollar (relative to the US dollar) through the type of relationship to commodity prices expected for a ‘commodity currency’. However, the long-run elasticity of the Canadian dollar, at less than one tenth, is substantially lower than for the Australian dollar, for which the elasticity is not significantly different from one. Thus, primary commodity prices expressed in Australian dollars are largely insulated from movements in world prices of primary commodities, whereas Canadian primary commodity prices move pro-cyclically with world industrial production.

Our results for determining the price inflation show a positive and significant impact of primary commodity price inflation in both Australia and Canada, although the magnitude of impact is much greater for Canada than for Australia. This taken together with the evidence that Canadian inflation is also positively impacted by US inflation, where the latter has also been positively impacted by primary commodity price inflation according to Bloch, Dockery and Sapsford (2004), means the evidence suggests that Canadian inflation rises and falls with world commodity price inflation. The link between commodity inflation dynamics and domestic inflation for Canada is thus similar to the experience of the major industrialized countries, the US, UK and Japan, examined in Bloch et al (2004) and different from the experience of Australia.

DATA APPENDIX

World price of the primary commodity (PC)
Source: IMF Index of Primary Commodity Prices in US$, International Financial Statistics (various issues).

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

World/US wage level (Wus)
Source: US Average hourly earnings per manufacturing worker, current dollars, Datastream: US Department of Labor.

World/US long-term interest rate (Rus)
Source: US 10 year Treasury constant maturity rate, average of business days (%) Release H.15 from Federal board of Governors, downloaded from Federal Reserve Bank of St Louis; http://www.stls.frb.org/fred/

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

World/US price of finished goods (PXus)
Source: US Producer Price Index, Bureau of Labor Statistics, downloaded from http://www.stls.frb.org/fred/ (Federal Reserve Bank of St Louis)

Australian primary commodity prices in AU$ (PCau)
Source: Reserve Bank of Australia Index of Primary Commodity Prices, DX Database.

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

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

Australian Price of competing foreign products (PXus,au)
Source: US Producer Price Index, US Department of Commerce Bureau of Economic Analysis Database and Australian exchange rate (Eau).

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

Australian domestic output (Xau)
Source: GDP at constant prices, DX Database

Australian long-term interest rate (Rau)
Source: Australian 10-year Bond Rate, DX Database

Australian short-term interest rate (Iau)

Source: Australian 13-week Commonwealth Note Rate, DX Database

Australian unemployment rate (Uau)
Source: Australian Bureau of Statistics Database

Canadian Dollar Exchange Rates (Ecn)
Source: Canadian exchange rate *vis a vis* the US dollar, expressed as US$ per Cn$ (Ecn), Datastream, IMF International Financial Statistics)

Canadian domestic price level (PXcn)
Source: Canadian Producer Price Index, Datastream, IMF International Financial Statistics.

Canadian long-term interest rate (Rcn)
Source: Canadian Government bond yield – long term, Datastream, IMF International Financial Statistics.

Canadian short-term interest rate (Icn)
Source: Canadian 3-month treasury bill tender (monthly average), Datastream, Cansim – Statistics Canada.

Canadian Domestic output (Xcn)
Source: Canadian GDP volume index, Datastream, IMF International Financial Statistics.

Canadian Domestic Wages (Wcn)
Source: Canadian hourly wages, Datastream, IMF International Financial Statistics.

Canadian Domestic unemployment rate (Ucn)
Source: Canadian unemployment rate, % of civilian labour force, Datastream, OECD Database.

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