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On Commodity-Sensitive Currencies and Inflation Targeting

by

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Abstract

Two aspects of the recent monetary history of Canada, Australia, and New Zealand stand out: the sensitivity of their dollars to prices of resource-based commodities, and inflation targeting. This paper explores various aspects of these phenomena. It uses standard empirical models, and an investigation of the different approaches to inflation targeting in the three countries—including a case study of the 1998 international financial crisis—to assess how well a floating currency serves a resource-rich economy, and how monetary policy ought to be conducted during periods of turbulence in commodity and currency markets. The broad swings and cycles in the Canadian, Australian, and New Zealand dollars are found to have been helpful to macroeconomic stability. It appears that the most effective monetary policy approach focuses on domestic inflation control over the medium term. In a crisis of confidence in the financial markets, of the kind that sporadically affected the Canadian dollar in the first half of the 1990s, a case can be made for short-term monetary actions to stabilize expectations. Apart from crisis situations, *as long as a credible low-inflation policy is followed*, monetary policy does not have to be concerned with the exchange rate per se.

JEL classification: E31, E52, F31, F42
Bank classification: Exchange rates; Inflation targets; International topics; Monetary policy

Résumé

Deux éléments ressortent de l'histoire monétaire récente du Canada, de l'Australie et de la Nouvelle-Zélande : d'une part, la sensibilité des devises de ces nations aux variations des cours des produits à base de matières premières; d'autre part, l'utilisation de cibles de maîtrise de l'inflation. L'auteur se penche sur différents aspects de ces phénomènes. Il met à profit des modèles empiriques standards et examine les différentes approches adoptées dans les trois pays relativement aux cibles d'inflation — notamment en consacrant une étude de cas à la crise financière internationale de 1998 — afin de déterminer dans quelle mesure un régime de changes flottants sert les intérêts d'une économie riche en ressources naturelles, et de quelle façon la politique monétaire doit être conduite lorsque les marchés des devises et des matières premières traversent des périodes de turbulence. L'auteur constate que les variations et les cycles marqués du cours des dollars canadien, australien et néo-zélandais ont favorisé la stabilité macroéconomique. Il semble également que l'approche la plus efficace en matière de politique monétaire consiste à maîtriser le taux d'inflation intérieur à moyen terme. Lorsque les marchés financiers subissent des crises de confiance comme celles qui ont sporadiquement secoué le dollar canadien durant la première moitié des années 1990, il est justifié de recourir à des mesures de politique monétaire à court terme afin de stabiliser les attentes. En dehors des situations de crise, les autorités monétaires n'ont généralement pas à se préoccuper du niveau du taux de change, *dans la mesure où une politique crédible de faible inflation est poursuivie*.

Classification JEL : E31, E52, F31, F42
Classification de la Banque : Taux de change; Cibles en matière d'inflation; Questions internationales; Politique monétaire

Executive Summary

Two aspects of the recent monetary history of Canada, Australia, and New Zealand stand out: the sensitivity of their dollars to prices of resource-based commodities, and inflation targeting. This paper explores various aspects of these phenomena. With respect to commodity prices and exchange rates, it examines:

- the behaviour of real commodity prices, the terms of trade, and real exchange rates
- linkages between these variables
- the relative impact of commodity prices and exchange rates on output
- the possibility of excessive commodity sensitivity for the three currencies

Information on these issues is important for assessing how well a floating currency serves a resource-rich economy, and it also bears on the conduct of monetary policy, which exerts an important influence over, and can be affected by, the exchange rate. How monetary policy, and in particular inflation targeting, should be conducted during periods of turbulence in commodity and currency markets is a controversial topic in Canada, Australia, and New Zealand.

There is a compelling economic logic in the choice of the inflation target/flexible exchange rate regime for these countries. But modes of operating within this framework are still a work in progress. The policy question examined concerns the appropriate response of the interest rate to exchange rate changes, or how much exchange rate flexibility the central bank should allow. To shed light on this, the paper examines differences between the strategies of the Bank of Canada, the Reserve Bank of Australia, and the Reserve Bank of New Zealand. These differences were significant: the Reserve Bank of Australia has had a lower propensity to vary its interest rate in response to movements in the exchange rate than the central banks of Canada and New Zealand.

The first conclusion is that the behaviour of real exchange rates has helped the process of macroeconomic adjustment in the three countries.

- Descriptive statistics reveal a clear positive relationship between the real international prices of the commodities that Canada, Australia, and New Zealand export and the real exchange values of their currencies. The decline in the real exchange values of the commodity-sensitive currencies over the past 25 years follows a considerably larger decline in the real price of commodities. Cyclical movements are also positively correlated.

- Conventional econometric estimates suggest that both real commodity prices and real exchange rates have rather small effects on total spending in these countries. The exchange rate response to commodity prices ensures that GDP is even less sensitive to such shocks. Movements in real exchange rates have provided a partial buffer to earnings in the primary sector as real commodity prices have declined; more importantly, the positive effect on cost-competitiveness has increased profitable opportunities in new activities. Thus, substantial real

depreciations have not stalled the ongoing decline in the proportion of resource-based goods in total exports.

- Theory and data do not support the notion that commodity-sensitive currencies may be *too* sensitive to commodity prices. The sensitivity of the exchange rate to commodity price shocks has been of about the right size to stabilize the level of output and employment. Currency misalignments that might pose a threat to monetary stability are hard to detect. An econometric test did uncover a trace of speculative contagion between the Australian and New Zealand currencies, but the Canadian dollar does not seem to be affected by commodity contagion.

The second conclusion is that monetary policy in these countries should focus directly on inflation control over a medium-term horizon. Movements in the currency per se, in the absence of a crisis in the financial markets, generally do not warrant a monetary policy response. This conclusion is partly based on the findings of equilibrating relationships between commodity prices and exchange rates. In addition, the comparative analysis of policies suggests that the flexible approach to inflation targeting adopted early on in Australia—which features a medium-term horizon and a low propensity to change interest rates in response to exchange rate movements—produced the best macroeconomic results.

The conclusion, therefore, is that *as long as a credible low-inflation policy is followed,* monetary policy can let the exchange rate find its own level.

Sommaire

Deux éléments ressortent de l'histoire monétaire récente du Canada, de l'Australie et de la Nouvelle-Zélande : d'une part, la sensibilité des devises de ces nations aux variations des cours des produits à base de matières premières; d'autre part, l'utilisation de cibles de maîtrise de l'inflation. L'étude aborde différents aspects de ces phénomènes. En ce qui a trait aux cours des produits de base et aux taux de change, l'auteur examine :

- le comportement des cours réels des produits de base, les termes de l'échange et les taux de change réels;
- les liens entre ces variables;
- l'incidence relative des cours des produits de base et des taux de change sur la production;
- la possibilité que les trois devises en question soient excessivement sensibles aux cours des produits de base.

Il importe de recueillir des informations sur ces différents points afin de déterminer dans quelle mesure un régime de changes flottants sert les intérêts d'une économie riche en ressources naturelles. Ces renseignements tirent aussi à conséquence pour la conduite de la politique monétaire, qui exerce une incidence notable sur le taux de change et peut à l'inverse subir l'influence de ce dernier. Dans ces trois pays, l'orientation à donner à la politique monétaire, principalement au regard des cibles d'inflation, durant les périodes de turbulence des marchés des devises et des produits de base, est un sujet controversé.

Le choix d'un régime de changes flottants assorti de cibles d'inflation, dans ces pays, est dicté par la logique économique. Toutefois, les modes de fonctionnement qu'il convient d'adopter à l'intérieur de ce cadre font toujours l'objet de recherches. Du point de vue de la politique, la question qui se pose ici concerne la réaction appropriée des taux d'intérêt aux variations du taux de change, ou le degré de flexibilité du taux de change que doit permettre la banque centrale. Afin de clarifier cette question, l'auteur se penche sur les éléments qui distinguent les stratégies de la Banque du Canada, de la Banque de réserve d'Australie et de la Banque de réserve de Nouvelle-Zélande. Ces différences sont considérables. Par exemple, la Banque de réserve d'Australie a eu moins tendance que les banques centrales canadienne et néo-zélandaise à modifier ses taux d'intérêt en réponse aux variations du taux de change.

La première conclusion que tire l'auteur est que le comportement des taux de change réels a favorisé le processus d'ajustement macroéconomique dans les trois pays étudiés.

- Les statistiques descriptives font état d'un lien positif clair entre les prix internationaux réels des produits de base exportés par ces pays et les cours réels de leurs devises. La baisse de la valeur réelle des devises sensibles aux prix des produits de base, durant les 25 dernières années, a suivi un repli encore plus marqué des cours réels de ces produits. Les variations cycliques sont aussi positivement corrélées.

- Les mesures économétriques traditionnelles donnent à penser que les prix réels des produits de base, comme les taux de change réels, ont des effets plutôt minimes sur la dépense globale dans les pays considérés. Comme le taux de change est influencé par les cours des produits de base, le PIB est encore moins sensible à leur évolution. Les mouvements des taux de change réels ont partiellement compensé les pertes de revenus du secteur primaire lorsque les prix réels des produits de base ont diminué. Mais ce qui importe plus encore, c'est que l'effet positif qui en a résulté sur la compétitivité des coûts a élargi l'éventail des activités rentables. Par conséquent, les importantes dépréciations réelles n'ont pas freiné l'amenuisement constant de la proportion des produits à base de ressources naturelles dans les exportations totales.

- Ni la théorie ni les données recueillies n'appuient la thèse selon laquelle les monnaies qui sont sensibles aux cours des produits de base pourraient l'être *trop*. Les variations du taux de change survenues à la suite de modifications des prix des produits de base étaient généralement d'une ampleur propre à stabiliser le niveau de la production et de l'emploi. Un désalignement de la devise à ce point grave qu'il menacerait la stabilité monétaire est difficile à concevoir. Un test économétrique a néanmoins décelé des traces de contagion spéculative entre les monnaies de l'Australie et de la Nouvelle-Zélande. Le dollar canadien, par contre, ne semble pas touché par la contagion associée aux produits de base.

La seconde conclusion de l'auteur est que la politique monétaire de ces pays devrait se focaliser sur la maîtrise de l'inflation à moyen terme. Les variations que subit une devise, en l'absence d'une crise des marchés financiers, ne justifient généralement pas une intervention des autorités monétaires. Cette conclusion se fonde partiellement sur les effets stabilisateurs de la relation entre les cours des produits de base et les taux de change. En outre, l'analyse comparative des politiques donne à penser que l'approche souple en matière de cibles d'inflation adoptée dès le début en Australie — objectifs à moyen terme et faible propension à modifier les taux d'intérêt en réaction aux variations du taux de change — a donné les meilleurs résultats sur le plan macroéconomique.

L'idée maîtresse qui ressort de l'étude est donc que la politique monétaire peut généralement laisser le taux de change trouver de lui-même son niveau, *dans la mesure où une politique crédible de faible inflation est poursuivie.*

1. Introduction

Two aspects of the recent monetary history of Canada, Australia, and New Zealand stand out. The first is the sensitivity of the Canadian, Australian, and New Zealand dollars to prices of resource-based commodities.[1] Some journalists think that they are too sensitive, alleging that currency speculators overplay the resource dependence of these economies, or that the central banks have been lax in allowing commodity price weakness to affect the currency. This leads to the second aspect: the dedication of monetary policy since the early 1990s to explicit low-inflation targets.

This paper explores various aspects of these phenomena, and, with respect to commodity prices and exchange rates, examines:

- the behaviour of real commodity prices, the terms of trade, and real exchange rates
- linkages between these variables
- the relative impact of commodity prices and exchange rates on output
- the possibility of excessive commodity sensitivity for the three currencies

Information on these issues is important for assessing how well a floating currency serves a resource-rich economy, and it also bears on the conduct of monetary policy, which exerts an important influence over, and can be affected by, the exchange rate. How monetary policy, and in particular inflation targeting, should be conducted during periods of turbulence in commodity and currency markets is a controversial topic in Canada, Australia, and New Zealand.

The economic logic in the convergence to the floating exchange rate/inflation target regime must be acknowledged. Commodity price changes can imply substantial movements in the real equilibrium exchange rates of commodity exporters. A flexible nominal rate, in principle, allows a real rate adjustment to take place promptly, without prolonged periods of domestic inflation or deflation and unemployment, and without exchange market crises. If a monetary regime is not constrained by a fixed exchange rate, however, its effectiveness requires some other firm nominal anchor.[2] During the 1970s and 1980s, following the collapse of the Bretton Woods fixed parities, monetary policy in these countries failed to find a solid foundation, and in consequence allowed chronic inflation. This problem was resolved in the 1990s, when New Zealand and Canada, joined somewhat later by Australia, successfully pioneered the inflation-targeting approach to monetary policy (Bernanke et al. 1999).

1. Canada floated its exchange rate in 1970, three years before the other major economies. Australia and New Zealand followed over a decade later, in 1983 and 1985.
2. For a scholarly appraisal of alternative monetary orders, see Laidler (1999).

Modes of operating within this framework are still a work in progress. The policy question examined in this paper concerns the appropriate response of the central bank's interest rate to exchange rate changes, or how much exchange rate flexibility the central bank should allow. To shed light on this, differences between the Bank of Canada, the Reserve Bank of Australia (RBA), and the Reserve Bank of New Zealand (RBNZ) are examined. These differences were significant: the RBA has had a lower propensity to vary the short-term interest rate in response to movements in the exchange rate than the Bank of Canada and, until recently, the RBNZ.

Section 2 describes, for the three economies, the commodity composition of trade, the behaviour of commodity prices and currencies, and the terms of trade. It stresses that prices of all commodities do not move in tandem, and—following the seminal work of Amano and van Norden (1992) (hereafter, AvN)—distinguishes especially between energy and non-energy prices. Section 3 assesses the importance of resource-based activity to Canada, Australia, and New Zealand, using econometric estimates of the influence of commodity prices on the terms of trade, exchange rate, and output. Section 4 describes the different evolution of inflation targeting in the three countries, and illustrates this with a case study of policies during the commodity and financial market turbulence of 1998. Section 5 outlines some broad policy conclusions.

2. Commodity and Currency Facts

2.1 Commodity trade composition and destination

Table 1, column 2, indicates the extent to which Canada, Australia, and New Zealand are *net* exporters of commodities. All three countries are to a small extent dependent on commodity imports, especially Canada, owing to its proximity to, and high division of labour with, the United States, which is also rich in natural resources. The next three columns show the composition of exports. Canada has the lowest proportion in agriculture, New Zealand by far the highest.

Table 1. Percentages of total resource-based exports, 1990–99

	Resource-based imports/exports Sum of SITC 0 to 4 divided by sum of SITC 0 to 9	**Non-energy materials** SITC 2+4	**Energy** SITC 3	**Agriculture** SITC 0+1
Canada	42	40	35	25
Australia	22	36	31	33
New Zealand	27	27	4	69

Source: *Monthly Statistics of International Trade*, OECD.

Canada and Australia, unlike New Zealand, are large producers of minerals and energy products. Canada is, in addition, a huge exporter of forest products. (Appendix 1 provides a more detailed breakdown of the commodity exports of the three countries.)

The United States is Canada's dominant export market, whereas the markets for Australia and New Zealand are more evenly spread over the globe (Table 2).

Table 2. Major export markets, 1990–99

	Percentage of total exports to			
	United States	**Japan**	**European Union**	**Other Asia**
Canada	83	3	5	4
Australia	8	22	12	39
New Zealand	12	14	15	24

Source: *Direction of Trade Statistics Yearbook*, IMF.

2.2 Trend and cycle in relative prices

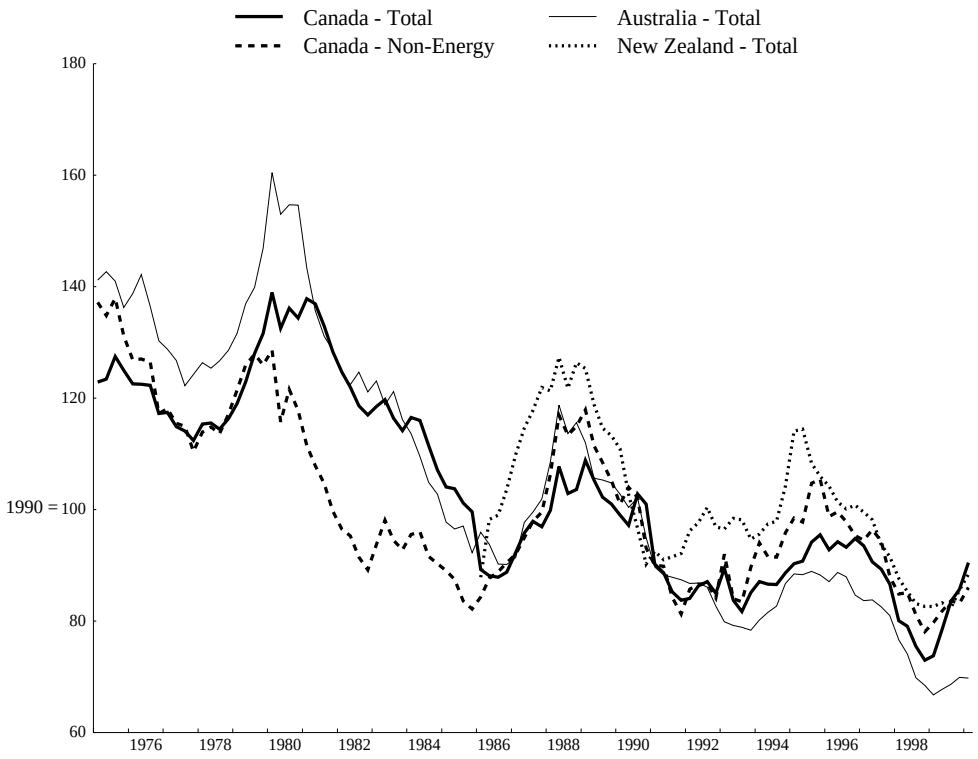
This section considers the behaviour over time of three sets of relative prices: real prices of commodities, real exchange rates (gauged against broad price indexes), and terms of trade (merchandise export prices divided by import prices).[3]

2.2.1 Real commodity prices

As Chart 1 shows, since the highs of the 1970s, the price of basic materials relative to that of finished goods and services has been declining. Statistical regressions indicate a trend decline of about 2 per cent a year for Canada, and almost 3 per cent for Australia (Table 3).[4] The rate of decline of real non-energy prices was somewhat lower, at about 1 1/2 per cent for Canada and 2 per cent for Australia.[5] Measured against GDP deflators, rather than goods prices, the rates of decline would be about one half percentage point steeper, because of the increasing relative price of services.[6] Rates of decline of that magnitude cannot but have substantial effects on real incomes and the allocation of resources.

3. Throughout this paper commodity prices are in real U.S. dollars.
4. Unit-root tests suggest that the cyclical variations around these trends are stationary. Over the twentieth century as a whole, however, there is no clear trend in real commodity prices (see Coletti 1992–93), and the series does not appear to be stationary.
5. Available commodity price indexes for New Zealand go back only to the mid-1980s.
6. There may, however, be an upward bias in the price index for services, because of the greater difficulty of accounting for productivity and quality improvement, especially for government services.

Chart 1: Relative prices—commodities over finished goods



Sources: Statistics Canada, RBA, and RBNZ, as per Djoudad, Murray, Chan, and Daw (2001).

Table 3. Estimated trend in real commodity price index
Adjusted by producer price of finished goods

1975Q1–2000Q1	**Estimated trend (standard deviation)** per cent p.a.
Canada	
Total	-1.96 (0.11)
Non-energy	-1.42 (0.14)
Australia	
Total	-2.88 (0.12)
Non-energy	-2.28 (0.17)

Empirically, relative prices between different commodities are far from stable. A study by the RBNZ concluded that, while prices of related commodities (e.g., copper and gold), which might be substitutes, show systematic co-movement, those of unrelated commodities (e.g., copper and

lumber) do not (Cashin et al. 1999a and b). Coletti (1992–93) outlines some reasons for divergent price movements: technical change, shifts in demand for final goods, discoveries, depletion, and environmental protection.

For our purposes, a distinction has to be made between energy and other materials, because AvN found that the two affect the Canadian dollar very differently.

Table 4 shows correlation coefficients between real commodity price indexes of the three countries. The correlations between levels of these variables would capture common trends as well as common shorter-run movements, whereas the correlations between first differences would take out the trend factor. Correlations between Canadian and Australian commodity price indexes are high at all frequencies. One reason for this would be the importance of mineral extraction for both countries. The correlation between Canada and New Zealand is somewhat lower, probably because of the much greater importance of agricultural output for New Zealand.

Table 4. Correlations between real national commodity price indexes
U.S. dollar values adjusted by U.S. GDP deflator

Levels (upper triangle) and *first differences (lower triangle)*			
1986Q1–2000Q1	**Canada**	**Australia**	**New Zealand**
Total commodities			
Canada	1	0.93	0.85
Australia	*0.64*	1	0.89
New Zealand	*0.28*	*0.46*	1
Non-energy			
Canada	1	0.93	
Australia	*0.61*	1	

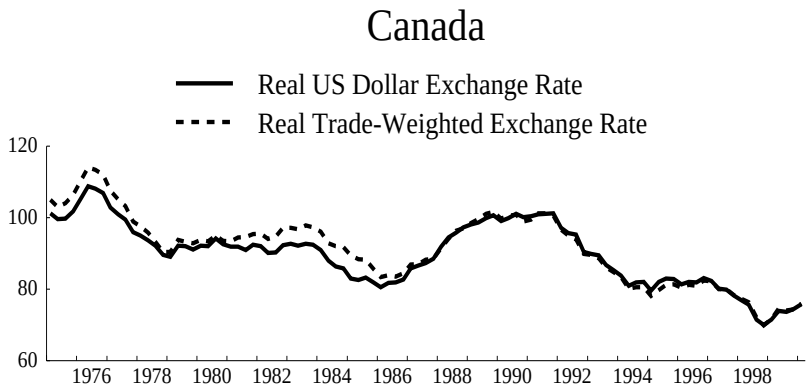
2.2.2 Real U.S. dollar exchange rates

Chart 2 shows indexes of real (i.e., price-level-adjusted) exchange rates for the three currencies, each measured on both a U.S. dollar and a trade-weighted basis. The trade-weighted Canadian dollar follows the U.S. dollar exchange rate very closely, because of the dominant weight of the United Sates in Canadian trade. The correlation between the trade-weighted and the bilateral rate is looser for the Australian and New Zealand dollars, particularly in the first half of the 1980s and the late 1990s, when the U.S. dollar was appreciating strongly worldwide. But for these currencies, too, the two indexes usually move in the same direction.

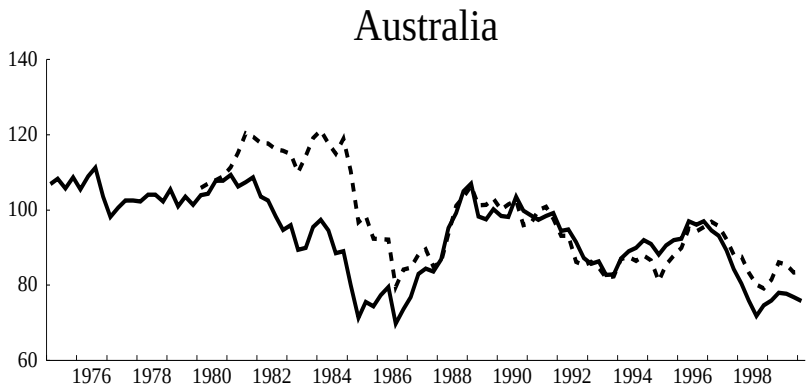
On each measurement, over the past 25 years a downward trend is evident in the real exchange value of the Canadian and Australian currencies. For the real New Zealand dollar, large cycles are evident, but the long-term trend looks virtually directionless.

There is a fair degree of co-movement among the three currencies, especially between the Australian and New Zealand dollars. Some of this is caused by the correlation of their respective commodity price indexes. Whether there is also an element of speculative contagion is discussed in section 3.

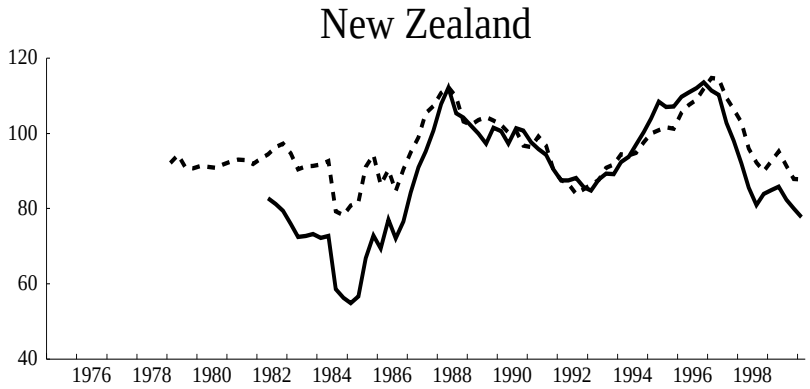
Chart 2: Real exchange rates



Source: Bank of Canada: GDP deflator-adjusted measures; 6-currency index.



Source: *International Financial Statistics (IFS)*, IMF. CPI-adjusted measures.



Source: *IFS*, IMF: CPI adjustment.

2.2.3 Terms of trade

Although economists sometimes use the two variables interchangeably, the terms of trade (merchandise export prices over import prices) and real commodity prices are distinct concepts exhibiting significantly different behaviour. For Canada and New Zealand, there has been a slight positive long-run trend in the terms of trade over the past 25 years, but unit-root tests, as well as visual inspection, indicate that this trend is not stable (Chart 3). These time-series properties contrast markedly with those for commodity prices over the same period. Australia alone exhibits similar declining trends for both the terms of trade and real commodity prices, but even here the 25-year decline in the terms of trade is considerably less than that of real commodity prices.[7]

Chart 3: Merchandise terms of trade

Sources: Statistics Canada; *IFS*.

7. Gruen and Kortian (1995) found stationarity around a declining trend in the Australian terms of trade over a similar period. This result might not hold over a long run of data.

3. Behavioural Relationships Between Commodity Prices, Exchange Rates, Terms of Trade, and Output

3.1 Commodity price and exchange rate

3.1.1 Correlations

Tables 5 and 6 give a glimpse into the commodity currency phenomenon. USD refers to a real U.S. dollar exchange value, and TWI refers to a trade-weighted multilateral exchange rate index (an increase indicating appreciation).

Table 5. Correlation of real exchange rate with real commodity price index

	Lag/lead of real commodity price index						
	t-12	**t-3**	**t-1**	**0**	**t+1**	**t+3**	**t+12**
Canada USD							
Total commodity	0.52	0.57	0.57	0.57	0.57	0.57	0.53
Non-energy commodity	0.68	0.69	0.69	0.69	0.69	0.67	0.63
Canada TWI[a]							
Total commodity	0.69	0.72	0.72	0.71	0.71	0.69	0.62
Non-energy commodity	0.78	0.76	0.74	0.74	0.73	0.70	0.62
Australia USD							
Total commodity	0.72	0.78	0.79	0.79	0.79	0.78	0.75
Non-energy commodity	0.77	0.81	0.81	0.81	0.79	0.78	0.69
Australia TWI[b]							
Total commodity	0.86	0.80	0.78	0.77	0.76	0.75	0.66
Non-energy commodity	0.83	0.72	0.70	0.68	0.66	0.64	0.51
New Zealand USD							
Total commodity	0.63	0.56		0.49		0.37	-0.03
New Zealand TWI[b]							
Total commodity	0.52	0.47		0.40		0.29	-0.05

Notes: Real U.S. dollar exchange rates and commodity prices based on GDP deflators. Canada and Australia: monthly, January 1973–June 2000. New Zealand: quarterly, 1986Q1–2000Q1; t-12 refers to 4-quarter lag, etc.

a. Bank of Canada 6-currency trade-weighted index, adjusted by GDP deflators.

b. IMF effective exchange rate, adjusted by CPIs.

Table 5 contains correlation coefficients between commodity price indexes and exchange rates, for a one-year range of leads and lags. Results are shown for just non-energy commodities, and for total commodities. The correlation coefficients are uniformly positive for lagged and contemporaneous commodity prices, and are either flat or declining for leading values of

commodity prices. There are no clear lead-lag patterns vis-à-vis the U.S. dollar, but the peak effect of resource prices on the TWI invariably seems to involve a lag—of a year or more for the Australian and New Zealand dollars.[8] As expected, the results tend to be stronger (higher correlations, clearer lead-lag patterns) for non-energy than for total commodity prices.

Comparing countries, one finds the highest correlations for Australia, indicating that, of the three currencies, the Australian dollar has mirrored commodity prices most closely. As will be discussed later, this fact has helped mould different attitudes of policy-makers in the three countries towards the exchange rate.

Table 6 shows correlations of quarterly deviations from trend, which capture cyclical common movements. Total commodity prices have no clear correlation over the cycle with the Canadian dollar, but for non-energy commodities there is a positive correlation (the AvN effect again). The relatively high correlations for Australia stand out at this frequency (although the numerical coefficients for New Zealand are somewhat greater, they are less reliable because of the short estimation period).

Table 6. Correlation of deviations from trend: real exchange rates and real commodity prices

Canada 1975Q1–200Q1				**Australia** 1975Q1–2000Q1				**New Zealand** 1986Q1–2000Q1	
USD		**TWI**		**USD**		**TWI**		**USD**	**TWI**
Total	***Non-energy***	***Total***	***Non-energy***	***Total***	***Non-energy***	***Total***	***Non-energy***	***Total commodity price index***	
-0.01	0.26	0.01	0.13	0.63	0.59	0.45	0.23	0.69	0.64

3.1.2 Error-correction model

While simple correlations may verify a connection between commodity prices and currency values, they do not reveal the size of the response of the exchange rate. To measure this, the best models available are the AvN-inspired error-correction models estimated by Djoudad, Murray, Chan, and Daw (2001)—hereafter DMCD. Their coefficient estimates (excluding constant terms and interest-differential coefficients) are given in Table 7.

8. In rigorous tests, however, AvN did find Granger causality from non-energy commodity prices to the real value of the Canadian dollar in U.S. funds. As will be discussed later, this casts doubt on the hypothesis that market speculation immediately incorporates all relevant information.

Table 7. Exchange rate error-correction model for USD real exchange rates

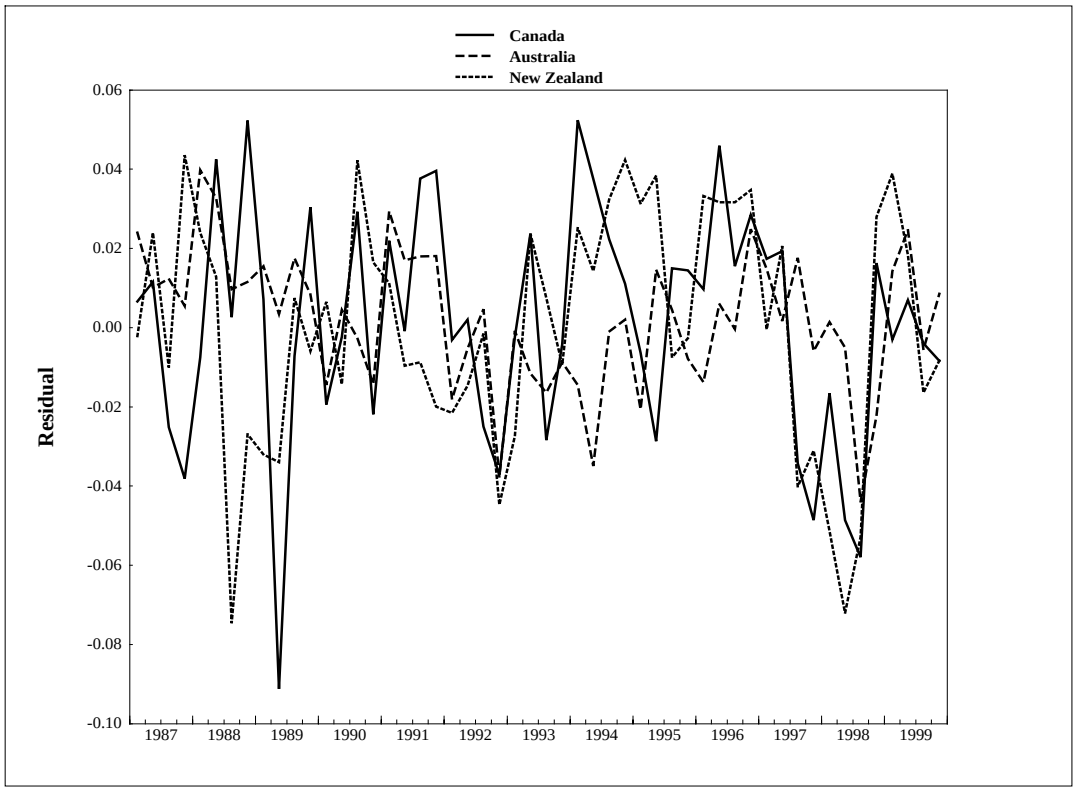
Estimation period 1973Q1–1999Q4	Estimated coefficients of Djoudad, Murray, Chan, and Daw (2001)		
	Long-run price elasticity		
U.S. dollar per currency	Non-energy commodity	Energy	Adjustment parameter
Canadian dollar	0.41	-0.15	-0.16
Australian dollar	0.55	-0.62	-0.22
New Zealand dollar	0.62	NA	-0.11

Each of the estimates is significantly different from zero at a high probability threshold. The negative effect of real energy prices conforms with the findings of AvN, and can be given a theoretical justification. The estimated long-run effect of non-energy commodity prices on the U.S. dollar values of the Canadian, Australian, and New Zealand dollars is numerically quite large, but since the adjustment parameter is quite low, the short-run impact is much weaker. For example, a 10 per cent increase in non-energy commodity prices would increase the exchange value of the Canadian dollar in the long run by about 4.1 per cent, but in the short run by only 0.16(4.1)=0.7 per cent.

3.1.3 Commodity currency contagion?

Speculative contagion could result in pricing aberrations. It is possible to test for the existence of such an effect, given a hypothesis about the form of contagion. One candidate is that exchange market participants do not distinguish carefully between commodity currencies, but routinely mark them all up or down to a similar degree on news that does not affect the various economies equally. This hypothesis can be tested by examining the correlations across the components of exchange rates that cannot be explained by underlying economic variables. The residuals of the DMCD equations can be used to gauge this component (Chart 4). Since the U.S. dollar is used as the common measure of exchange value, one would expect some positive correlation in the residuals, because of factors affecting the United States omitted from the equations, even if there were no contagion. A zero correlation would therefore be fairly strong evidence against the existence of such contagion.

Chart 4: Residuals from equations for U.S. dollar exchange rates



For the Canadian dollar, this kind of contagion does not seem to be present.[9] The correlation coefficients of the Canadian dollar against both the Australian and New Zealand currencies are not significantly different from zero (Table 8), and some large outliers occur independently (Chart 4). For the Australian and New Zealand currencies, however, the correlation of unexplained changes is just high enough to give the notion of contagion some plausibility.

Table 8. Cross correlation of U.S. dollar exchange rate residuals

From equations of DMCD

1987Q1–1999Q4	Canadian dollar	Australian dollar	New Zealand dollar
Canadian dollar	1	0.24	0.12
Australian dollar		1	0.41
New Zealand dollar			1

Note: Approximate standard deviation of coefficient = $(NOBS-3)^{-0.5} = 0.15$.

9. The relatively small errors for the Australian dollar suggest that the currency is less susceptible to portfolio disturbances than the Canadian dollar.

3.2 Commodities, exchange rates, and terms of trade

This section investigates interactions between commodity prices, the real exchange rate, and the terms of trade. The techniques used are similar to those of Longworth (1980).

A convenient assumption is that foreign currency prices of raw materials are set exogenously, but in fact Canada and Australia are major players in the world markets for some commodities (e.g., forest products and wool). Finished manufactured goods, which have been a growing proportion of merchandise trade, are considerably diversified, so that the elasticity of demand for this component of domestic production would be finite. Moreover, resource-based exports contain a fair, and probably increasing, amount of value-added. All this suggests that domestic variables might have some influence over the foreign currency prices of exports, at least for Canada and Australia.

For a not-so-small producer, the rate of change in the merchandise export prices index can be written as a weighted average of the world spot price of raw materials, the wholesale (or producer) price of domestic finished manufactured goods, and a value-added component for the additional inputs needed by exports. The value of the latter might be approximated by the GDP deflator times a coefficient, δ. An equation for export prices can then be written:

$$px = \phi(pcom^* + pfx) + \delta p + (1 - \phi - \delta)pg, \qquad (1)$$

where:

* = foreign variable valued in foreign currency
px = merchandise export price
*pcom** = world spot price of resource-based goods
p = GDP deflator
pfx = price of foreign exchange
pg = price of finished manufactured goods
pm = merchandise import prices
all variables = percentage rate of increase (or first difference of logarithm)

The coefficient ϕ represents the weight of world commodity prices in total export prices; $(1-\phi-\delta)$ represents the weight of finished manufactured goods prices, and δ represents the weight of the cost of services required to convert domestic materials and finished goods into export goods. In a completely dependent economy, too small to influence the world price of its exports, the terms of trade are determined just by foreign variables; i.e., $\phi=1$, and $\delta=0$. More generally, the weights δ and $(1-\phi-\delta)$ summarize the degree of influence that a country has over its own export prices ("market power").

Import prices, in domestic currency, would vary in proportion with the exchange rate and the foreign price of manufactured tradables; the latter would be a function of the foreign wholesale price of finished goods plus a value-added component (the share of which is assumed to be equal to that in home production):[10]

$$pm = pfx + \delta p^* + (1 - \delta)pg^*. \tag{2}$$

An equation for the proximate determinants of the rate of increase in the terms of trade would then be:

$$px - pm = \phi(pcom^* - pg^*) + (1 - \phi)[pg - pg^* - pfx] + \delta[(p^* - pg^*) - (p - pg)]. \tag{3}$$

The first term (in parentheses) on the right-hand side of equation (3) is the international price of commodities relative to finished goods; the second term (in square brackets) is the real exchange rate gauged by finished goods prices; and the third term (also in square brackets) is a real value-added differential. If foreign productivity growth in manufacturing is growing relatively rapidly, the last term would be positive.[11]

Unconstrained estimates of equation (3) are presented in Table 9 (the theoretical constraint that the first two coefficients sum to unity is easily rejected). The key result is that there is nothing close to a one-to-one relationship between commodity prices and terms of trade. The estimate for Australia is the closest, with an estimated elasticity of just 0.19. The estimates, therefore, do not suggest that international prices of resource-based exports have dominated the terms of trade of Canada, Australia, and New Zealand over the last quarter-century. Real trade-weighted exchange rates have exerted an impact of similar or greater magnitude. This suggests that the degree of substitutability in manufactured goods is considerably less than perfect.

Table 9. Estimates of terms of trade elasticities: quarterly rates of change

		Canada	Australia	New Zealand
Real commodities price USD index	ϕ	0.12 (0.03)	0.19 (0.07)	0.12 (0.07)
Real exchange rate: BIS finished goods TWI	$1 - \phi$	0.25 (0.06)	0.22 (0.06)	0.09 (0.09)
Value-added differential	δ	0.25 (0.09)		
Trend (per cent p.a.)		0.08 (0.38)	-0.70 (0.88)	1.04 (1.04)
Estimation period		1975Q1–2000Q1	1980Q1–1999Q4	1986Q1–2000Q1

Notes: All *real* prices relate to a wholesale price index for finished goods. Standard deviations in parentheses. Variables are first differences of logarithms. Terms of trade: Canada, Laspeyres index; Australia and New Zealand, unit value indexes.

10. The restriction that the coefficient δ is the same for imports and exports is supported by the data.
11. This relative price change stems from Balassa-Samuelson sectoral productivity growth differentials.

The real value-added differential for Canada is measured by the difference between the Bank of Canada's GDP deflator-based TWI and the Bank for International Settlements' producer-price-based TWI. The strongly positive coefficient picks up, among other things, the beneficial effect on the terms of trade of the rapid price decline in the high-technology equipment that Canada imports. For Australia and New Zealand, since deflator-based real TWIs were not available, CPI-based indexes were used instead to measure the value-added differential. The resulting estimates of δ were not significantly different from zero. In any case, the estimated time trends (constant terms in the growth-rate regression) are not significantly different from zero. This is somewhat surprising, as one would expect a positive estimated trend, reflecting the steep decline in the real price of high-technology imports, which is completely absent in the equations for Australia and New Zealand.

Equation (3) implies a relationship between the terms of trade and the real exchange rate measured with GDP deflators, which is a widely used measure of cost competitiveness:

$$px - pm = \phi(pcom^* - pg^*) + (1 - \phi)[p - p^* - pfx] + (1 - \phi - \delta)[(p^* - pg^*) - (p - pg)]. \qquad (4)$$

All definitions in equation (4) remain exactly the same as those in equation (3). But the first term in brackets involves the GDP-deflator-adjusted exchange rate. The coefficient on the latter is the same as that for the producer-price-adjusted exchange rate in equation (3). Thus, the estimate of the real exchange rate effect presented in Table 9 applies to both definitions of the real exchange rate. The coefficient on the value-added coefficient in equation (4), however, represents the weight on finished manufactured goods in export pricing, in contrast to that on additional export services in equation (3).

This evidence makes the usefulness of the simplest small open economy model, in which the foreign currency prices of all tradable goods are fixed exogenously, debatable.

The results also underline the ambiguity of a "terms of trade shock," especially for Canada. Outside the confines of the simplest small open economy model, there is a significant endogenous component to the terms of trade, and the source of the exogenous impulse is crucial. Changes in the terms of trade do not in general provide a close approximation to the changes in world commodity markets to which these exporting countries must adapt.[12] Moreover, the implications for the exchange rate of changes in the terms of trade differ radically according to the type of shock. An improvement in the terms of trade might represent an increase in the price of commodities, following which the real exchange rate of commodity exporters would appreciate.

12. The effect of the exchange rate on the terms of trade means that the use of such an approximation would lead to biased estimates of exchange rate equations. Given the results for equation (3), such a bias would be more serious for the Canadian than the Australian dollar.

But consider a short-run "improvement" deriving from a jump in domestic costs: the currency would depreciate in the future to restore competitiveness. And an improvement stemming from a trend decline in the relative world price of imports has ambiguous implications for the equilibrium exchange rate. An important relevant "shock" would be the rapid fall in the price of computer equipment, which all of these countries import heavily.

3.3 Commodity prices, exchange rates, and output

3.3.1 Export shares

How dependent are the economies of Canada, Australia, and New Zealand on international commodity markets? This section attempts to shed light on this, by presenting, first, some descriptive data on export concentration, and, second, some econometric estimates of aggregate demand functions.

Table 10 lists percentages of resource-based commodities in total merchandise exports.[13]

Table 10. Resource-based commodities: per cent of total exports of goods and services

	1970s	1980s	1990s
Canada	57	46	39
Australia[a]	75	71	58
New Zealand[b]	65	61	52

a. *Reserve Bank of Australia Bulletin*, January 1996. 1990s represented by 1994/1995 figure.

b. RBNZ estimates. 1970s represented by 1978 figure.

The decline in the resource share over the years has been steep, especially in Canada and Australia. The process of economic growth has, not surprisingly, involved a relatively rapid increase in exports of finished goods and services. (Probably, too, the composition of exports within the resource-based category has shifted towards fabricated content; e.g., window frames instead of lumber.)

Canadian critics of floating exchange rates claim that depreciation has favoured the resource-based sector at the expense of newer activities. Standard economic reasoning does not support this

13. The share of resource-based output to GDP is quite similar in Canada and Australia, despite the higher proportion of commodities in Australian exports, since the Canadian total export/GDP ratio is higher. Also, because trade grows faster than GDP, there is no clear downward trend in the output share of the resource sector (Novin and Stuber 1999).

notion. In the pure price-taking model, the exchange rate does not affect the price of raw materials relative to other tradables, and so does not influence the allocation of resources inside the tradables sector. If the price-taking assumption is relaxed, to recognize that Canada and Australia have some influence on the world price of their exports, the theory predicts that depreciation would hasten the relative decline of the resource sector. In this case, increased competitiveness reinforces the drop in the foreign currency price of raw materials that these countries export, while it does not affect the world price of other goods. Although empirically this effect could not be large, the further decline in the relative price of staple products would at the margin encourage labour and capital to move into other activities. The unabated shift in this direction following the substantial depreciation of the 1990s is consistent with the prediction that currency depreciation has a negligible, or slightly negative, effect on resource-based output relative to other tradables output. In contrast, the assertion that depreciation protects resource-based activity is not substantiated.

3.3.2 Empirical IS curves

For a commodity exporter, an IS curve shows combinations of the exchange rate, the interest rate, and commodity prices that achieve equilibrium in the market for goods and services. If the domestic interest rate is determined by the world interest rate (which in the long run would be a good hypothesis), then following a shock to commodity prices the real exchange rate would change to re-equilibrate the output market, and the coefficients of the IS curve would show the amount of the required change.

Estimates of the IS relationship are generally obtained from an aggregate demand function, a popular form of which is:[14]

$$\Delta y_t = \alpha_0 + \alpha_1(L)\Delta y^*_t + \alpha_2(L)\Delta r_t + \alpha_3(L)\Delta e_t + \alpha_4(L)\Delta pcom_t, \qquad (5)$$

where:

Δy_t = quarterly growth rate of real GDP
Δy^*_t = growth rate of foreign real GDP
Δr_t = quarterly change in real short-term rate of interest
Δe_t = quarterly rate of real appreciation of the domestic currency
$\Delta pcom_t$ = quarterly growth rate of real commodity prices (deflated by GDP deflator)

14. Variants of this equation have been estimated for Canada by Duguay (1994), and for Australia by de Brouwer and O'Regan (1997). Dennis (1997) estimates an aggregate demand equation for New Zealand that differs in important respects from equation (5): it is written in terms of the output gap, and it does not include commodity prices.

Various alternative empirical definitions for the explanatory variables were tried:

- Commodity price indexes—*Total* and *non-energy commodity price indexes* yielded similar estimates.
- U.S. and weighted foreign variables—For Canada, the United States is a close proxy for the rest of the world. For Australia and New Zealand, a U.S. measure gives different, but not statistically inferior, results to a more global measure. The variables in question are:
  - — real exchange value of the domestic currency: *bilateral U.S. dollar value* and a *trade-weighted index* (TWI); in both cases, an increase implies a loss of domestic cost-competitiveness
  - — foreign output: *U.S. GDP,* and *OECD GDP,* and the IMF's *World GDP*

The relevant combinations of definitions give up to six equations to estimate for each country. The results leave a lot to desire, especially those for New Zealand. Table 11 displays estimates, selected on the basis of the size of the estimated elasticity with respect to relative commodity prices. This choice results in relatively high estimates for the exchange rate elasticity, too.

Table 11. Aggregate demand functions: elasticities for quarterly growth of GDP

Estimation period 1975Q1–2000Q1		**Canada**	**Australia**
U.S. GDP	$\alpha_1(L)$	0.83 (0.07)	0.42 (0.12)
Real 3-month interest rate[a]	$\alpha_2(L)$	-0.19 (0.14)	-0.08 (0.16)
Real USD exchange value$	$\alpha_3(L)$	-0.14 (0.07)	-0.30 (0.10)
Real non-energy commodity price	$\alpha_4(L)$	0.07 (0.04)	0.19 (0.06)
Estimation period 1986Q1–2000Q1		**New Zealand**	
OECD GDP	$\alpha_1(L)$	0.66 (0.99)	
Real 3-month interest rate[b]	$\alpha_2(L)$	-1.31 (0.93)	
Real TWI	$\alpha_3(L)$	-0.16 (0.45)	
Real RBNZ commodity index	$\alpha_4(L)$	0.19 (0.34)	

Notes: Coefficients are sums over a distributed lag. Standard deviations are in parentheses. Variables are first differenced. For exact specifications, see Duguay (1994).
a. Canadian commercial paper rate, Australian bill rate.
b. Bank bill rate.

For what they are worth, the results suggest that the impact of the three relative price variables on output is weak—despite the deliberate bias in the selection.

There may be two explanations for this. The first is that the estimates—in particular, the low estimated commodity price effect—correctly capture a modest, ill-defined impact in the real world. The resource-based industries are themselves quite resilient, having weathered repeated sporadic slumps, and having adapted to the risks of wide variations in prices. They do not

immediately vary output and investment with every change in prices. In addition, the economies as a whole have become less dependent on their resource base than generally realized. Many factors affect activity across a wide range of sectors. At certain times, commodity price events are among the factors influencing economic activity, but their overall impact on the economy has typically not been dominant.[15]

The second explanation is that the estimated elasticities are biased towards zero, because of missing variables and simultaneity in the explanatory variables.[16] It is highly probable that the exchange rate and the interest rate have both systematically moved to equilibrate output in response to shocks to omitted variables. Likewise, commodity price changes to some extent reflect supply-side changes affecting GDP in the opposite direction. For example, technological improvements often boost GDP and at the same time reduce the raw material intensity of output, which reduces commodity prices; and resource depletion reduces GDP while raising raw material prices. This simultaneity would bias the estimated coefficients downwards.

Weak effects of natural resource prices on output would not imply that the Canadian, Australian, and New Zealand dollars should not be very sensitive to commodity prices. Suppose that the exchange rate moves to offset the output effects of commodity market shocks. Then from equation (5), one would have

$$0 = \alpha_2(L)\Delta e_t + \alpha_3(L)\Delta pcom$$

$$\Delta e_t/\Delta pcom = \alpha_3(L)/\alpha_2(L).$$

Thus, if the exchange rate plays an equilibrating role for the economy, its response to resource prices is given by the ratio $\alpha_3(L)/\alpha_2(L)$; i.e., the commodity price elasticity *relative to* the exchange rate elasticity. A weak exchange rate elasticity of output $\alpha_2(L)$ would imply that the equilibrium value of the currency has to move by relatively large amounts to offset shocks to output.

In fact, the estimates yield a $\alpha_3(L)/\alpha_2(L)$ ratio of about 0.5 for Canada, and somewhat more for Australia. That is, following an increase of 10 per cent in world commodity prices, an appreciation of about 5 per cent would keep the level of output roughly constant in both countries. In New Zealand, the elasticity ratio is about unity, suggesting that a 10 per cent appreciation

15. Any back issue of the Bank of Canada's *Monetary Policy Report*, the RBA's *Semi-Annual Statement on Monetary Policy*, or the RBNZ's *Monetary Policy Statement* serves to illustrate this point. Non-energy commodity events rarely play a large role in the economic assessments these reports present.
16. In an econometric study that is immune to these problems, Djoudad, Gauthier, and St-Amant (2001) find that real commodity prices explain a large proportion of the variance of the Canada–U.S. output growth differential.

would be required. Do exchange rates in fact move approximately by these magnitudes in response to changes in commodity prices? The estimates previously cited suggest they do—a statistical test for each country does not reject the hypothesis that the estimate of $\alpha_3(L)/\alpha_2(L)$ from Table 11 is equal to the exchange rate response in Table 7. That is, the typical reaction of the Canadian, Australian, and New Zealand dollars to a commodity price shock appears to be of about the right magnitude to stabilize GDP (but not the level of output in the resource-based industries).

3.4 The dynamics of exchange rate adjustment

3.4.1 Overshooting

According to Neary and Purvis (1982), sharp changes of real exchange rates may be economically benign. Neary and Purvis develop a three-sector model in which a resource boom causes the real exchange rate to respond more to a disturbance in the short run than in the long run. Indeed, in the long run the value of the currency need not change in the same direction as commodity prices.

This effect is due to a fixed short-run capital stock: in the long run, the adjustment of the capital stock, through depreciation or new investment, mitigates the adjustment in the equilibrium price. In contrast to the better-known Dornbusch overshooting, Neary-Purvis overshooting is entirely real in nature. The authors argue that in situations of relative price shocks, monetary policy actions to stabilize the exchange rate, even when it moves well out of line of purchasing power parity, would impede the process of adjustment.

3.4.2 Informational efficiency

The joint hypothesis that the exchange rate embodies all relevant information and that risk premiums are constant has been rejected in countless tests of exchange market efficiency. Exchange markets do not appear to take fully into account the implications of observed movements in commodity prices. Gruen and Kortian (1995) show the existence of excess returns in the market for Australian dollar assets, based on the predictable exchange rate effect of current terms of trade changes. They go on to conclude that commodity sensitivity is *excessive*, but their tests are not designed to detect this kind of market failure.

Empirical exchange rate equations contain lengthy adjustment lags in the response to commodity price changes. Consistent with this, tests by AvN and DMCD show Granger-causality from commodity prices to exchange rates. In the literature on efficient markets, Granger-causality tests are used to investigate whether a given set of information is immediately incorporated into an

asset price (e.g., Hamilton 1994, 306–07). The finding that changes in commodity prices Granger-cause exchange rates suggests that exchange rate markets are not informationally efficient. If they were, currencies would move immediately, not with a lag, which implies unexploited profit opportunities.[17] From the viewpoint of market efficiency, therefore, exchange rate responses to commodity shocks appear to have been too slow. Policy actions to further smooth the exchange rate would amplify this particular anomaly.

4. Monetary Policy for Commodity-Sensitive Currencies

4.1 Regimes and policies

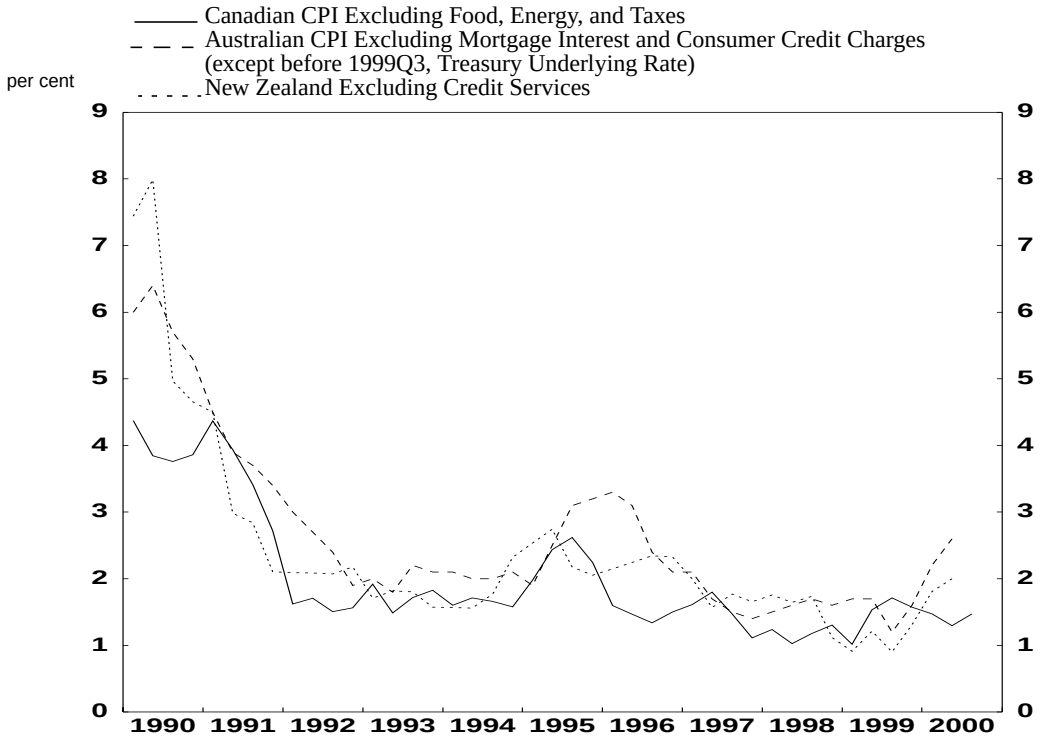
Changes in commodity prices can imply substantial movements in the real equilibrium exchange rates of commodity exporters. Flexible nominal rates allow this adjustment to take place promptly, without prolonged periods of domestic inflation or deflation and unemployment, and without exchange market crises.

For a considerable time, however, monetary policy suffered from the lack of a viable nominal anchor, which the official exchange rate parity had provided during the heyday of Bretton Woods. Policies were very lax in the 1970s, and even though they were tightened up in the 1980s they remained at variance with price stability. Central bankers (e.g., Burns 1979 and Bouey 1982) deplored the absence of a firm guideline to justify difficult decisions, which could result in substantial short-run losses of output and employment.

The difficulty was resolved in the 1990s for Canada, Australia, and New Zealand, after their successful pioneering of the inflation targeting approach to monetary policy (Bernanke et al. 1999). Low rates of inflation were established on schedule, and maintained (Chart 5; the 1999–2000 uptick in Australia and New Zealand reflects increases in energy prices, which are excluded from the core CPI in Canada). This is a remarkable change from the inflation of the preceding two decades. Furthermore, in contrast to the earlier generation, today's central bankers have expressed strong satisfaction with the framework that circumscribes their policies.[18]

17. According to the DMCD regime switching model, noise trading contributes further sluggishness.
18. For example, see the positive assessments in Thiessen (1998), Stevens (1999), and Brash (1999).

Chart 5: Core inflation

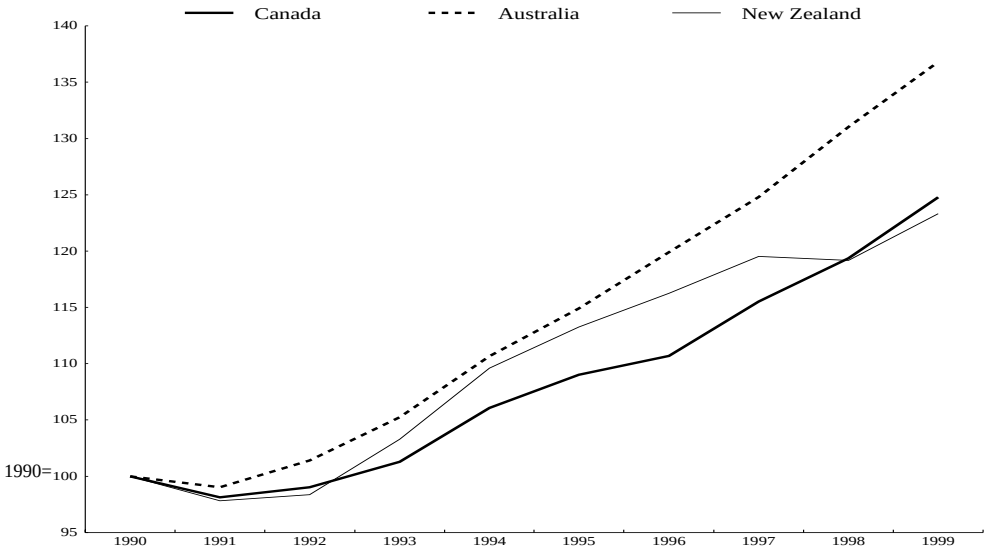


On all evidence, an effective framework seems to have been found. Issues remain open, however, regarding modes of operation within the inflation targeting/flexible exchange rate regime. How monetary policy should respond to exchange rate movements is one of them, and each of the central banks under consideration has distinct views on this.[19]

Do these differences matter? If the only criterion were inflation control, the evidence in Chart 5 suggests not, since inflation was pretty much the same across the three countries. Inflation control is not, however, just an end in itself. Output performance must be weighed in the balance, too, and here significant differences are apparent. After the recession of the early 1990s, output grew most steadily—and was on comparable estimates closest to full potential—in Australia (Chart 6).

19. Ball (1998) describes the general problem of inflation targeting in an open economy. His model is easily adapted to analyze the implications of shocks to the commodity terms of trade.

Chart 6: Real GDP



This difference reflects the behaviour of many factors, including structural differences—e.g., the emergence of Australia and, especially, New Zealand from a highly regulated economy—and idiosyncratic shocks. It is also likely that differences in monetary policy tactics, as outlined below, could have been a significant factor.

4.2 Interaction between short-term interest rates and exchange rates

Comparisons of the volatility of short-term interest rates and exchange rates (Table 12) reveal something of the nature of the policy differences between Canada, Australia, and New Zealand.

Table 12. Interest rate and exchange rate volatility

	Canada Bank Rate	Australia Official Cash Rate	NZ 90-day Bank bill	US$/C$	US$/A$	US$/NZ$
1993	0.76	0.38	0.90	1.74	1.86	1.34
1994	0.94	0.78	1.44	1.13	2.00	2.17
1995	0.80	0.00	0.36	1.23	1.39	1.23
1996	0.78	0.42	0.66	0.59	1.76	1.33
1997	0.33	0.45	0.51	1.14	3.79	3.55
1998	0.38	0.07	1.93	2.25	2.89	2.85
1999	0.21	0.09	0.38	0.87	1.11	1.44

Note: Standard deviations (per cent) from weekly data.

During the period of inflation targeting, Australia has experienced considerably less *interest rate volatility* than Canada and New Zealand. At the same time, Canada has experienced the least *exchange rate volatility*—and this is true for TWIs as well as the bilateral U.S. dollar rates shown in Table 12. This indicates differences in tolerance for exchange rate fluctuations. The following equation provides a pragmatic estimate of the typical short-run policy reaction to changes in the U.S. dollar exchange rate:[20]

$$\Delta(r_t - r^*_{t)} = \gamma_0 + \gamma_1 \Delta E_t \qquad (6)$$

where:

$\Delta(r_t - r^*_t)$ = weekly change in interest differential vis-à-vis U.S. federal funds rate
ΔE_t = weekly growth rate in nominal U.S. dollar value of the domestic currency

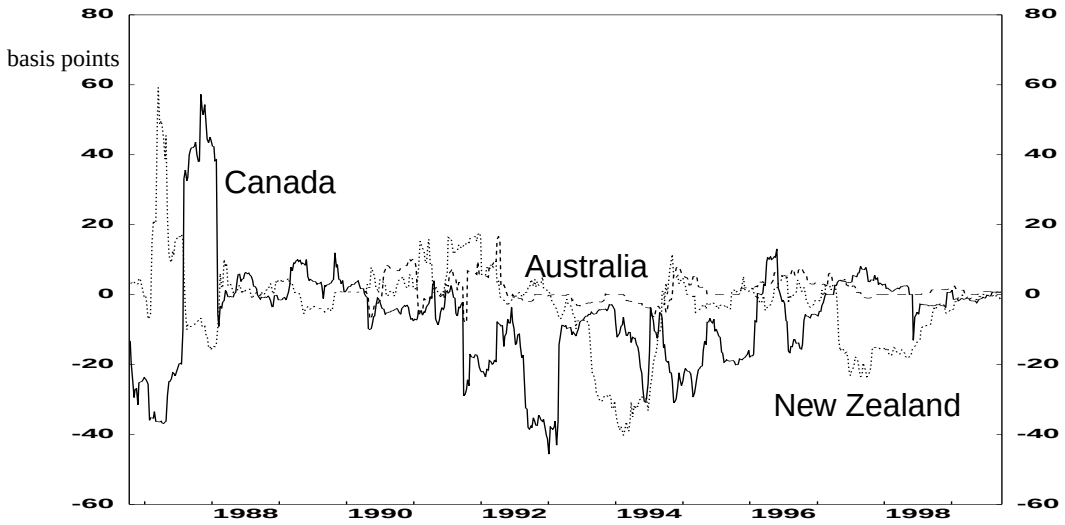
The differential is used, rather than the level of the domestic interest rate, to capture independent central bank actions, as opposed to movements that merely follow the U.S. short-term interest rate. Equation (6) was estimated over rolling 26-week horizons, from 1987 to 1999. For Canada, the policy interest rate is the Bank Rate, and for Australia the cash rate, while for New Zealand the bank bill rate is used.

In periods when the central bank actively wants to change monetary conditions, γ_1 will tend to be positive, as unexpected policy changes to the interest rate generally bring about changes in the currency in the same direction. However, in periods when the central bank reacts to undesired pressure on the currency, the coefficient γ_1 will be negative, since the policy rate would be hiked in the event of an undesired depreciation, and cut on an undesired appreciation. The estimated coefficients are plotted in Chart 7, with each point corresponding to the midpoint of the 26-week estimation periods.

20. This idea is from Mark Zelmer.

Chart 7: Short-term interest rate reaction to exchange rate

Estimates of γ_1: basis points per one per cent appreciation



In the 1990s, the estimated γ_1 coefficient for Canada is for all intents and purposes never positive, and sometimes strongly negative, especially in the first half of the decade. This suggests that during this period the Bank of Canada never initiated a change in monetary conditions that reinforced a movement in the Canadian dollar, but that it was often defending the exchange rate against market pressures. Although the episodes of pressure were not long-lived, the interest rate increases during them were substantial. For example, the Bank of Canada increased the Bank Rate in the three months ending November 1992—the AMS crisis—by more than 350 basis points (whereas the federal funds rate in the United States declined), and over the three months ending January 1995—the "tequila" crisis—by almost 300 basis points (whereas the federal funds rate increased by just 75 basis points).

4.3 Different exchange rate philosophies

The actions of the Bank of Canada and the RBNZ to counter movements of the exchange rate stemmed from two sources.

The first was the prominence of the Monetary Conditions Index (MCI) in their macroeconomic thinking. An appreciation of the exchange rate, in this view, represents tighter monetary conditions. In the absence of economic data suggesting a need for tighter money, the interest rate should be lowered. The Bank of Canada MCI indicates a 33 basis-point decrease for every surprise per cent appreciation of the domestic currency. In Canada, in the first half of the 1990s,

the MCI served a useful purpose (Freedman 1995). Financial markets were nervous about the growth in public debt, political stability, and the viability of the inflation targets, and risk premiums in Canadian interest rates rose. The currency was repeatedly subject to selling pressure as a result of portfolio shifts. The appropriate response to unexpected depreciation during these episodes, from a macroeconomic viewpoint, was to keep monetary conditions roughly stable by raising the policy interest rate.[21]

The second source of the inverse relationship derived from a concern for financial market stability, particularly in Canada. At times, exchange market disturbances feed on themselves, and extrapolative expectations can take hold. In a situation of collapsing confidence, the exchange rate depreciates and market interest rates rise, as risk premiums increase.[22] On several occasions, after sensing market disorder, the Bank of Canada raised the policy rate well above the requirements of the inflation control objective. Invariably, within a few months the market calmed down and the interest rate increase was reversed. The Bank maintained that, if it had held the interest rate constant, interest rates would eventually have been higher, and the exchange rate weaker, because of a longer-lasting increase in risk premiums.

After 1995, following a strong improvement in budgets, increased political stability, and several years of low inflation, confidence was restored.[23] As the incidence of portfolio shocks declined, the MCI became less useful. By 1998, the Bank of Canada was referring to the concept as an "operating guideline" rather than an "operational target." This change in usage is reflected in the estimates of the reaction coefficient, γ_1, which after 1996 vary around zero, except for the spike during the financial turbulence of 1998.[24]

The RBA, in contrast, has not shown a systematic response to fluctuations in the Australian dollar—the estimated γ_1 coefficient is usually near zero. This, in the context of considerably higher exchange rate volatility, illustrates that Australian monetary policy has been systematically

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21. From this viewpoint, since the United States does not dominate the trade of Australia and New Zealand the way it does that of Canada, one would expect the RBA and the RBNZ to respond less than the Bank of Canada to movements in the U.S. dollar.
22. Market interest rates might also be pushed up in anticipation of an increase in the policy rate. In Canada, the markets quickly caught on to the implications of the MCI for short-term interest rates. See Zelmer (1995).
23. Clinton and Zelmer (1997) discuss implications that the uncertainties in the first half of the 1990s, and of the improving environment in the second half, had for the conduct of monetary policy.
24. The Bank of Canada's adoption of eight pre-set action dates per year in December 2000 will reinforce the zero tendency of the exchange rate reaction coefficient. The RBA and RBNZ had already adopted pre-set dates. They fit well with an approach to inflation targeting that is not highly attuned to exchange rate changes. Indeed, *short-run* fluctuations in *any* variable will have less potential influence on policy actions.

more tolerant of currency movements than Canadian monetary policy. The lack of a systematic relationship does not mean that the Australian authorities ignore their dollar; they occasionally act quite aggressively when they are convinced that the exchange rate has overshot the equilibrium value. But these occasions are rare, and involve the heavy use of exchange market intervention—timed to have maximum impact—rather than the interest rate.

The usual inclination of the RBA to accept the judgment of the market on the exchange rate can be justified by the relatively low occurrence of exchange rate disturbances. Movements in the currency have usually reflected changes in underlying fundamentals, in particular commodity prices, rather than speculative disturbances. This implies that the Australian authorities have not had to worry too much about the possible implications of unexpected exchange rate changes, and they have had little use for the MCI concept (Stevens 1998). If most of the variance in the real exchange rate stems from shocks from aggregate demand or supply, the resulting variance in monetary conditions is generally in line with the objectives of policy, and there is no a priori case for resisting exchange rate changes with interest rate actions.

Moreover, the RBA from the outset insisted on the flexibility of its approach to inflation targeting (Debelle 1999, Stevens 1999). This is implied in the form of the target itself, which is expressed as a 2 to 3 per cent range, not a point, and which is to be achieved on average over the business cycle, not necessarily each and every year. This longer-run focus guarantees that monetary policy is not overly preoccupied with one-off price level impacts of changes in the exchange rate. (This approach has nevertheless had good results over the short run, as the target range has been met every year.)

The New Zealand central bank interest rate reaction seems to be mixed: the estimated γ_1 coefficient (Chart 7) is usually zero, as for Australia, but a couple of periods (1993–94 and 1997–98) show the negative response often observed for Canada. The story involves three phases. The most distinctive was during the early years of inflation targeting. In contrast to the more flexible approach of the RBA, during this phase the RBNZ focused on trying to keep inflation within the target range over all 12-month periods.

The idea that this might be feasible was encouraged by research suggesting that the exchange rate, through the price of imports, had a dominant and reliable effect on the price level (Grimes and Wong 1992, Archer 1995, and Brash 1999). A one per cent depreciation was estimated to translate into an increase of consumer prices of about 0.3 per cent. The central bank calculated a path for the exchange rate deemed to be consistent with achieving the inflation target. Mayes and Chapple (1995) explain the procedures with great clarity: “We then compute a band around that exchange rate which is consistent with inflation remaining within 0% and 2% all the time. We do not

publish that band . . . but we signal the market if the edge of the band is being approached." Remarkably, these hints were sufficient, without any other market intervention, to keep the New Zealand dollar within the central bank's "comfort zone."

The emphasis on hitting short-run targets reflected the concern of the RBNZ to establish a strong reputation. Missing the range even briefly might have been very damaging to the effort to convince a sceptical public. In this respect, the phase of short-run, exchange rate-oriented inflation control was successful.

It was not an approach that could survive long. Over time, indirect, longer-lasting effects on the rate of inflation, via the balance of aggregate demand and supply, come through with increasing force. An attempt to hit short-run targets for inflation through the exchange rate is eventually liable to run into instrument instability (Black, Macklem, and Rose 1997). This was to become clear in practical terms by mid-decade. Strong capital inflows had pushed up the value of the New Zealand dollar. Trying to offset the price level impact, the RBNZ cut interest rates to very low levels. This encouraged a domestic boom, and an acceleration of inflation to the top of the target range. In 1994 and 1995, the central bank tightened, and the currency appreciated even more; the rise in the TWI, from trough to peak, was about 30 per cent. Brash (1999a) describes the dilemma as follows:

- in 1996, a sharp further tightening would have been necessary to keep inflation inside the range in the short run, but since output growth was slowing, and the excess demand gap fast disappearing, a further tightening would create a high risk of undershooting the target range in the future
- large fluctuations in the exchange rate had produced a considerably smaller and less-certain effect on the price level in the 1990s than previous research had estimated
- credibility of inflation control had by this point improved such that a one-off price level shock was less likely to be confused by the public with a resurgence of inflation

As a consequence, the RBNZ began to pay more attention to the longer run (1 1/2 to 2 years), and to the lagged effect of monetary policy first on aggregate spending, and then on inflation (Orr, Scott, and White 1998). In 1997, New Zealand inflation targeting entered a second phase, with a switch in focus from the exchange rate to the MCI. The weights chosen for the latter—1.0 for the interest rate and 0.5 for the exchange rate—reflected estimates of the medium-term elasticity of output with respect to these variables (Dennis 1997, Gerlach and Smets 2000). In 1997, the RBNZ began to publish a "conditional band" for the MCI; i.e., a projected path thought to be in line with achieving the inflation target range. In the event of an unexpected change in the exchange rate, this band would provide a guide as to the appropriate movement, if any, in the short-term interest

rate. However, this did not work well. First, it led to interest rate volatility, as money market operators used the MCI mechanically as a basis for speculation. Second, a cumulation of real shocks justifying a depreciation began to hit the economy. Since the operating target for the MCI had to be revised downwards repeatedly, the MCI did not make the conduct of policy any simpler. Also, and more fundamentally, new research strongly suggested that the exchange rate was often affected by real sector shocks. The policy implication was that, on an unexpected change in the external value of the currency, it would be better for the central bank to hold the interest rate in the short run, rather than the MCI (Hunt and Orr 1999).

In 1999, a third phase of policy implementation was introduced, in which the RBNZ would announce an official cash rate (an overnight interest rate), subject to review eight times a year on dates fixed in advance (RNBZ 1999). This would simplify the process, and solve the problem of unnecessary interest rate volatility. The MCI has become just another information variable. The RBNZ has thus converged towards the RBA approach. Both central banks nowadays stress the merits of a flexible, medium-term approach to inflation targeting, and de-emphasize the importance of the edges of the target range. They allow the exchange rate to fluctuate in the short run without resistance from the central bank interest rate.

4.4 Case study of monetary policies in 1998

4.4.1 Policy actions during the market turbulence

In 1998, Canada, Australia, and New Zealand suffered a large drop in commodity prices. The year-over-year fourth-quarter decline in a U.S.-dollar index of non-energy commodity prices was 12 per cent for Canada, 15 per cent for Australia, and 10 per cent for New Zealand. The decline was steepest in the second and third quarters, as the Asian crisis deepened and the turmoil in Russia culminated with a government debt default. A global flight to quality favoured U.S. government securities. There was heavy selling of assets of commodity-producing countries, which in large part reflected serious economic realities. The U.S. dollar values of the Canadian, Australian, and New Zealand dollars depreciated by 9, 10, and 15 per cent, respectively (on a trade-weighted basis, of course, the declines were smaller, because of the steep Asian depreciations).

Central banks were operating under conditions of unusual uncertainty, and were anxious to restore orderly conditions to financial markets, as well as to maintain a level of monetary conditions appropriate for domestic objectives. In the first half of the year, the Bank of Canada accepted the continuing depreciation of the Canadian dollar, but it eventually reacted when it thought that

self-feeding speculation, and exaggerated perceptions of risk, were causing unwarranted marking down of Canadian dollar assets. The November 1998 *Monetary Policy Report* stated:

> From May through the first weeks of August the dollar declined steadily, for a cumulative depreciation of about 4 per cent on the G-10 index and of more than 5 per cent against the U.S. dollar. In the second half of August the pace of decline picked up, and it became increasingly difficult for the market to see where the currency might eventually settle. Extrapolative expectations began to take hold, especially as the value of the Canadian dollar in terms of the U.S. dollar broke new lows day after day.
>
> The increased risk premiums that emerged in Canadian interest rates became increasingly worrisome. Long-term interest rates were rising when comparable interest rates in the United States were falling . . . . Also, short-term interest rates rose . . . even though the Bank of Canada was holding the band for the overnight rate at 4.5 to 5.0 per cent.
>
> The intensification of the decline in the Canadian dollar and the rise in Canadian medium-term and long-term interest rates signalled an undermining of the confidence of holders of Canadian dollar financial instruments. The Bank intervened heavily in the foreign exchange market, and then on 27 August raised the Bank Rate by 1 percentage point to counter the negative pressures in financial markets.

The Bank was influenced as much by the increase in the risk premiums in Canadian interest rates as by the fall of the dollar. The rise in the Bank Rate was intended to be a temporary measure to relieve the upward pressures on market interest rates. Referring to a chart of the MCI, the Bank denied that its actions implied tighter short-run monetary conditions: “monetary conditions have fluctuated widely but, with the sizable decline in the dollar [since May], have, on balance, eased considerably.”

The RBA had a more sanguine attitude to the speculation, which drove the Australian currency also to record lows against the U.S. dollar, and pushed up market interest rates. The RBA November 1998 *Statement on Monetary Policy* noted that some countries in similar circumstances, particularly Canada, had raised official interest rates. Although these actions highlighted the vulnerability of the Australian dollar, the RBA did not change its cash rate. Instead, it felt that

> the most appropriate way . . . to deal with the exchange market pressures was by intervention on the foreign exchange market, since the selling pressures reflected speculative activity rather than any loss of confidence in policy settings in Australia. The Bank undertook two main rounds of intervention, in May/June and August/September.

Market information received by the RBA suggested that hedge funds were heavy short sellers of the Australian currency. The RBA reckoned that their exposures would soon have to be covered. Official intervention, even though it might not have a large impact on the current exchange rate, could force the hedge funds to close their positions unprofitably. The RBA resoundingly won the

poker game. In October, when hedge funds scrambled for cover, the Australian dollar rose 10 per cent against the U.S. dollar in a single week.

The RBA had identified and reacted to a specific disturbance in the market. It expressed no concern with the decline in the exchange value of the Australian dollar as such. Indeed, the RBA regarded the depreciation as broadly appropriate for the economy, given the drop in demand from Asia and the global commodities slump. During August, whereas the Bank of Canada saw the depreciation of the Canadian dollar as an *easing* of monetary conditions, the RBA, confronted with a considerably larger depreciation, described its monetary policy settings as *steady.* This is a good reflection of the different philosophies of these central banks towards the exchange rate.

Monetary policy implementation in New Zealand was in the MCI phase. The Governor's "Overview and policy assessment," which leads off the RBNZ *Monetary Policy Statement*, featured the MCI, to the exclusion of either component.[25] Throughout 1998, New Zealand had a considerably weaker economy than either Canada or Australia—in part because of a severe drought. During that year, successive issues of the Statement projected ever-larger decreases in the MCI, as activity remained unexpectedly sluggish. Over the four quarters to 1998Q2, even though the interest rates were raised, the MCI fell substantially as a result of a depreciation of about 15 per cent in the TWI. The international crisis implied a further drop in demand. In 1998Q3, the RBNZ cut the short-term interest rate by 2 1/4 per cent, and the TWI dropped a further 2 1/2 per cent. Interest rates and the currency continued to decline through the fourth quarter as the RBNZ kept up an aggressive easing.

This episode, during the second half of 1998, illustrates distinctive traits in monetary policy conduct:

- Canada—defensive reaction against sharp changes in the exchange rate. The Bank of Canada was concerned that sharp movements in the currency, along with upward pressure on Canadian interest rates, stemmed from, and contributed to, destabilizing speculation, and reacted with a substantial increase in interest rates.
- Australia—no reaction. The RBA did not worry too much about the exchange rate depreciation as such, but it was concerned about the disruptive gaming of hedge funds, which it effectively countered with exchange market intervention.
- New Zealand—MCI operating target phase. Monetary policy in New Zealand became actively conducive to depreciation, which the RBNZ saw as part of the necessary easing in the MCI.

25. The switch away from the MCI is clear in the March 1999 RBNZ *Monetary Policy Statement*.

4.4.2 After the turbulence

The international economy emerged quickly from the crisis. An important factor was a global easing of monetary policy during the fourth quarter of 1998 led by the U.S. Federal Reserve. Increased provision of liquidity helped deal at once with financial instability and the global economic slowdown. Commodity prices rebounded in 1999 from the sharp drop in the second half of 1998. Against this background, the economic performance of Canada, Australia, and New Zealand improved markedly. The annual data in Table 13 show the broad macroeconomic picture.

Table 13. A monetary policy summary: annual averages

	1999/1998 per cent change				Interest rate
	GDP	Core inflation	Nominal exchange rate		Overnight or cash rate
			TWI	U.S. dollar	
Canada	3.9	1.5	*6-currency:* -0.6	-0.2	4.7
Australia	4.4	1.5	*IFS:* 0.0	2.5	4.8
New Zealand	4.8	1.1	*IFS:* -2.6	-1.3	4.6[a]

a. January and February, 90-day bank bill rate.

Activity rose strongly in these economies in 1999, such that by the end of the year GDP was within reach of conventional estimates of potential. Given the lower starting point and lower inflation in New Zealand, and the more aggressive easing of monetary conditions that went along with this, the relatively large increase in that country's GDP was perhaps to be expected. The weakness of the New Zealand dollar and the strength of the Australian dollar in 1999 also reflected cyclical differences. Short-term interest rates were remarkably similar for the year as a whole, and in each case the policy rate had been raised to 5 per cent by the end of the year. In 2000, these economies would be essentially at full capacity, and the central banks would raise interest rates somewhat further to moderate the growth of spending.

In the light of the establishment of non-inflationary, high-employment levels of output in these countries, one might infer that in each case the policy actions during the turmoil of 1998 appropriately reflected different situations. There is evidence to support this view in the ex ante assessments published by the central banks in 1998. For example, in November, the Bank of Canada's *Monetary Policy Report* spotted positive factors, which included the robustness of the U.S. economy, among the uncertainties. As it turned out, this relatively optimistic view was closer to the mark than critics of the August Bank Rate hike realized. It must be admitted, however, that the policy-makers did not expect the widespread strength that later emerged in the global economy, or the easing by the U.S. Federal Reserve that encouraged it. In 1998, the international warning signs had been mainly on the deflationary side. Under these circumstances, the Canadian

Bank Rate increase, oriented towards financial stability, entailed a clear macroeconomic risk. The more expansionary stance in Australia and New Zealand, permitting a larger currency depreciation, was more directly attuned to the deflationary potential of the international shocks. Although the Bank Rate increase was promptly reversed as confidence returned, the temporary difference in policy stances seems to have had visible consequences, since subsequent output growth in the three countries was lowest in Canada. This was despite the more favourable global position of Canada, which is far less exposed to the Asian market (see Table 2), and which benefited much more from booming U.S. demand.

If interest rate changes had a perceptible impact on output, high-frequency volatility of exchange rates, of which there was plenty in 1998, had no interesting macroeconomic effects. Indeed, one can read the Australian experience in the second half of 1998 as a lesson for letting a sharp exchange rate change take place, without resistance from the central bank interest rate, even if an overshoot seems to be in process. With the benefit of hindsight, one sees the Australian dollar dropping and then rebounding back to the same range—a clear overshoot—and yet afterwards an enviable output and inflation performance.

Lasting changes in levels of real exchange rates, however, do matter. The depreciations of the Canadian, Australian, and New Zealand dollars since 1997 are a case in point: these depreciations played an important role in the adjustment to reduced demand for raw materials. They buffered local-currency prices of commodities, and at the same time encouraged the reallocation of resources to other tradable goods and services. This experience illustrates that the trends and cycles in the commodity currencies have been useful from a macroeconomic viewpoint.

5. Conclusion

The behaviour of real exchange rates has helped the process of macroeconomic adjustment in Canada, Australia, and New Zealand:

- Descriptive statistics reveal a clear positive relationship between the real international prices of the commodities these countries export and the real exchange values of their currencies. The decline in the real exchange values of the commodity-sensitive currencies over the past 25 years follows a considerably larger decline in the real price of commodities. Cyclical movements are also positively correlated. In turn, positive shocks to both of these variables have a positive impact on the terms of trade.

- Conventional econometric estimates suggest that real commodity prices and real exchange rates have rather small effects on total spending in these countries. The exchange rate response

to commodity prices ensures that GDP is even less sensitive to such shocks. Movements in real exchange rates have provided a partial buffer to earnings in the primary sector as real commodity prices have declined; more importantly, the positive effect on cost-competitiveness has increased profitable opportunities in new activities. Thus, substantial real depreciations have not stalled the ongoing decline in the proportion of resource-based goods in total exports.

- Theory and data do not support the notion that commodity-sensitive currencies may be *too* sensitive to commodity prices. The sensitivity of the exchange rate to commodity price shocks has been of about the right size to stabilize the level of output and employment. Currency misalignments that might pose a threat to monetary stability are hard to detect. An econometric test did uncover a trace of speculative contagion between the Australian and New Zealand currencies, but the Canadian dollar does not seem to be affected by commodity contagion.

These findings suggest that policy need not be preoccupied with exchange market speculation. The epithet "commodity currencies," used by financial commentators, might be too simple and too undiscriminating, but nothing in the behaviour of the Canadian, Australian, and New Zealand dollars suggests that exchange markets badly misread macroeconomic developments.

A counter-argument is that currency misalignments have been avoided only because central banks have been careful to look after the exchange rate. However, over the past 10 years the strategies adopted in this regard by the Bank of Canada, the RBA, and the RBNZ have been quite different: the Bank of Canada has often moved the Bank Rate counter to the movement in the Canadian dollar; the RBA, in contrast, typically does not change the cash rate in response to movements in the Australian dollar; and the RBNZ has gone through three phases—the current one similar to Australia, the previous one similar to Canada. In each case, the exchange rate generally moved to equilibrate the economy.

Among the various approaches, a priori the RBA strategy seems to have been most effective, since easily the best macroeconomic performance was realized in Australia. It is unlikely just a coincidence that the RBNZ eventually adopted a mode of conduct very similar to the Australian model. Under the latter, interest rate actions are directed squarely at the inflation target a year or two ahead. Unless there is definite information to the contrary, the inclination is to treat an unexpected change in the currency as evidence that the real equilibrium exchange rate has changed, not as a portfolio disturbance or an undesired shift in monetary conditions. In the event that commodity prices or other economic data go in the same direction, this bias is reinforced, so that even sharp exchange rate changes may be tolerated without a policy action.

The broad swings and cycles in the Canadian, Australian, and New Zealand dollars have been helpful to macroeconomic stability. From this perspective, the sensitivity of these currencies to commodity prices has been about right. If one can generalize from this experience, the conclusion is that *as long as a credible low-inflation policy is followed*, and in the absence of a crisis in financial markets, movements of exchange rates do not in themselves justify alterations to monetary policy.

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Appendix A

Table A.1: Composition of Non-Energy Commodity Price Indexes

Canada		Australia		New Zealand	
Barley	1.8	Barley	2.4	Kiwi fruit	3.7
Canola	2.0	Rice	0.8	Wholemeal MP	10.6
Corn	1.2	Sugar	5.8	Skim MP	3.7
Wheat	8.5	Wheat	13.2	Apples	3.1
Beef	9.4	Beef	9.0	Fish	6.7
Hogs	4.9	Cotton	3.3	Casein	6.7
Cod	0.01	Wool	17.9	Butter	6.5
Lobster	0.5	Gold	19.4	Cheese	8.3
Salmon	0.6	Aluminium	8.9	Beef	9.4
Gold	4.3	Copper	3.1	Lamb	12.5
Silver	0.9	Zinc	1.8	Wool	7.7
Aluminium	4.6	Nickel	2.5	Skins	1.6
Copper	4.5	Iron ore	10.6	Aluminium	8.3
Nickel	3.7	Lead	1.3	Sawn timber	4.6
Zinc	4.2			Logs	3.5
Potash	2.0			Pulp	3.1
Sulphur	1.4				
Lumber	13.8				
Newsprint	12.8				
Pulp	18.9				
TOTAL	100		100		100

Table A.2: Composition of Energy Commodity Price Indexes

Canada		Australia		New Zealand	
Crude oil	62.3	Crude oil	15.7	Crude oil	100
Natural gas	29.9	Natural gas	11.1		
Coal	7.8	Coal	73.2		
TOTAL	100		100		100

Source: Djoudad, Murray, Chan, and Daw (2001, Appendixes).

See Table 1 for proportions of energy to total commodity exports.

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