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New Zealand: Selected Issues

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NEW ZEALAND

Selected Issues

Prepared by a staff team consisting of Kalpana Kochhar, Martin Cerisola, Roberto Cardarelli, and Kenichi Ueda (all APD)

Approved by Asia and Pacific Department

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EXECUTIVE SUMMARY

1. This paper was prepared as background to the 2001 Article IV consultation with New Zealand.

2. New Zealand's economic growth has been relatively disappointing since the mid-1980s compared with Australia and other OECD countries. Chapter I ("*An Exploration into the Income Divergence between New Zealand and Australia*") presents an empirical comparison of New Zealand's growth performance with that of Australia during the post-reform period. The paper shows that most of the divergence in income per capita between the two countries has been the result of lower accumulation of capital per hour worked, and to a lesser extent, lower efficiency in utilizing resources in New Zealand. The different pace of capital deepening in the two economies has been associated with differences in the relative cost of factors of production, as well as in the structure of the two economies. The relatively larger share of New Zealand's net capital invested in residential housing may have constrained capital accumulation, while the relatively low capital intensity in agriculture suggests that New Zealand has not fully exploited the potential for growth in a sector where it has a comparative advantage.

3. During the past decade, New Zealand experienced large migration flows, which raised some concerns about a possible "brain drain" and its net cost on the economy. Chapter II ("*Implications of Migration on Economic Growth and Welfare of New Zealanders*") examines how migration has affected the income and welfare of New Zealand nationals. New Zealand's growth performance—measured by the New Zealander's income regardless of their residence—provides a more positive view on growth than that suggested by more traditional measures, such as the gross domestic product. The paper looks into the welfare cost of migration stemming from changes in tax rates and social security transfers. While the welfare costs of tax changes appears to be quite high, it is likely the case that the current pay-as-you-go system contributes to retaining beneficiaries while providing incentives for those who contribute to the system to emigrate abroad; however, further research in this area is needed. The paper also notes that, in an economy with highly mobile labor, the welfare cost of migration should be taken into account in the design of the tax and social security systems.

4. Chapter III ("*Exchange Rate Pass-Through and Inflation in New Zealand*") explores empirically the extent to which fluctuations in the exchange rate affect inflation. Inflation in New Zealand has been low and relatively stable during the past decade; however, exchange rate shocks have been significant, and do not appear to have been passed on fully to domestic prices. The paper looks into the role of several factors which may have contributed to changing the price-setting behavior in New Zealand, such as the inflation targeting framework, the role of structural reforms in raising the degree of uncertainty about the underlying nature of the exchange rate shocks, the increased penetration of imports in the economy, and the role of productivity in helping firms to absorb changes in costs. The paper shows that the exchange rate pass-through has varied considerably during the 1990s in New Zealand, and that most of the decline in the short-term pass-through to import and consumer

prices appears to have been largely transitory in nature. The permanent impact of fluctuations in the exchange rate on domestic prices has also declined markedly in New Zealand, primarily owing to a decline in the pass-through to tradable goods as well as to a decoupling of non-tradable good inflation from the exchange rate. While positive supply shocks, such as the subdued growth in unit labor costs, have been important, the increased credibility of the inflation targeting framework has been instrumental in reducing the degree of exchange rate pass-through in New Zealand.

I. An Exploration into the Income Divergence Between New Zealand and Australia[1]

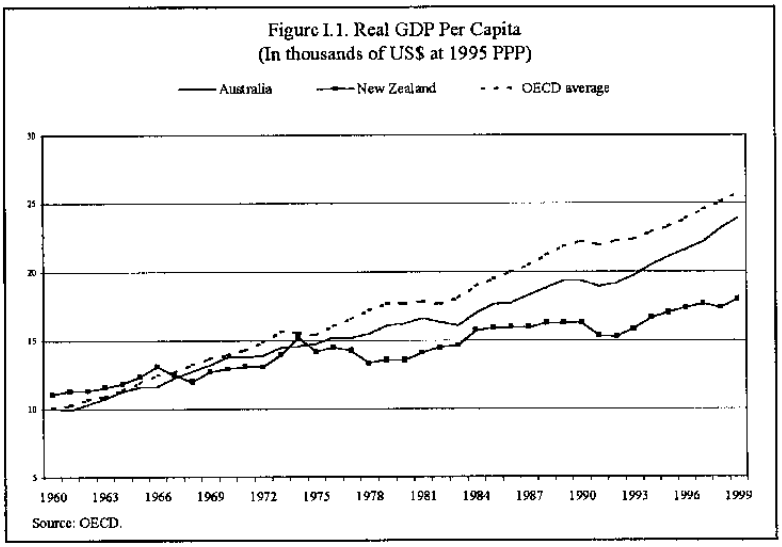
A. Introduction

5. Despite the extensive program of reforms started in the second half of the 1980s, New Zealand has not performed as well as other industrialized countries. Since 1985, New Zealand's real GDP growth has averaged around 2 percent per annum, compared with an average of 3 percent for OECD countries. As a result, New Zealand has slipped further from sixteenth to twentieth place in the OECD ranking of GDP per capita.

6. Meanwhile Australia, which has followed a broadly similar program of economic liberalization, has fared much better than New Zealand in the last 15 years in terms of growth of output per capita (Figure I.1). While New Zealand started from a higher level in the 1960s, Australia caught up in the 1970s, and since the start of the 1980s, the gap between the two economies has widened. With an average growth of around 3.7 per annum in the last 15 years, Australia has been able to significantly reduce the gap with the OECD average, and its GDP per capita now stands at about 30 percent above that of New Zealand.

7. The increase in income per capita dispersion could be transitory (due to temporary shocks along the transition to steady-states), or it could be signaling that New Zealand and Australia are converging to two different long-run equilibria, where a high degree of inequality could persist. It could also be that the differences in the two country's growth "fundamentals" are increasing and that inequality will increase further, before the relative position of the countries stabilizes. In each of these cases, it is the long-run difference in the *levels* of output between the two countries that is the most interesting one to explain.

Figure I.1. Real GDP Per Capita
(In thousands of US$ at 1995 PPP)



Source: OECD.

8. The objective of this chapter is to assess in a coherent, quantitative framework some possible explanations for the increasing difference in output per capita between Australia and New Zealand in the post-reform period (1988-2000). In particular, it aims at quantifying the role played by differences

[1] Prepared by Roberto Cardarelli (x38059), who is available to answer questions.

in the accumulation of physical and human capital, and in changes of factor productivity. Special focus is placed on sectoral performance to examine whether aggregate divergence masks important differences in sectoral productivity.

9. A traditional Solow-type growth accounting framework is applied, both over time and across the two countries. Despite its limitations, this methodology remains an important first step in productivity analysis, as it permits disentangling the relative contribution to output from the accumulation of factors of production and the efficiency in their utilization (total factor productivity).[2] This chapter differs from other recent studies that have utilized a growth accounting approach to evaluate New Zealand's productivity performance (Diewert and Lawrence, 1999) in two respects: first, this chapter focuses on productivity levels; and second, it uses new chain linked estimates of output and productive capital stock from Statistics New Zealand and the Australian Bureau of Statistics.

10. The main results of the chapter are:

- the 20 percent average difference in market sector's GDP per capita between Australia and New Zealand over the last decade is entirely explained by a difference in labor productivity between the two countries.
- Around ¾ of the gap in labor productivity is accounted for by the relatively lower capital deepening in New Zealand.
- The difference in total factor productivity accounts for the other quarter.
- Human capital accumulation contributed more to labor productivity in New Zealand than in Australia, owing to the significant upgrading of skills of New Zealand's labor force.
- In contrast to Australia, New Zealand's TFP growth has benefited less from a reallocation of resources towards its most efficient sectors over the last decade.

11. Both the lower capital intensity and the absence of allocative gains since the end of the 1990s are in principle consistent with the existence of structural disadvantages that may limit New Zealand's growth prospects, compared to those for Australia. In particular, the smaller domestic market may have prevented New Zealand from successful diversification away from primary production (where New Zealand has a strong comparative advantage) and towards higher-growth manufacturing and service sectors. Trade barriers that limit scale and investment opportunities may also have prevented full realization of New Zealand's comparative advantage in primary production.

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[2] See Hulten (2000) and Barro (1999) for an extensive discussion of TFP and Solow's residual.

12. However, other factors may be at play in determining the divergence in GDP per capita between the two countries. In particular, the relatively higher share of New Zealand's net capital invested in residential housing may have acted as a constraint on capital accumulation, especially given the relatively low household saving rate in New Zealand. Further, the relatively low capital intensity in agriculture, albeit partly explained by the omission of livestock from the stock of capital, seems to suggest that New Zealand has not fully exploited the potential for growth in the sector where it has a comparative advantage.

13. The chapter is structured as follows: Section B explains the approach followed to evaluate productivity levels in Australia and New Zealand and compare quality adjusted human and physical capital accumulation in the two countries. Section C presents the main results of the comparison, while Section D analyzes whether the two countries differed in their ability to benefit from a better allocation of resources (labor and capital) across sectors in the last decade. Section E concludes.

B. Comparing Productivity Levels

14. Table I.1 shows that on average, in the period 1988-1999, New Zealand's market sector output per capita has been 20 percent smaller than that of Australia. A first step into the investigation of this difference is to break down the output per capita into its two components: output per hour worked (labor productivity) and hours worked per person (labor utilization). Table I.1 shows that New Zealand's market sector utilized more labor resources relative to Australia.[3]

Table I.1. Accounting for Differences in GDP Per Capita Between NZ and AUS, Market Sector, 1988-1999

NZ Relative Levels (AUS=1)	1988	1999	Average
Output per capita (Y/P)	0.88	0.76	0.80
Labor productivity (Y/H)	0.82	0.76	0.80
Labor utilization (H/P)	1.08	0.99	1.01
Of which			
Hours worked per employed (H/E)	1.06	1.01	1.02
Employment rate (E/L)	1.02	1.01	1.01
Labor force participation (L/P)	0.99	0.97	0.97

Output (Y): GDP at factor cost, Market Sector, in 1996 NZ dollars (Australian dollars converted using OECD PPP exchange rate). Source: Staff estimate based on data from SNZ and ABS.

Hours worked (H): Total actual hours worked. Source: for New Zealand, the Household Labor Force Survey, for Australia, the Labor Force Survey (see Annex 1).

Employed (E): Employment of the business sector, source: OECD.

Labor Force (L) and Persons (P): source: OECD.

15. As New Zealand actually led Australia in terms of labor utilization, the difference in output per capita must be due to a gap in labor productivity. The next step is to decompose that gap into differences in factor utilization and in total factor productivity (TFP). This is done through a cross-sectional application of the Solow approach to growth accounting,

[3] As the main focus of the chapter is on average magnitudes over the period considered, no adjustment is made to filter out business cycle effects. Moreover, the period 1988-1999 almost fully coincides with a peak-to-peak cycle for both countries.

which exploits the symmetry between time and space and approximates the relative TFP with the following expression:

$$[1]\ \ln\left(\frac{TFP_{NZ}}{TFP_{AUS}}\right)=\ln\left(\frac{y_{NZ}}{y_{AUS}}\right)-\left[\frac{1}{2}(\alpha_{K,NZ}+\alpha_{K,AUS})\ln\left(\frac{k_{NZ}}{k_{AUS}}\right)+\frac{1}{2}(\alpha_{H,NZ}+\alpha_{H,AUS})\ln\left(\frac{h_{NZ}}{h_{AUS}}\right)\right]$$

where α_H represent the income (y) share of labor input (h) and α_K the income share of capital input (k). Equation [1] derives the relative TFP between New Zealand and Australia by subtracting the weighted average of the log difference in human and physical capital inputs from the log difference in output. A number of observations should be made regarding Equation [1]:

- Comparing TFP levels of two countries amounts to asking the question: how much output could country X produce using country Y inputs or vice versa? As the choice of the base country affects the answer, this question implies an index number problem that must be solved with some form of weighting. Equation [1] is consistent with the index number theory, as the utilization of the arithmetic averages of the two factor income shares makes the relative TFP of Equation [1] a Tornqvist index, known to be the best discrete approximation of Divisia indexes.[4]

- Equation [1] is based on the typical assumptions underlying the Solow approach to TFP, namely that factors of production are paid their marginal product (perfect competition in factor markets), and that technical change is not specific to any factor of production but improves the efficiency of all factors equally (it is Hicks-neutral). Constant returns to scale are assumed only when the income share of capital is estimated from the National Accounts as a residual (output less compensation of employees), but in principle are not required as the return to capital (and thus its income share) could be estimated directly.

- The output concept is value added, not gross output. While the choice of the value added concept is justified by the focus on aggregate value added, the exclusion of intermediate inputs from the analysis may lead to a biased estimate of technical changes at a sectoral level (Basu and Fernald, 1995).

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[4] Other alternatives have been used in the productivity literature in the context of a multi country framework, as the one that compares each country with the average of all countries (Cummings, Christensen and Jorgenson, 1981). Studies that have compared these two methods arrived at the conclusion that they produce similar results (see Harrigan, 1997, and Jones and Hall, 1996).

16. In light of these observations, great care should be exercised in taking the Solow residual as a measure of the technological endowment of a country. Other factors are included in the residual, such as those associated with changes in the level of organizational and managerial practices, model misspecification and measurement problems. The focus of this chapter however, is not as much in "explaining" TFP or in measuring differences in technological endowments of Australia and New Zealand, as it is in estimating the relative role played by capital accumulation and TFP as proximate causes of the large and increasing differences in output per capita between the two countries.

17. In this context, it is especially important to recognize that different types of labor and different capital assets contribute differently to output in Equation [1]. Treating them as if they were homogenous would amount to treating as productivity enhancements the investments that substitute among different types of inputs. A more accurate allocation of the sources of economic growth between investments and productivity would need to be based on constant quality indices of labor and capital inputs. Following the consolidated literature on TFP estimation (started by Jorgenson and Griliches, 1967), this study attempts to capture cross-country differences in the "quality" of human and physical capital accumulation by considering different types of labor and physical capital and by proxying their marginal productivities with market remuneration.

Labor Input

18. As for labor, three types of workers are identified for New Zealand and Australia: those with tertiary education, those with secondary education, and those without secondary school certification. For simplicity, they are all assumed to work the same number of hours, and the labor income share of each type of labor in Equation [1] is estimated by using the relative wages for the three groups.[5]

19. The difference between the weighted sum of hours worked by the three types of labor and the unweighted sum is an index of the compositional changes in labor inputs, or its quality improvement. Table I.2 shows that, according to this index, New Zealand has had an advantage over Australia in terms of human capital accumulation. The main force behind this result is the larger increase in workers with tertiary education, and the reduction in workers without secondary qualification in New Zealand compared to Australia.

20. A limitation of this indicator is that it does not take into account differences in the "quality" of tertiary education. For example, it could be argued that, in terms of their contribution to output growth, it is more critical to have a larger pool of workers with tertiary

[5] These assumptions are similar to those used in Scarpetta, Bassanini, Pilat and Schreyer (2000).

degrees in scientific disciplines than in the arts or humanities, for example.[6] Needless to say, any adjustment for the quality of tertiary education needs to be country-specific and, therefore, extremely difficult to pursue on a cross-country basis.[7]

Table I.2

A. Index of Labor Quality

	Hours Worked 1/ (1)	Labor Services 2/ (2)	Index of Labor Quality 3/ (3)
New Zealand, 1987-2000	0.2%	0.6%	0.4%
Australia, 1987-2000	1.1%	1.1%	0.0%

1/ Average growth rate of aggregate hours worked in market sector.
2/ Weighted average of rates of growth of hours worked by different types of labor, with relative labor income as weights.
3/ Difference between (2) and (1).

B. Employment by Educational Attainment, Market Sector 1/

	New Zealand 2/		Australia 3/	
	1984	1996	1984	1996
Without qualifications	43.9%	30.2%	40.4%	39.0%
With school qualification 4/	30.9%	30.7%	21.5%	20.8%
With postschool qualification	25.3%	39.1%	38.1%	40.2%
Higher degree and Postgraduate	1.9%	8.0%	-	1.4%
Bachelor Degree	2.0%	4.1%	-	6.4%
Diploma and Vocational qualification 5/	18.2%	21.4%	-	32.3%
Other post school qualifications	2.9%	5.5%	-	-

1/ Does not include finance and insurance.
2/ Source: Census 1981 and 1996 (intermediate years obtained by interpolation).
3/ Source: data for 1984 adopted from "Productivity and the Structure of Employment," 1999, Productivity Commission; data for 1996 from Education and Training, ABS.
4/ For New Zealand, includes school certificate and 6th form certificate (Year 12 or university entrance); for Australia, those who completed highest level of secondary school available (Year 12 or equivalent).
5/ New Zealand 1981 includes non-university post-school qualification and undergraduate diploma; New Zealand 1996 includes basic, skilled, intermediate and vocational qualifications; Australia 1996 includes skilled and basic vocational qualification, associare and undegraduate diploma.

[6] Little (2001) refers to the low share of engineers in graduates in New Zealand (6 percent of total college graduates, against around 20 percent in Finland). From this result, he notes that, while aggregate data could lead to a relatively sanguine view around human capital, at a more disaggregated level there are more worrying questions on whether the structure of the New Zealand education system is sufficiently directed to growth-oriented activities.

[7] It could, of course, be argued that the larger proportion of workers with vocational secondary education in Australia signals a stronger connection between the education system and the specific skill requirements of the production process.

Capital Input

21. The concept of capital input used in Equation [1] is the flow of "productive" services from a given stock of capital. Productive capital is obtained by adjusting each vintage in use for the loss of efficiency caused by physical decay ("wear and tear") and retirement. This allows the expression of the stock of capital in standard "efficiency units," and its use as a measure of the productive services from that asset (assumed to be proportional to the productive stock) (OECD, 2001).

22. This concept is different from net capital, as the latter measures the market value of the asset and thus captures its depreciation (loss of market value) rather than its deterioration (loss of productive capabilities) associated with aging. Productive capital is also different from gross capital as the latter only takes into account the withdrawal of the assets, and ignores the loss of productive capacity of those still in operation. Hence, gross capital stock can be interpreted as a special case of productive capital, where the physical efficiency of the asset remains intact over time and suddenly drops to zero when it is retired. While this is reasonable for certain types of assets, such as computers, for other types of capital "wear and tear" is a fact, and gross stock tends to overestimate the contribution of capital to production.

23. In Equation [1] capital input is represented by the productive services of five different assets: Plant and Machinery, Transport equipment, Building and Construction, Intangible Assets and Land.[8] One important difference from previous estimates of capital stock for New Zealand is that capital input used in this study is a chain-linked measure of capital in constant prices. Chain-linking allows the removal of biases associated with fixed-weight volume measures, in particular the excessively large weights given to those IT capital assets whose relative prices have declined rapidly over the years.[9]

24. Each asset's share of capital income in Equation [1] is obtained by estimating the assets rental prices, taken as a measure of their marginal productivity. Abstracting from tax considerations, the rental price for the asset j at time t is estimated as:

$$[2] \qquad \mu_{j,t} = p_{j,t}\left(r_t + \delta_{j,t} - \pi_{j,t}\right)$$

According to Equation [2], in an efficient capital market the return from renting one dollar of the asset 'j' must be enough to cover the opportunity cost of capital (r), the loss in the asset's

[8] These assets capture around 90 percent of the total productive capital stock for the market sector in Australia (including livestock and inventories). Using the estimates of livestock and inventories as in Diewert and Lawrence, a similar percentage is found for New Zealand.

[9] Over 1988-1998, chain-linked gross capital formation in New Zealand grew on average 0.5 percent less per year than the previously published, fixed weighted figures (see Statistics New Zealand, 1998).

market value as it ages (δ_j, the depreciation rate for asset j), and the capital losses associated with a fall in the price of the asset (π_j denotes the rate of change of the asset's price p_j).

25. The gross return on using an asset ($r+\delta-\pi$) is higher for assets with relatively faster depreciation and larger negative capital losses, such as IT capital goods (computers within the category Plant and Machinery and software within the category Intangible Assets). The combination of high returns and falling prices should induce firms to substitute towards this type of capital. Weighting different assets through their rental prices aims at capturing this substitution process within the estimate of capital stock in Equation [1], as assets with higher rental prices receive a larger weight in Equation [1] compared to the case in which a homogeneous stock of capital is considered.

26. As for the labor input, an indicator of the compositional shift in capital (towards assets with higher productivity) is the difference between the weighted average of the assets rates of growth with weights given by the capital income shares and the weighted average of the assets rates of growth with weights given by the asset share of aggregate capital stock:

$$[3] \qquad \sum_{j=1}^{N}\left(\frac{\mu_{t,j}\,K_{j,t}}{\sum_{j=1}^{N}\mu_{j,t}\,K_{j,t}}\right)\Delta\ln(K_{j,t}) - \sum_{j=1}^{N}\left(\frac{p_{j,t}\,K_{j,t}}{\sum_{j=1}^{N}p_{j,t}\,K_{j,t}}\right)\Delta\ln(K_{j,t})$$

27. The growth of capital services (the first term) is higher than the growth of capital stock (the second term), if the accumulation of capital is biased in favor of assets with higher productivity. In the literature on productivity and the "new economy" (Jorgenson and Stiroh, 2000) the main objective of Equation [3] is to evaluate the compositional shift in capital accumulation that is associated with investment in IT assets. Unfortunately, Statistics New Zealand does not publish separate estimates of productive capital stock for IT hardware within Plant and Machinery, and this limits the extent to which the comparison of Equation [3] for New Zealand and Australia can indicate a different pace in IT capital accumulation.

Table I.3

A. Index of Capital Quality

	Capital Stock	Capital Services	Index of Capital Quality
New Zealand			
1987-1999	2.0%	2.3%	0.3%
1987-1994	1.5%	1.7%	0.2%
1995-1999	2.7%	3.1%	0.4%
Australia			
1987-1999	2.9%	3.6%	0.7%
1987-1994	2.7%	3.1%	0.4%
1995-1999	3.2%	4.1%	0.8%

B. Real Investments and Net Capital Stock in New Zealand and Australia

	Real Investments Average Rates of Growth 1988-2000		Net Capital Stock at Current Prices (replacement cost) Share of Total			
			NZ		AUS	
	NZ	AUS	1988	2000	1988	2000
Residential Buildings	4.2%	5.5%	40%	46%	30%	35%
Plant, Machinery and Transport Equipment	4.6%	5.8%	16%	16%	21%	19%
Other buildings and structures	0.4%	1.0%	43%	38%	47%	43%
Intangible assets	3.1%	14.9%	1%	1%	2%	3%
Total	3.1%	4.5%	100%	100%	100%	100%

Source: Statistics New Zealand and Australian Bureau of Statistics.

28. That said, Table I.3 shows that New Zealand's capital accumulation has suffered from a "quality

gap" compared to Australia, especially in the second half of the 1990's. Some features of the capital accumulation process in the two countries are also shown by Table I.3. The pace of capital investment in Australia has been higher than in New Zealand in the period considered, especially in Intangible Assets (mostly expenditure on mineral exploration, due to Australia's large mining sector). Moreover, Australia has a larger share of net capital stock in Plant and Machinery and (especially) Building and Construction, while New Zealand has a much larger share of net capital represented by Residential Building.

Currency Conversion

29. A key difficulty in comparing productivity levels between New Zealand and Australia is translating real output and capital expressed in different currencies into common currency units. Market exchange rates are inappropriate for this conversion, as they fluctuate widely and in general do not reflect differences in countries' real prices. In principle, local currency producer prices for specific goods should be compared (unit value ratios), and aggregated to build a sector specific conversion factor.[10]

30. In the absence of unit value ratios, the approach followed in this chapter has been to use the sector-specific expenditure Purchasing Power Parities produced by the OECD (1996). As these prices derive from retail surveys, they are adjusted for cross-country differences in trade margins and net indirect taxes, which should not affect the comparison (see Hooper, 2000). Table I.1.1 in Annex I.1 shows the sector-specific relative prices associated with the conversion factors used in this chapter.

C. Results

31. Once comparable estimates of output, labor, and capital (and their factor shares) have been obtained, it is possible to use Equation [1] to assess the relative contributions from capital accumulation and TFP in determining relative labor productivity in New Zealand and Australia. Table I.4 shows that:

- the contribution from human capital has been about the same in the two countries (on average in the period considered);
- around ¾ of the 20 percent average New Zealand gap in labor productivity in the period 1988-1999 comes from differences in capital accumulation;

[10] Unit-value ratios are the ratios between values and volumes of different goods as reported in production statistics. However, using these ratios also has its limits, as they do not reflect differences in product quality across countries, and usually allow coverage of only a very limited sample of goods (Van Ark, 1999).

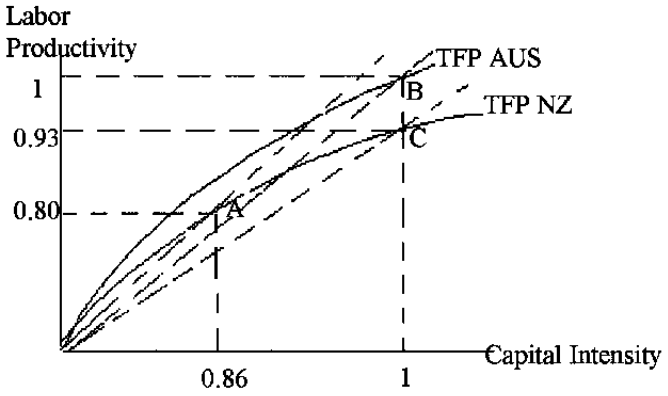
Table I.4. Levels Accounting: New Zealand's Ratios with Australia, (Australia=1), by Sectors

	Labor Productivity			Human Capital			Capital Intensity			Total Factor Productivity		
	1988	1999	Average	1988	1999	Average	1988	1999	Average	1988	1999	Average
Market sector	0.82	0.73	0.80	0.99	1.01	1.00	0.85	0.83	0.86	0.97	0.86	0.93
Agriculture, Fishing and Forestry	0.77	0.76	0.77	1.00	1.07	1.03	0.68	0.79	0.74	1.14	0.89	1.01
Mining and Quarrying	1.19	0.94	0.98	1.00	1.01	1.01	0.94	0.80	0.98	1.28	1.17	1.00
Manufacturing	0.80	0.62	0.73	0.98	1.02	1.00	0.98	0.92	0.97	0.83	0.65	0.75
Electricity, Gas and Water Supply	1.21	0.99	1.18	1.01	1.02	1.02	0.67	0.76	0.78	1.79	1.28	1.49
Construction	0.81	0.57	0.73	1.05	1.07	1.06	0.92	0.89	0.90	0.83	0.59	0.76
Wholesale Trade	0.91	0.77	0.93	0.99	0.98	0.99	0.87	0.89	0.88	1.06	0.89	1.06
Retail Trade	1.14	1.00	1.11	0.94	1.05	1.00	0.91	0.92	0.94	1.34	1.03	1.18
Accommodation, Cafes and Rest.	0.92	0.78	0.90	1.00	1.02	1.01	0.95	0.77	0.88	0.97	0.99	1.01
Transport and Storage	0.72	0.97	0.89	0.99	1.05	1.02	0.86	0.88	0.85	0.84	1.05	0.96
Communication Services	0.52	0.61	0.62	0.99	1.00	0.99	0.80	0.77	0.80	0.66	0.79	0.78
Finance and Insurance	0.93	0.70	0.79	-	-	-	1.01	0.72	0.85	0.92	0.97	0.93
Cultural and Recreational Services	0.65	0.80	0.74	0.98	0.98	0.98	0.74	0.88	0.90	0.89	0.92	0.84

- the other quarter of the gap is due to differences in TFP;
- had New Zealand had the same capital intensity as in Australia, the labor productivity gap would have been reduced to around 7 percent on average in the period (point C in Figure I.2).

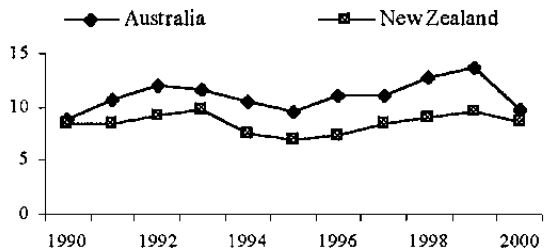
Figure I.2

Labor Productivity, Capital Intensity and TFP in Australia and New Zealand (AUS=1),
Averages 1988-1999.



32. The existence of different capital intensities between the two countries reflects different relative factor costs. Figure I.3 shows that the estimate of the cost of labor relative to capital has been higher in Australia than in New Zealand in the period considered. While the two countries were at a relatively similar position at the start of the period, the cost of labor relative to capital has eventually become larger in Australia, especially over the second half of the 90's. The higher relative

Figure I.3. Cost of Labor Relative to Capital



Cost of labor: Compensation of employees (from National Accounts, in 1996 NZ dollars) divided by hours worked.
Cost of capital: Weighted average of the assets rental prices, (see Annex I), with weights given by the assets shares of capital income.

wage growth in Australia was mainly responsible for the different pattern in the relative cost of factors.[11]

33. This difference could be due to the different timing of labor market reforms. While New Zealand started these reforms at the start of the 1990s by making welfare benefits less generous and deregulating the labor market through the 1991 Employment Relations Act, Australia's labor market reforms started only in the second half of the 1990s. Given its relatively more flexible and cheaper labor force, New Zealand may have been induced to move towards relatively labor-intensive production technologies, compared to Australia (see also OECD, 2001).[12]

34. At the same time, however, other forces may be at play that explain the relatively faster capital accumulation in Australia. Table I.3 shows that a larger share of net capital is invested in residential buildings in New Zealand than in Australia. The share of New Zealand's household portfolio invested in housing is one of the largest among OECD countries (OECD, 2001). Several factors may explain this bias, such as cultural attitudes and economic convenience (large capital gains from housing investment in the past). However, it is likely that the taxation regime, which exempts housing from any form of taxation, while taxing income and capital gains from other types of investments, has also played a role.[13]

35. Australian household portfolios are also mostly dominated by housing (Ellis and Andrews, 2001). However, the concentration of wealth in housing may have a larger impact

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[11] The higher estimated rental price of capital in New Zealand is a consequence of its smaller stock of capital (and, thus, larger marginal productivity). However, the same result holds if adopting market-based measures of the rental price of capital, for example, by estimating the opportunity costs of capital r in Equation [2] with the return on long-term government bonds (see Annex I.1). Adopting a CAPM approach, Lally (2000) also confirms that the real cost of capital for a typical firm in New Zealand has been modestly larger than in Australia, and considerably higher than in the United States. A critical factor behind this result is the allowance for currency risk, and a relatively higher market risk premium in New Zealand, which in turn is the result of the less diversified and more volatile New Zealand's market.

[12] Labor market reforms implemented in New Zealand had obvious beneficial effects in terms of inducing higher employment and of enhancing the resilience of New Zealand's economy in face of adverse shocks. Moreover, the potential negative impact of labor market reforms on capital deepening may be a temporary phenomenon that does not reflect long-run trends.

[13] New Zealand does not have a comprehensive capital gain tax, but the income from any asset held with the purpose of resale is taxable. For example, equities transactions involving managed funds are taxed, while individuals can hold and trade (within certain limits) equities without being taxed.

on growth potential in New Zealand, because of the relative scarcity of savings available to finance more productive forms of investments in this country. The low household saving rate and the small size of private pension funds (whose size has decreased after the removal of tax concessions in the 1990s) in New Zealand are likely to reduce the proportion of housing assets that would be consistent with a given rate of output growth.[14]

36. A different explanation for the relatively lower capital deepening experienced by New Zealand focuses on the limited investment opportunities that would be open to countries with a small potential market (Skilling 2001). Skilling speculates that the small size of domestic market combined with the distance from foreign markets would make the "effective size" of New Zealand smaller than some critical mass required to have high growth performance. Nonlinearities in the production function associated with internal and external economies of scale would make it much more difficult for New Zealand's small and geographically isolated firms to invest, export and grow. Accordingly, it is Australia's relatively larger domestic market that ultimately explains the differences in both capital deepening and TFP growth.

37. This hypothesis is not entirely consistent with the sectoral analysis of productivity levels. For example, one sector in which New Zealand should be less affected by market size is the primary sector, which exports almost all of its product and in which New Zealand has a distinct comparative advantage. Table I.4 shows that in the agriculture fishing and forestry sector, New Zealand's average gap in terms of labor productivity is associated with a much lower capital intensity than in Australia.[15] This could reflect the difference in the structure of the two countries' agricultural sectors, and in particular the combination of a cooperative

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[14] It is widely perceived that the relative low level of domestic savings has not been a constraint on New Zealand's economic growth, as New Zealand has been able to access foreign savings to meet investment demand (Claus and others, 2001). It may be argued, though, that the heavy dependence on foreign capital is one of the factors that contributed to a relatively higher capital costs in New Zealand compared to Australia, as mentioned in Footnote 11.

[15] It should be stressed, however, that the sectoral results shown by Table I.4 should be taken with some caution, for at least two reasons. First, as noted above, this study does not consider livestock as a capital assets, as such data do not exist for New Zealand. Because the relatively larger diary sector in New Zealand implies that this country is likely to use relatively more livestock than Australia, the capital deepening gap in the agricultural sector may be overstated. Second, the estimates of TFP at a sectoral level suffers from some potentially important sources of measurement errors, such as the one associated with the use of expenditure PPPs and that arises from the monopsonistic nature of the diary sector in New Zealand. Under the latter, the allocation of total value added in the diary sector across raw milk production (agriculture), processing (manufacturing) and marketing (wholesale trade) is likely to have been distorted relative to outcomes in a competitive market structure.

structure and a single-buyer desk for export in New Zealand, which may have restricted capital investment in the sector.[16]

38. In contrast, almost all of the New Zealand's relative gap in labor productivity in the manufacturing sector (where effective scale is more likely to play a role) is due to a lower level of relative TFP, while capital intensity has been broadly similar to Australia. This result contrasts with a recent paper by Fare, Grosskopf and Margaritis (2001), showing that New Zealand's TFP record in manufacturing sector has been on average slightly better than Australia's. The reason for this difference could be two-fold; first, this study uses the new chain linked series of capital stock; second, the final period of the analysis in Fare et al is 1996, and misses the period during which Australia's IT capital accumulation accelerated.

39. Figure I.4 plots the time profile of relative TFPs of the different ANZSIC sectors and for the market sector as a whole. Eyeballing these charts shows that New Zealand has generally been catching up in sectors where the gap with Australia was larger at the start of the period (in particular Communication), and has instead lost ground in sectors where it had a relative advantage to start with. The only exceptions are Manufacturing and Construction, where New Zealand has failed to catch up with Australia. The divergence of aggregate TFP at a market sector level over the period considered in this study is thus primarily explained by the poorer performance of these two sectors.

D. Resource Reallocation Across Sectors

40. The existence of significant differences in relative productivity levels across ANZSIC sectors suggests that there is scope for aggregate productivity gains through a reallocation of resources from low to high productivity sectors. Since one of the objectives of the microeconomic reforms implemented in the two countries in the last 15 years was to improve the economy's allocative efficiency, it is interesting to assess to what extent Australia and New Zealand have differed in this respect.

41. As showed by Annex I.2, an indicator of an economy's success in moving resources into sectors with higher returns is provided by the difference between the growth rate of aggregate TFP and the weighted average of sectoral TFP growth rates (with the weights given by the sector shares of aggregate output). This difference measures the contribution to aggregate TFP growth from a shift of labor and capital inputs to sectors where they earn a

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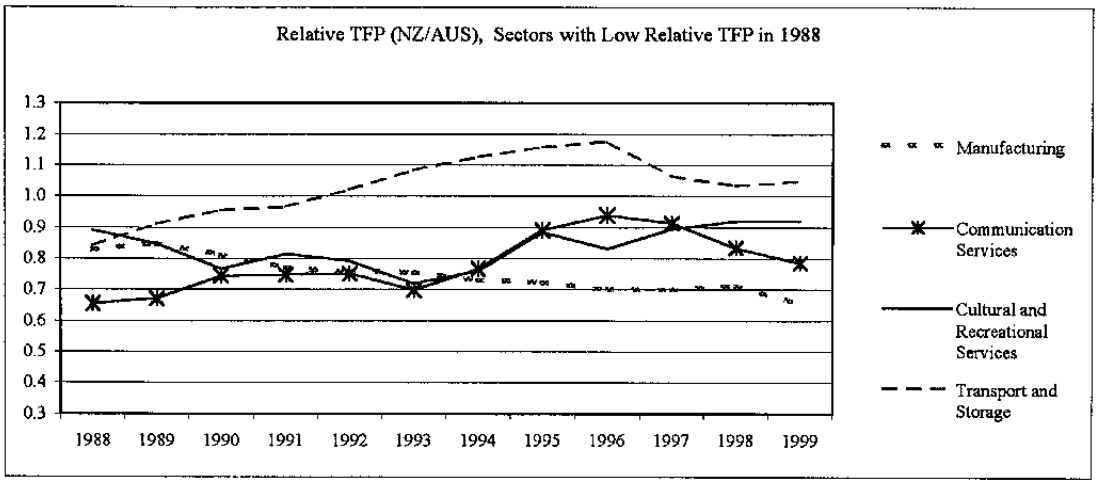
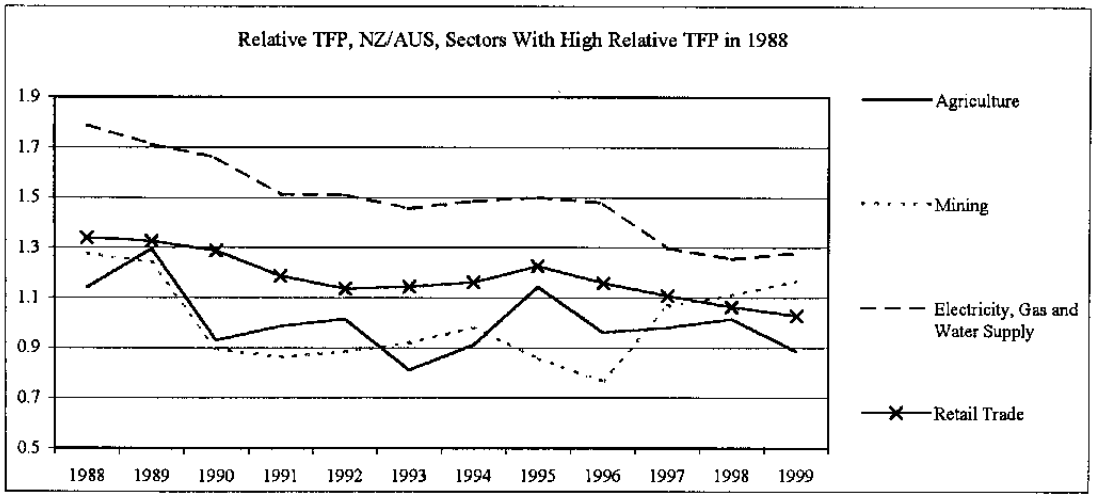
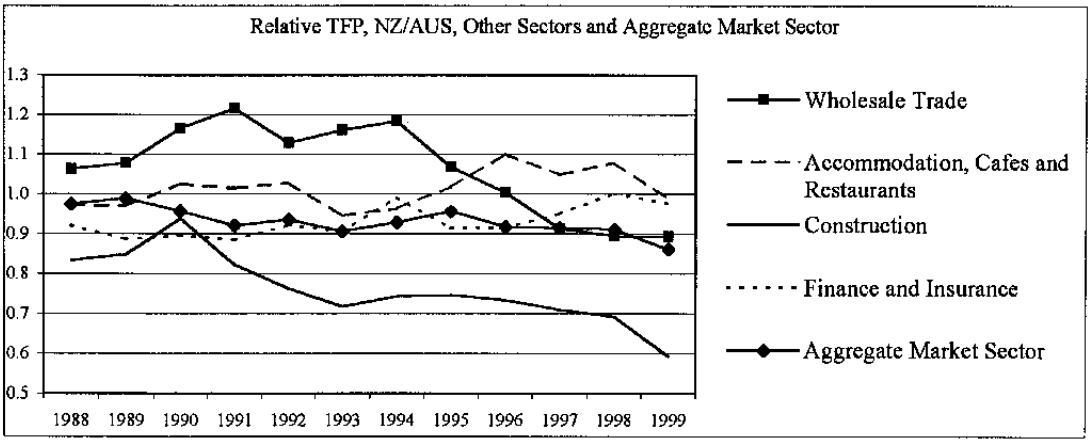
[16] The fact that equity capital can only be raised by suppliers limits the source of capital for cooperatives relative to traded corporations. As stated by Lewis and Quigley (2001), this is an important issue where profitable opportunities for expansion exists. See also Sinclair (1999).

Figure I.4. Relative TFP Levels







higher than average remuneration (that is, sectors with higher than average TFP levels). Alternatively stated, the market sector's TFP growth rate can be expressed as the sum of two terms; one which reflects productivity growth within each sector, and one (RF) that depends on the reallocation of factors across sectors:

$$\Delta \ln(TFP_t) = \sum_{i=1}^{N} va_i \Delta \ln(TFP_{i,t}) + RF$$

42. Table I.5 shows that in the period considered by this study, the size of the reallocation factors has been on average quite small in both countries. This may be due to the fact that the bulk of the reallocation of capital and labor had taken place in the 1980s (and thus before the period considered).[17] Moreover, it is consistent with evidence that static allocative efficiency gains are generally low (Timmer and Szirmai, 2000). More significant, though, is the difference in the sign of the RF terms in the two countries, as the average annual RF is slightly negative in New Zealand but positive in Australia. Interestingly, the positive reallocation factor in Australia is entirely due to the reallocation of capital towards its most productive uses, which has more than offset the negative effect of the reallocation of labor.

Table I.5. Reallocation Effect and Aggregate Market Sector TFP Growth

	Aggregate TFP Growth	Due to:		Reallocation Effect From	
		Productivity Growth Effect	Reallocation Effect	Labor Shift	Capital Shift
New Zealand					
1989-1999	0.8%	0.9%	0.0%	-0.1%	0.0%
1989-1995	1.1%	1.0%	0.1%	0.0%	0.1%
1995-1999	0.6%	0.6%	-0.1%	0.0%	-0.1%
Australia					
1989-1999	1.9%	1.7%	0.1%	-0.2%	0.3%
1987-1995	1.4%	1.2%	0.2%	-0.2%	0.3%
1995-1999	2.2%	2.2%	0.0%	-0.3%	0.3%

43. Since New Zealand has undergone larger structural change than Australia since the mid 1980s,[18] this difference could indicate that allocative gains in New Zealand may have been prevented by the limited access of resources to sectors with comparatively high relative

[17] Buckle and others (2001) show that substantial changes in output sector shares had ceased by the beginning of the 1990s. Clearly, most of the rationalization process induced in New Zealand by the elimination of assistance and protection polices took place at firms levels within each sectors (Savage and Bollard, 1990, as quoted in Skilling, 2001). This suggests that the sectoral level of the analysis above does not capture adequately the static efficiency gains involved in the adjustment process that followed the reform program.

[18] This results from extending to the 1990s the measurement of structural changes in Australia and New Zealand based on a structural change index as in Productivity Commission (1998).

productive levels. This hypothesis finds support in the decline of the share of capital invested in agriculture (one of the high-productivity sectors) in the period considered.[19]

44. Alternatively, these results may be suggesting the existence of structural factors that limit New Zealand's ability to gain from policies aimed at improving allocative efficiency compared to Australia. Again, effective size may be playing an important role in this respect. As pointed out by Skilling (2001b), even if the New Zealand economy has been reasonably successful in diversifying away from agriculture, structural factors related to size and distance made a profitable shift from the primary sector into the manufacturing and services sector problematic. In these sectors, New Zealand lacks a comparative advantage and New Zealand firms face real difficulties in establishing a competitive advantage.

45. According to this hypothesis, New Zealand's relative low growth performance is due to its having a comparative advantage in the "wrong" sector of the economy, namely, primary production. "Wrong" here means that this sector is characterized by lower growth prospects than manufacturing and services, where much of the technological progress in the 1990s has taken place and for which world demand has grown at a faster rate.[20] Australia's advantage over New Zealand is thus the relatively larger domestic market, which has made relatively easier for this country to move away from commodity production and to establish and sustain a competitive advantage in other areas of the economy.[21]

E. Conclusions

46. Using new and comparable data on output and capital stock in New Zealand and Australia this study shows that New Zealand per capita income divergence in the post-reform period has been primarily associated with a slower, quality-adjusted, physical capital accumulation process and, to a lesser extent, with lower TFP growth. The relative gap in the capital/labor ratio reflects differences in relative factor costs and is consistent with a smaller

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[19] Hall (1996) also finds that New Zealand employment shift in the post reform period (1985-1993) have been into sectors with lower rather than higher output and labor productivity growth. Purdue (1999) finds that during the 1990s the distribution of output by sectors changed so as to produce only a small (but positive) effect on aggregate productivity.

[20] Briggs, Bishop and Fan (2001) find that New Zealand's relative low export growth in 1985-1998 is due to its comparative advantage in primary sectors, which have shown relatively weaker growth over this period (partly because of still high degree of protectionism).

[21] Mc Lean and Taylor (2001) emphasize another structural advantage of Australia, namely, its larger endowment of mineral resources (that accounts for almost 40 percent of its exports). Absent this advantage, they speculate that the postwar growth trajectory of Australia may have looked similar to that of New Zealand.

range of investment opportunities in New Zealand. New Zealand's relatively lower capital deepening may also reflect the larger share of its net capital represented by residential buildings.

47. Although cultural attitudes are probably a large factor behind the large investment in housing, a role has also been played by economic factors, namely the significant (in the high inflation environment of the 1990s) and untaxed capital gains and the absence of taxation on the imputed rental income derived from this type of investment. In terms of policy implications, the analysis above suggests that some consideration could be given to reforms of the tax system that would "level the playing field" for different vehicles of savings.

48. The study also shows that New Zealand's relative efficiency in the utilization of primary inputs has been declining in the period after the reforms. The divergence of aggregate markets sector TFP is ultimately caused by divergence in manufacturing, while New Zealand has been catching up Australia in some of the service sectors, where it had a relative productivity gap at the end of the 1980s, e.g., communication.

49. The analysis also cast doubts on the notion that allocative efficiency gains from the reforms have significantly boosted New Zealand's TFP growth. While structural factors, in particular, the small size of domestic market and protective trade barriers limiting scale and investment opportunities, may be playing a role, there are also "distortions" that have reduced the effectiveness of structural changes in enhancing productivity growth. In particular, the cooperative structure and the monopsonistic nature of a significant part of the New Zealand's most efficient sector (agriculture), and one which suffers least from scale disadvantages, may have prevented New Zealand from fully benefiting from its main comparative advantage.

METHODOLOGICAL AND MEASUREMENT ISSUES

Productivity level comparisons of the type presented in the chapter require developing comparable measures of output and input levels. As results can be quite sensitive to differences in estimation procedures, extreme care should be devoted to obtaining comparable indicators for the two countries, even if they are not necessarily the best measure for each individual country. This Annex briefly outlines some of the problems encountered in this process and outlines the methodology used to get around them.

Output

Sectoral output is defined as gross value added adjusted to a factor-cost basis. The valuation at factor costs amounts to exclude all indirect taxes on products (for example, GST, excise duties, import duties) and on production (for example, levies), and all subsidies. Hence, the value added concept considered in this study is the sum of compensation of employees and gross operating surplus from the National Accounts. Since sectoral value added is available in chain volume terms at basic prices for Australia and at producer prices for New Zealand, the annual rates of change from these series have been applied to GDP at factor costs in 1995/96 prices.

A difference between the two countries involves bank service charges, as Statistics New Zealand does not deduct these charges from the output of individual sectors. The 1995/96 value added for New Zealand's ANZSIC sectors is thus adjusted by using the 1995/96 New Zealand input-output table, which shows each sector's intermediate consumption of bank service charges.

Prices

An important step in comparing productivity levels is the conversion of the two countries' output and capital into a common currency. The approach in this chapter is to use PPP exchange rates. Using a single, economy-wide PPP exchange rate, however, would amount to ignoring variations in relative price levels across sectors. Hence, whenever possible this study applies industry-specific PPP exchange rates calculated by the OECD (see OECD, 1996 and 1993). These rates are obtained as weighted averages of national relative prices evaluated at a retail level and aggregated using expenditure shares.

The OECD 1996 price comparison covered around 2500 goods and services that have been allocated into 65 expenditure categories. While in some cases the match between these expenditure categories and the sectors considered in this study is straightforward (as for transport services, accommodation cafes and restaurant, and cultural services), for the other sectors the OECD PPP rates were used as a proxy. This was the case of the PPP rate for fuel and power, used for the electricity gas and water sector, while for manufacturing this study uses the weighted average of PPPs rates for the following categories: food, beverage and tobacco; clothing and footwear; household equipment; recreational goods; books,

newspapers, and other printed matters; transport equipment; miscellaneous goods, and machinery and equipment (with weights given by the goods' shares of total expenditure). For retail and wholesale trade sector, the PPP rate for total consumption was used. For all other sectors, in the absence of a better conversion factor, the PPP rate for the whole GDP was used. The only exception is for communication, for which the relative price level is obtained from the Australian Productivity Commission (1999). The conversion rates for capital assets were also derived from the OECD expenditure-based PPP rates.

The conversion rate for sector i (to be applied to magnitudes in Australian dollar) are obtained as ratios between the expenditure prices PE:

$$EPPP_{i,AUS} = \frac{PE_{i,AUS}}{PE_{i,NZ}}$$

As these prices include distribution margins, the PPPs conversion rates used in this study are adjusted for the cross country-differences in these margins:

$$EPPP^{m}_{i,AUS} = \frac{PE_{i,AUS}/(1+\delta_{i,AUS})}{PE_{i,NZ}/(1+\delta_{i,NZ})}$$

where δ are the distribution margins obtained as the ratio between distribution margins and total supply purchaser prices (from the Australian and New Zealand 1996 input-output tables). A further correction is made to take into account cross country-differences in net indirect taxes:

$$EPPP^{*}_{i,AUS} = \frac{1+t_{i,NZ}}{1+t_{i,AUS}} EPPP^{m}_{i,AUS}$$

where t are the ratios between net taxes on products and total supply purchaser prices. Table I.1.1 shows the price level indices used in this study (defined as the ratio between $EPPP^{*}$ and the 1996 market exchange rate).

Table I.1.1. New Zealand/Australia: Relative Price Levels [1/]

(AUS=100)

ANZSIC Sectors	PPP		
	Unadjusted	Adjusted for Distribution Margins	Adjusted for Net Indirect Taxes
Agriculture, fishing and forestry	102	114	114
Mining and quarrying	102	110	106
Manufacturing	98	104	106
Electricity, gas, and water	86	86	85
Construction	110	110	105
Wholesale trade	102	102	101
Retail trade	102	102	102
Accommodation, cafes and restaurants	89	89	84
Transport and storage	85	85	77
Communications [2/]	140	140	140
Finance and insurance	102	102	103
Cultural and recreational services	100	100	106
Total market sector	102	102	102
Capital goods			
Non residential building	110	110	110
Transport equipment	97	98	103
Machinery	80	87	94

1/ Estimated from Purchasing Power Parities and Real Expenditure, OECD 1993 and 1996.
2/ Relative prices of communication services from International Benchmarking of Telecommunication Services, New Zealand Summary, April 1999, Productivity Commission, Canberra, Australia.

Labor Input

The comparability of hours worked is hindered by the adoption of different data collection and processing procedures across the two countries. The Australian Bureau of Statistics publishes a measure of hours worked by ANZSIC sector based on the quarterly Labor Force Survey (LFS). Hours worked are measured as total hours actually worked during a reference week of the quarter by all those employed (employees, employers and self-employed). Hence, hours paid for but not worked (because of annual leave, sickness, holidays) are excluded from the estimate.

In New Zealand, there are two main sources of hours worked by sector. The first one is the Quarterly Employment Survey (QES), which records the hours paid for, not the actual hours of work. As this is a business survey, the statistic units are business locations with at least one full-time equivalent employee (one full time or two part-timers). This means that those self-employed who do not employ staff (own-account workers, in the definition of the ABS) are outside the scope of the survey. Finally, the survey does not cover Agriculture and Mining.

The other source of hours worked by sector is the quarterly Household Labor Force Survey (HLFS), which provides data on actual hours worked and covers all sectors. Even if the QES has a greater level of sectoral detail (based on an ANZSIC classification), for the sake of comparability this study adopts the estimates of hours worked from the HLFS, as reported in the Diewert and Lawrence database, and uses data on hours paid from the QES to match the ANZSIC classification.

Hours Worked, New Zealand

- Agriculture, fishing and forestry: total hours worked (sum of 4 quarters) from the HLFS, as in the Diewert and Lawrence (DL) database, Table C7;
- Mining and quarrying: as above;
- Manufacturing: as above;
- Electricity, gas and water supply: as above;
- Construction: as above;
- Wholesale trade: obtained applying the share of wholesale trade of total hours worked in the sectors wholesale trade, retail trade, and accommodation cafes and restaurant as in the QES to the aggregate "Trade, Restaurant and Hotels" from the HLFS as in the DL database;
- Retail trade: as above;

- Accommodation, cafes and restaurants: as above;

- Transport and storage: obtained applying the transport share of the total hours worked in the sectors transport and communication in 1996 from HLFS to the aggregate "Transport and Communication" sector in the HLFS as in the DL database; (this amounts to assume that before 1996, around 70 percent of the total hours worked in the sector "Transport and Communication" was attributable to the transport sector, as in 1996);

- Communication services: as above;

- Finance and insurance: obtained applying the finance and insurance share of the total hours worked in finance and insurance and property & business services from the QES to the aggregate "Financial Services" in the HLFS as in the DL database; and

- Cultural and recreational services: obtained applying the cultural and recreational services share of the total hours in the sectors cultural and recreational services, health & community services, personal & other services and education from the QES to the "Community Services" aggregate in the HLFS as in the DL database.

The major difference between the two surveys is their timing, as the Australian Labor Force Survey refers to a reference week of the quarter, while the HLFS carries out the interviews each week and thus refers to a weekly average for the quarter. Hence, the Australian series is more exposed than the New Zealand's one to the noise arising from public holidays and other days lost during the reporting period.

An adjustment for different quality of labor input is made by using data on employment by educational attainment in different sectors of the economy. For New Zealand, the data on educational attainment by sector have been derived from the Census 1981, 1986 and 1996. For Australia, the data on educational attainment by sector for the year 1984 and 1997 are those published in Barnes et al (1999). Data for intermediate years are obtained by cubic interpolation.

The wage shares of the three types of labor considered (with tertiary qualification, with secondary qualification, and without secondary school qualification) have been estimated by using the relative wages of these three groups as reported in the OECD publication "*Education at a glance*."

Capital Input

Productive Capital Stocks

Equation [1] in the text includes the productive stock of five different capital assets: Transport equipment, Plant and Machinery, Non Residential Building and Constructions, Intangible assets and Land. These stocks are obtained from the official statistical offices,

with the only exception of the stock of Land used for productive purposes for New Zealand that is taken from Diewert and Lawrence (1999). All series are in chain volume terms and are available for each ANZSIC sector.

Using capital inputs produced by the official statistical offices may be a source of biases in international productivity comparison if the methodologies followed by the national offices are very different. This does not seem to be the case for SNZ and ABS, however, because they follow a reasonable similar methodology in estimating productive capital stocks. In particular, both statistical offices use the same hedonic prices to deflate investments in computers and the same age efficiency reduction parameters utilized by the U.S. Bureau of Labor Statistics. The assets' average service lives used in the perpetual inventory model are also quite similar, with the only exception of Transport Equipment, whose average life is shorter for New Zealand than for Australia.[22]

The different number of assets for which official estimates of the productive capital stock are available in the two countries, raises a series of aggregation issues. For instance, while Statistics New Zealand publishes the productivity capital stock for Plant and Machinery as a whole, the Australian Bureau of Statistics publishes estimates of four different capital assets within this group (Computers and peripherals, Industrial machinery and equipment, Electrical and electronic equipment, Other plant and equipment). As the SNZ's estimate of Plant and Machinery is the sum of these distinct assets, for the sake of comparability the stock of Plant and Machinery for Australia is obtained by adding the stocks of its four components.[23] Summing the productive capital stock of different assets, however, amounts to ignoring the differences in the proportional factor that links the stocks of the asset to its productive services.

Rental Prices

The rental price of asset j in sector i at time t is estimated according to the equation:

$$p_{i,j,t}\left(r_{j,t}+\delta_{i,j,t}-\pi_{i,j,t}\right)\left(\frac{1-\tau_t z_{i,j,t}}{1-\tau_t}\right)$$

where:
$p_{i,j,t}$ is measured as the investment deflator from Statistics New Zealand and the Australian Bureau of Statistics;
$\pi_{i,j,t}$ is the rate of change of $p_{i,j,t}$;

[22] According to SNZ, such diversity reflects the fact that New Zealand imports a significant larger amount of second-hand cars (with a shorter mean life) than Australia (where import protections are more stringent).

[23] As a general rule, this chapter ignores the bias arising from the non-additivity of chain volume figures, which is likely to be of a second order magnitude.

$\delta_{i,j,t}$ is the depreciation rate of the asset i in sector j calculated as follows:

$$\delta_{i,j,t} = \frac{NKS_{i,j,t} - NKS_{i,j,t-1} - I_{i,j,t}}{NKS_{i,j,t}}$$

where NKS refers to the chain volume net capital stock and I to chain volume investments (both obtained from the two national statistical offices);
τ_t is the corporate tax rate;
$z_{j,t}$ is the present value of depreciation allowances for asset j, calculated as follows (see Moes, 1999):

$$z_{j,t} = \frac{f_{j,t}\,\delta_{i,j,t}\,\tau_t}{\rho_t + f_{j,t}\,\delta_{i,j,t}}$$

where $f_{j,t}$ is the depreciation tax loading factor (taken from Moes (1999) for New Zealand and the Australian Taxation Office for Australia) and ρ_t is the discount rate (10 years government bond rate).

Finally, the opportunity cost of capital r can be estimated in two ways. According to the first one, a sector-specific rate $r_{i,t}$ can be derived as the rate that makes the aggregate income from capital services (rental price times capital stock) equal to the aggregate capital income estimated from the National Accounts (gross operating surplus):

$$GOS_{i,t} = \sum_{i}^{N} p_{i,j,t} K_{i,j,t} \left(r_{i,t} + d_{i,j,t} - \pi_{i,j,t}\right)\left(\frac{1-\tau_t z_{j,t}}{1-\tau_t}\right)$$

where $GOS_{j,t}$ is the current price gross operating surplus for sector j at time t obtained from the NA, $K_{i,j,t}$ is the productive capital stock for the asset i in sector j at time t, and all other variables are obtained as above. As GOS is obtained residually (as the difference between value added and compensation of employees), adopting this methods implies to assume constant returns to scale.

The other method consists in estimating an economy-wide nominal cost of capital from market rates. A vast choice of market rates is available, and possible options are the use of an average of borrowing and lending rates, government bond rates, corporate bonds rates, or E/P ratios (see Hsieh, 2000).

In this chapter the first method (constant return to scale) is applied, but the second one is also explored (using the interest rate on 10 years government bonds) as a way to implicitly assess the distortions associated with imposing constant returns to scale. Alternatively stated, the absence of a significant differences between the dynamic of factor returns from the National Accounts and those estimated from market data is taken as an implicit "dual" confirmation of the TFP estimates obtained under constant returns to scale.

Table I.1.2. Estimated Rental Prices of Capital

	Average 1988-1999	Net Return	Depreciation	Asset Inflation
New Zealand				
Intangible assets	38%	8%	26%	-4%
Non residential building and other construction	10%	8%	5%	3%
Plant and machinery	28%	8%	18%	-2%
Transport equipment	31%	7%	24%	0%
Land	4%	0%	0%	0%
Australia				
Intangible assets	29%	7%	15%	-7%
Non residential building and other construction	7%	6%	4%	4%
Plant and Machinery	25%	6%	16%	-2%
Transport equipment	15%	5%	12%	3%
Land	3%	5%	0%	2%

Factor Shares

The labor income shares α_L for the three types of labor considered in Equation [1] in the text are obtained as follows:

$$\alpha_L^{i,j} = \frac{W_{i,t}}{VA_{i,t}} \frac{w_{i,j,t} L_{i,j,t}}{\sum_j^3 w_{i,j,t} L_{i,j,t}} = \frac{w_{i,j,t} L_{i,j,t}}{VA_{i,t}}$$

where the first ratio on the right hand side is the sector-*i* compensation of employees as share of sector-*i* value added, and the second term is the share of sector-*i* compensation of employees that is attributed to the type of labor denoted by *j*, e.g., tertiary education. $w_{i,j,t}$ is the relative wage of workers *j* (normalized to the wage of those with secondary education), as derived from OECD's *Education at Glance*.

The labor income share for sector-*i* has been adjusted to take into account that the income of self-employed, part of which is remuneration for labor, is included in the gross operating surplus. Following OECD (2000), part of the gross operating surplus is thus allocated to labor assuming that self-employed have the same average remuneration than employees (the share of self-employed over total employed by ANZSIC sectors is obtained from the labor force surveys).

As for the capital income shares α_K in Equation [1] in the text, they are obtained as follows:

$$\alpha_K^{i,j} = \frac{GOS_{i,t}}{VA_{i,t}} \frac{\mu_{i,j,t} K_{i,j,t}}{\sum_j^5 \mu_{i,j,t} K_{i,j,t}} = \frac{\mu_{i,j,t} K_{i,j,t}}{VA_{i,t}}$$

where the asset rental prices $\mu_{i,j,t}$ are obtained as described above, assuming constant returns to scale.

REALLOCATION FACTOR

The growth rate of market sector's TFP is:

$$[1] \qquad \Delta \ln(TFP_t) = \Delta \ln(VA_t) - \alpha_L \Delta \ln(L_t) - \alpha_K \Delta \ln(K_t)$$

where VA is the market sector's value added, L is the market sector's hours worked and K the market's sector capital stock.

Aggregate TFP can be obtained also as the weighted average of sector i TFPs $(i=1...S)$, with weights given by the sector i share of value added:

$$[2] \qquad \sum_i^S va_i \Delta \ln(TFP_{i,t}) = \sum_i^S va_i \left[\Delta \ln(VA_t^i) - \alpha_L^i \Delta \ln(L_t^i) - \alpha_K^i \Delta \ln(K_t^i)\right] \qquad with\ va_i = \frac{VA_{i,t}}{VA_t}$$

To explain the meaning of the difference between Equation [1] and Equation [2], Equation [1] must be expressed in a different way. Using the equivalencies:

$$\Delta \ln(VA_t) = \sum_i^S va_i \Delta \ln(VA_{i,t})$$

$$\Delta \ln(L_t) = \sum_i^S \frac{L_i}{L} \Delta \ln(L_{i,t})$$

$$\Delta \ln(K_t) = \sum_i^S \frac{K_i}{K} \Delta \ln(K_{i,t})$$

Equation [1] can be written as:

$$[3] \qquad \Delta \ln(TFP_t) = \sum_i^S va_i \Delta \ln(VA_{i,t}) - \alpha_L \sum_i^S \frac{L_i}{L} \Delta \ln(L_{i,t}) - \alpha_K \sum_i^S \frac{K_i}{K} \Delta \ln(K_{i,t})$$

Using the following equivalencies:

$$\alpha_L \frac{L_i}{L} = \frac{wL}{VA} \frac{L_i}{L} = \frac{w_i L_i}{VA_i} \frac{VA_i}{VA} \frac{w}{w_i} = \alpha_L^i\ va_i \frac{w}{w_i}$$

$$\alpha_K \frac{K_i}{K} = \frac{rK}{VA} \frac{K_i}{K} = \frac{r_i K_i}{VA_i} \frac{VA_i}{VA} \frac{r}{r_i} = \alpha_K^i\ va_i \frac{r}{r_i}$$

Equation [3] can be expressed as:

$$[4] \qquad \Delta \ln(TFP_t) = \sum_i^S va_i \Delta \ln(VA_{i,t}) - \sum_i^S \alpha_L^i va_i \frac{w}{w_i} \Delta \ln(L_{i,t}) - \sum_i^S \alpha_K^i va_i \frac{r}{r_i} \Delta \ln(K_{i,t})$$

The difference between Equation [2] and Equation [4] can thus be expressed as follows:

$$\Delta \ln(TFP_t) - \sum_i^N va_i \Delta \ln(TFP_{i,t}) = \sum_i^N va_i \alpha_L^i \Delta \ln(L_t^i) \left[\frac{w_t^i - w_t}{w_t^i} \right] + \sum_i^N va_i \alpha_K^i \Delta \ln(K_t^i) \left[\frac{R_t^i - R_t}{R_t^i} \right]$$

The difference between the aggregate TFP growth rate and the weighted average of sectoral TFPs is positive if labor and capital inputs increase in those sectors with a higher than average return (and, thus, with higher TFP). Denoting the term on the right hand side with RF (which stands for reallocation factor), it is possible to express the rate of growth of aggregate TFP as the sum of two terms, one that reflects the growth of TFP within each sector, and one that reflects the ability of the economy to move resources towards sectors with higher productivity:

$$[5] \qquad \Delta \ln(TFP_t) = \sum_i^N va_i \Delta \ln(TFP_{i,t}) + RF$$

References

Barro, Robert J. ,1999, "Notes on Growth Accounting," NBER Working Paper, No. 6654.

Barnes Paula, Rick Johnson, Anthony Kulys and Scott Hook, 1999, "Productivity and the Structure of Employment," Staff Research Paper, Productivity Commission, Canberra.

Basu Susanto and Fernald John, 1995, "Returns to Scale in U.S. Production: Estimates and Implication," International Finance Discussion Paper, Board of Governors of the Federal Reserve System, No. 546.

Briggs, Phil, Phil Bishop and Emma Fan, 2001, "New Zealand Economic Growth: Why has it been so low?," NZIER Working Paper, 01/02.

Buckle, Bob, David Haugh and Peter Thompson, 2001, "Calm After Storm? Supply Side Contributions to New Zealand's GDP Volatility Decline," NZ Treasury Working Paper, 01/33.

Claus Iris, David Haugh, Grant Scobie and Jonas Tornquist, 2001, "Saving and Growth in an Open Economy," NZ Treasury Working Paper , No. 01/32.

Cummings, Diane, Lauritis Christensen and Dale Jorgenson, 1981, "Relative Productivity Levels, 1947-1973: An International Comparison," European Economic Review, Vol. 92.

Diewert, Denis and Erwin Lawrence, 1999, "Measuring New Zealand's Productivity," NZ Treasury Working Papers, 1999/5.

Ellis Luci and Dan Andrews, 2001, "City Sizes, Housing Costs, and Wealth," Reserve Bank of Australia Discussion Paper, 2001-08.

Fare, Rolf, Shawna Grosskopf and Dimitri Margaritis, 2001, "Productivity Trends in Australian and New Zealand Manufacturing," The Australian Economic Review, Vol. 34, No. 2.

Hall, Viv, 1996, "Economic Growth," in *A Study of Economic Reform: The Case of New Zealand*, ed. by B. Silverstone, A. Bollard and R. Lattimore, Elsevier.

Hall, Robert E. and Charles I. Jones, 1996, "The Productivity of Nations," NBER Working Paper, No. 5812.

Harrigan, James, 1997, "Cross-Country Comparisons of Industry Total Factor Productivity: Theory and Evidence," Federal Reserve Bank of New York Research Paper, No. 9734.

Hooper, Peter, 1996, "Comparing Manufacturing Output Levels Among the Major Industrial Countries," in *Industry Productivity: International Comparison and Measurement Issues,* OECD.

Hsieh, Chang-Tai, 2001, "What Explains the Industrial Revolution in East Asia? Evidence from the Factor Markets," forthcoming, American Economic Review.

Hulten, Charles R., 2000, "Total Factor Productivity: A Short Biography," NBER Working Paper, No. 7471.

Jorgenson Dale and Zvi Griliches, 1967 "The Explanation of Productivity Change," The Review of Economic Studies, Vol. 34, No. 99.

Jorgenson, Dale and Kevin Stiroh, 2000, "Raising the Speed Limit: U.S. Economic Growth in the Information Age," Brookings Papers on Economic Activity, No. 1.

Lally, Martin, 2000, "The Real Cost of Capital in New Zealand: Is It Too High?," New Zealand Business Roundtable.

Lewis Evans and Neil Quigley, 2001, "Watershed for New Zealand Dairy Industry," NZ Institute for the Study of Competition and Regulation (ISCR), Monograph Series, No. 1.

Little, Struan, 2001, "Growth and Policy in Other Countries: Lessons from the Losers," NZ Treasury.

McLean Ian and Alan Taylor, 2001, "Australian Growth: A California Perspective," NBER Working Paper, N0. 8408.

Moes, Alowin, 1999, "Effective Tax Rates on Capital in New Zealand—Changes 1972-1998," NZ Treasury Working paper, No. 99/12.

Organization for Economic Co-Operation and Development, 1996, "Purchasing Power Parities and Real Expenditures," Paris.

Organization for Economic Co-Operation and Development, 2000, "OECD Productivity Manual: A Guide to the Measurement of Industry Level and Aggregate Productivity Growth."

Organization for Economic Co-Operation and Development, 2001, "2000/01 Annual Review-New Zealand," Paris.

Productivity Commission, 1998, "Aspects of Structural Change in Australia," Research Paper, Productivity Commission, Canberra.

Purdue, Donna, 1999, "Productivity Growth and Industrial Structure: The Case of New Zealand," NZIER, mimeo.

Scarpetta Stefano, Andrea Bassanini, Dirk Pilat and Paul Schreyer, 2000, "Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level," ECO/WKP 21, OECD.

Skilling, David, 2001a, "The Importance of Being Enormous—Towards An Understanding of the New Zealand Economy," NZ Treasury.

Skilling, David, 2001b, "Comparative Disadvantage: New Zealand's Economic Growth in Historical Perspective," NZ Treasury.

Sinclair, Geoff, 1999, "Costs and Benefits of Producer Board Deregulation," NZ Treasury Working Paper, No. 99/4.

Statistics New Zealand, 1998, "Chain Volume Measures in the New Zealand National Accounts."

Timmer Marcel and Adam Szirmai, 2000, "Productivity Growth in Asian Manufacturing: the Structural Bonus Hypothesis Examined," Structural Change and Economic Dynamics, Vol. 11

Van Ark, Bart, 1996, "Issues in Measurement and International Comparison Issues of Productivity—An Overview," in *Industry Productivity: International Comparison and Measurement Issues,* OECD.

II. Implications of Migration on Economic Growth and Welfare of New Zealanders[24]

A. Introduction

50. In recent years, New Zealand has experienced large migration flows. During the 1990's, in gross terms, more than 16 percent of the population left and a similar number entered the country. Gross emigration exhibited an increasing trend throughout the 1990's, while gross immigration increased until the mid-1990's and has declined since (Figure II.1). In the face of such large scale migration flows, much has been written about whether New Zealand may be losing highly skilled people and to what extent such migration has imposed a net cost on the New Zealand economy. This paper focuses on examining how migration affects the growth of the economy and the welfare of the nation. In this context, the role of policies is also examined.

51. Assessing the impact of migration on GDP growth is fraught with difficulties. There are a number of competing theoretical predictions:

- *Quantity and price effect* (a general equilibrium effect): As people migrate to higher wage countries, the labor force would decline, as would GDP, and domestic wages would eventually converge to destination country levels. However, these outcomes do not seem to be readily observed as wage differences persist between destination countries and New Zealand.

- *Direct externality to productivity*: If high skilled workers raise the productivity of the economy, their emigration causes a loss. However, empirical studies in other countries show weak and mixed evidence about the economy- or the industry-wide scale effect on output.[25]

- *Brain gain*: When expected income in a foreign country is higher, emigration opportunities give people larger incentive to acquire skills.[26] Hence, human capital accumulation could be higher even for those who end up staying New Zealand.

52. Looking at the effects of migration on GDP implies that the key policy concern is maximizing the welfare of people residing in New Zealand. However, an alternative policy objective could be to maximize the welfare of New Zealand nationals regardless of their

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[24] Prepared by Kenichi Ueda (x36368), who is available to answer questions.

[25] See, for example, Basu and Fernald (1996), Jones (1998), and Klenow and Rodríguez-Clare (1997).

[26] See, for example, Mountford (1997) and Beine et al. (2001).

residence.[27] Economic theory suggests that people can maximize their utility when they have freedom of choice over their residence. Even if their expected incomes in a foreign country are the same as in New Zealand, New Zealand nationals could avoid a temporary weak labor market through migration. More generally, in dynastic economic models, an individual maximizes his dynasty's welfare, which depends on his descendants' welfare wherever descendants live. Also, in life-cycle consumption models, people care about their own consumption no matter where they live.

53. With these considerations, this paper asks the following questions: what the growth performance would have been, if the income of all New Zealanders, regardless of their location, is taken into account; and what are the welfare costs associated with a change in tax and social security transfers.

54. There is a considerable literature on statistical investigations of the relationship between migration flows and several policy and other variables. For example, a study by Hatton (1995) investigates the U.K. emigration for 1870 to 1913 and concludes that short-term fluctuations were driven largely by changes in employment rates while the long-term level of emigration was determined largely by the relative wage. Tokarick (1999) finds that the relative unemployment rate and the relative personal tax to GDP ratio significantly explains the emigration of professionals and managers from Canada to the United States. This paper differs from the literature, not only in that the focus is wider, but also in that the regression analysis employed here is based on a set of variables that are derived from theoretical considerations.

55. This paper extends the literature by estimating the gross product of nationals and the welfare cost of migration for New Zealand. It consists of three parts. Section B presents some facts on migration data. It is based on several preceding studies, in particular, Bushnell and Choy (2001) and Glass and Choy (2001), but also presents new findings. Section C provides an estimate of the gross product of New Zealanders regardless of their residence. Section D shows an estimate of the welfare cost of migration associated with a change in tax rates and social security transfers. It is narrowly defined as the marginal change in utility of emigrants to tax and social security transfers, multiplied by number of emigrants.

56. The main findings of this paper are:

- Although far from conclusively, a careful analysis of the data supports the fact that New Zealand has experienced some form of "brain drain."

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[27] Different measures of national income are useful for different purposes. For example, if the effect of migration on tax revenue is concerned, the focus would be on New Zealand residents including immigrants.

- Growth performance measured by New Zealander's income is clearly better than suggested by GDP.

- Welfare costs associated with marginal changes in tax rates seem quite high, though those associated with social security transfers need further investigation.

A. Some Facts on Migration Data

57. Migration data is compiled by Statistics New Zealand from questionnaires filled out by all the people who enter and depart from New Zealand. This paper uses a cohort-based aggregate data with age and occupation entries for permanent and long-term (PLT) migrants, that is, those who have indicated their intention to stay in their destination countries for more than one year. Since the New Zealand occupational classification (NZSCO) has changed substantially in the middle of 1991 to meet the 1988 standard occupational classification of the International Labor Organization (ILO), only occupational information after 1992 is used.

58. New Zealand and Australia share a common labor market. This makes Australia the largest destination country for New Zealanders. Moreover, a New Zealander who has a British grandparent can move to work in the United Kingdom freely. From April 1991 to December 2000, 44 percent of emigrants moved to Australia, 23 percent to the United Kingdom, and 5 percent to the United States. These three countries accounts for more than 70 percent of destination of total PLT emigrants.

59. However, in January 2001, Australia terminated its preferential treatment of New Zealand emigrants in terms of income support.[28] Although it is not yet measurable, this institutional change might discourage emigration and could be one cause for the recent decline of emigrants to Australia. This paper uses data only up to end-2000.

60. Much recent work has been done to examine migration flows using the same data source. Bushnell and Choy (2001) and Glass and Choy (2001) (BC-GC) present a comprehensive picture of New Zealand migration flows and summary discussion of theories. Their main findings are:

- *Brain exchange*: They found no evidence of a brain drain, but rather evidence of "brain-exchange," the skill composition (occupation based) of immigrants and emigrants is similar.

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[28] Previously, from 1969, newly arrived New Zealanders could receive benefits from the Australian government from the day they arrived. Following this change and subsequent amendments, they face the same residency requirements (meeting residency criteria and two years residency) as other foreigners before they can claim benefits.

- *Substitutability of emigrants with immigrants*: BC-GC concludes that a typical immigrant, despite being relatively highly educated, is likely to have a lower income and lower probability of labor force participation and employment than a New Zealand born person in the first year of arrival, and needs 10-14 years to compare favorably with a New Zealand born person in terms of income earned. BC-GC call for settlement policies to facilitate better use of immigrant skills.

- *Age composition of emigrants/immigrants*: There has been a tendency for younger people to move out compared to those who move in New Zealand. Since older people typically possess higher human capital, this tendency, BC-GC argue, would support their hypothesis that there has been no brain drain. More specifically, in the last 30 years, 20-24 year old age group has had the largest share in departures, and 30-49 year old age group has been the largest share in arrivals.

- *Impact on labor force*: BC-GC cites the Business and Economic Research Limited (BERL) report (1999) for the New Zealand Department of Labour. Over 1992 to 1998, immigrants have increased the stock of human capital in New Zealand by1 percent per annum overall and by 3 percent per annum in the professional category.

61. Although BC-GC found little evidence of "brain-drain," a closer look may be necessary. According to the data that this paper relies on, net bilateral migration flows between New Zealand and its four largest emigrants destinations—Australia, the United Kingdom, the United States, and Canada—are almost balanced except for Australia, where outflows outweigh inflows. Reported skill compositions (occupation based) are almost the same in bilateral flows between New Zealand and these four destination countries. But, the fact that the four countries pay higher wages, within the same occupation, may be *prima facie* evidence that emigrants have higher skill levels than average New Zealand workers.

62. The largest net inflows come from Asian countries. Reported skill compositions of immigrants from these countries are skewed towards high levels. However, while about half of immigrants from Australia, the United Kingdom, the United States, and Canada reported their occupations, only about 30 percent of Asian immigrants reported. Moreover, according to an independent study by the government of Auckland City (2001), immigrants from Asian countries face higher unemployment rate, and lower wages compared to native-born workers with the same qualifications. Thus, the actual skill distribution of immigrants might be lower than what is reported.

63. More detailed data reveals a clearer picture of emigrants. Relatively higher skilled people emigrate more to the United States and United Kingdom than to the Australia. However, even to the United Kingdom, the skill distribution of emigrants is skewed towards the low end compared to the skill distribution of the New Zealand population. This trend is clearer in the case of emigrants to Australia. The data for the managers and professionals (major Group 1 and 2 of NZSCO90) shows that (i) New Zealand has received a net inflow in total, (ii) experienced a large net outflow to Australia, (iii) almost negligible net flows to the

United States, Canada, and Japan, and (iv) large inflow from other countries, especially from China, Hong Kong, and India. As for the lowest skill level (major Group 9 of NZSCO90), (i) New Zealand has received a large net inflow in total, (ii) especially from developing countries, (iii) experienced net outflow to Australia, and (iv) negligible net flows to the United States, the United Kingdom, and Canada.

64. The experience in New Zealand with migration is similar to other advanced economies like Canada. Tokarick (1999) summarizes several studies on Canadian migration and concludes that (i) emigration of highly skilled Canadian professionals to the United States increased substantially in the 1990s, (ii) at the same time, immigration of workers with similar skills has partially offset the number of emigrants to the United States, however, (iii) available evidence suggests that immigrants to Canada may be less productive because it takes some time for them to catch up with Canadian-born workers in terms of earnings, as a result (iv) the loss of Canadian professionals to the United States is likely to have imposed a net cost on the Canadian economy. Tokarick (1999) concludes that a reduction in personal income tax rates could reduce the incentive for highly skilled Canadians to migrate to the United States.

65. The latest OECD Employment Outlook (2001) studies immigration issues mostly from the point of view of recipient, OECD countries. Some of main findings are (i) foreigners have a higher tendency than nationals to occupy blue collar posts, (ii) the employment of foreigners plays a buffer role in the labor market's adjustment to cyclical fluctuations, and (iii) in some cases, foreigners fulfill the mismatch of sectoral labor market: some countries encounter labor shortage in the information technology (IT) sector workers, and others in workers with low qualification. OECD (2001) notes that a number of countries, in particular Canada, France, and Sweden, are concerned about emigration by their own high-skilled workers.

C. An Alternative Way of Measuring Income: Gross Migration-Corrected Product (GMP)

Definition of GMP

66. The first question this paper addresses is what the growth performance of New Zealanders could have been if their incomes are taken into account regardless of where they live. Since GDP is the gross product of people living in a country, it is not exactly the gross product of New Zealand nationals. Note that GNP is different from GDP only by the gap between residents' income raised in foreign countries and non-residents' income raised in the country, and thus it does not capture the gross product of New Zealand nationals either. This paper calculates what is termed GMP, the gross migration-corrected product. GMP is estimated by adding income of New Zealanders living abroad, and subtracting income of foreigners living in New Zealand. A simple definition of GMP is as follows:

$$\text{GMP} \equiv \text{GDP} + \text{income of emigrants} - \text{income of immigrants.} \quad (1)$$

67. To calculate GMP, four factors are taken into account: the number of immigrants and emigrants, the proportion of migrants who are employed,[29] their skill composition, and wage differentials among countries. To simplify the calculation, this paper assumes the emigrants' income in countries other than Australia, the United Kingdom, and the United States is the same as they earn in New Zealand. Since Canada and Japan are also important emigrant destinations, and wages are higher there than in New Zealand, this assumption probably underestimates GMP. Also, based on BC-GC and Auckland City Report (2001), this paper assumes earnings of immigrants from industrial countries are the same as the New Zealand workers, but earnings of immigrants from developing countries are the same as those of Pacific Islanders and Others categories in the New Zealand labor market data.[30] The labor force participation rate and unemployment rate of immigrants are treated similarly.

68. With these assumptions, GMP is now defined as:[31]

GMP ≡ GDP

+ income of emigrants in Australia, the United Kingdom, and the United States

+ income of emigrants in other countries

– income of immigrants from developing countries

– income of immigrants from industrial countries. (2)

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[29] This paper assumes emigrants in Australia, the United Kingdom, and the United States share the same labor force participation rate and unemployment rate as local people. This is a potential source to underestimate GMP. New Zealand emigrants can be expected to have higher employment rates (and probably incomes) in the United Kingdom and the United States, because employment is the key criteria for long-term residency in these countries. Even in Australia, with free access and lower skill profiles, emigrant New Zealanders are said to have higher employment rates than Australians or New Zealand residents.

[30] Immigrants from developing countries have more dependents—41 percent are below 20 years old and 5 percent are above 60 years old. These numbers for immigrants from industrial countries are 22 percent and 4 percent, respectively. The NZ Household Labor Force Survey (2000) shows that the labor force participation rate of Pacific Islanders and Others is 58 percent, and their unemployment rate is 11 percent. In contrast, the overall labor force participation rate is 65 percent and the overall average unemployment rate is 6 percent. Also, according to Income Survey (2000), Pacific Islanders and Others earn only 80 percent of the average income. These numbers are used for GMP estimates.

[31] See Annex II.1 for a detailed discussion of the methodology used to calculate GMP.

69. Before calculating GMP, emigrants' hourly earnings in foreign countries are estimated for high-, middle-, and low-skilled occupations.[32] Figure II.2 shows the estimates in the 1990's, which can be summarized as follows:

- Low-skilled New Zealand workers earned about half of the comparable U.S. workers, while comparable Australian and the U.K. workers earned about 80-95 percent of the U.S. workers earnings.

- While the high-skilled New Zealanders earned less than double that of low-skilled individuals, the high-skilled United States (United Kingdom) people earned five (four) times more than the New Zealand low-skilled workers.

- Although the United States and the United Kingdom's relative wage seems to have fluctuated against New Zealand wages, that for Australia and New Zealand has been relatively stable.

GMP Estimate and Policy Issues

70. Table II.1 shows the GMP estimate in the 1990's. Salient features are:

- In spite of low real GDP growth, GMP—New Zealand nationals' income—growth was impressive, especially in the latter half. The average growth of GMP from 1993 to 2000 is 4.0 percent, compared to the average growth of GDP 3.6 percent.[33] This is because a sizable population resided in high growth countries, and this population has also grown over last decade.

- GMP growth is also less volatile than GDP growth. While the variance for 1993 to 2000 of GDP growth is 3.4, that of GMP is 1.9.

- In per capita terms, the difference between real GMP growth and real GDP growth is less, but still the average growth of per capita real GMP from 1993 to 2000 is 2.7 percent, better than that of per capita real GDP, 2.5 percent.[34] The variance of per

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[32] All figures are based on market exchange rate. For calculations of real values in other parts of this paper, these wage data are transformed to real NZ dollar terms using PPP and the NZ GDP deflator. In Figure II.2, suffices H, M, and L represent hourly earnings for high-, middle-, and low-skilled workers. See Annex II.1 for detailed data issues to calculate GMP.

[33] In the same period, the average GDP growth of Australia was 4.3 percent, that of the United Kingdom was 3.0 percent, and that of the United States was 3.7 percent.

[34] In the same period, the average per capita real GDP growth of Australia was 3.1 percent, that of the United Kingdom was 2.7 percent, and that of the United States was 2.5 percent.

capita real GMP growth is 1.8, again, much lower than that of per capita real GDP growth, 2.9.

- Although the gap between the levels of real GMP and real GDP is increasing, it is relatively stable in per capita terms. This is because New Zealand population has grown much less than New Zealand nationals due to migration. As a sizable number of people have migrated out, New Zealand population growth was 1.1 percent on average for 1993 to 2000, and was only ½ percent in 1999 and 2000. On the other hand, estimated New Zealand nationals growth is about 1.3 percent on average.

71. Growth of per capita real GDP was lower than that of per capita real GMP growth in the latter half of 1990's. This implies that the GDP per capita has been diluted by the migration pattern—emigration of the young, return of the old, more children per immigrants, and low labor force participation with high unemployment rate for immigrants from developing countries. If New Zealand intends to achieve GDP per capita growth at least as the same level as GMP per capita growth, key issues are the following:

- It would be important to examine policies that could underlie the migration pattern where the old appear to be replacing the young. The design of the superannuation scheme could be a factor. Eligibility for New Zealand superannuation payments requires total residency of 10 years after the age of 20, and residency of 5 years after the age of 50. New Zealand superannuation is a pay-as-you-go system[35] in which benefits paid are independent of the contribution and the income of beneficiaries. Benefits are flat payments and depend only on average wage level of the country and the composition of the recipient family.

- It would be helpful to improve the labor force participation rate, reduce the unemployment rate, and strengthen wage performance for immigrants from developing countries. These could be accomplished by policies to target better settlement of these immigrants.[36]

D. Welfare Cost of Migration

72. Next, the paper tries to measure a welfare cost of migration. The cost associated with emigration consists of monetary and non-monetary costs. For marginal people who are indifferent to emigration, this cost is calculated as the difference of the net present value of incomes in both countries. If a person could earn $1000 higher annual income in Australia

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[35] Partial pre-funding of the superannuation is going to be introduced in 2002.

[36] The New Zealand government, the Auckland City government, and citizens have already been involved in active discussions and started various initiatives to address these issues. See, for example, the Auckland City (2001) report.

than in New Zealand at current wage differentials, this $1000 reflects the monetary and non-monetary cost of migration. By reducing this income difference through well-articulated tax and social security policies, the New Zealand government could enhance the New Zealanders' welfare.

73. It should be noted that only the non-monetary cost represents a welfare cost, because the monetary cost to an emigrant represents value-added attributable to those who provide the goods and services associated with moving. The non-monetary cost represents a utility loss, and the government cannot capture this loss as tax revenue. In this sense, the non-monetary cost is similar to the dead-weight-loss associated with income tax in the labor market, though it is not exactly the same. This paper actually assumes that there is no change of labor supply as a result of tax or social security system, and thus assumes away any dead-weight-losses associated with them. Rather, it tries to capture only non-monetary utility loss of emigrants. In this sense, this is a partial equilibrium analysis, and likely to underestimate the true welfare cost in a dynamic general equilibrium setting.

74. The wage differentials between New Zealand and emigrant destination countries are used to estimate the welfare cost. However, the wage differentials also reflect existing migration barriers among countries. Fortunately, this is not the case for the wage differential between New Zealand and Australia, except for the monetary cost of moving, because they form the common labor market with mutual income support systems (at least prior to January 2001). Thus, sections below focuses on emigrants from New Zealand to Australia.

Methodology

75. Absent other distortions, persistent wage differences between two countries can be considered as reflection of a stronger preference for the country that pays lower wage to its residents.[37] Emigration does not cause any welfare cost in this case, because emigrants' utility loss is compensated by higher income. However, if a newly introduced income tax distorts their decision about where to reside, it may induce people to emigrate and create welfare costs. Assuming firms compete in product markets under exogenous world prices, introduction of a new income tax forces firms to offer lower wages than before. Marginal people who stayed in the country before the introduction of the tax will then emigrate to the high wage country. This emigration flow continues until the marginal emigrants become

[37] The analysis in this section is based on the assumption that preferences explain wage differentials. Theoretically, the wage difference can be regarded as a reflection of skill levels within the same occupation between New Zealand and Australia. However, empirically, to explain the wage difference by skill differences for the New Zealand and Australian labor markets, it is necessary to have data on skills that are not captured by occupational nor educational differences. Unfortunately, the data are not available. As noted in Chapter I, the New Zealanders as a whole had slightly better educational attainment than the Australians in 1996.

indifferent between staying and leaving the country. A similar analysis applies to a rise in the income tax rate, the corporate tax rate, or the social security burden.

76. Currently, both New Zealand and Australia already have well-established tax and social security systems, and thus the relevant question is how the welfare cost of migration varies with a small change of tax and social security system. To this end, it is necessary to know both the elasticities of the number of emigrants to a change in tax rates/social security payments and current income differentials corrected for monetary costs.

Utility Loss at Market Value

77. An individual *i*'s decisions on residency and consumption are simply represented by the following life-time utility maximization, given the income stream in each location with world price fixed at one:[38]

$$\max_{c_{it}Ta_i} \sum_{t\in Tn_i} \beta^t \left(u(c_{it}) + q_i\right) + \sum_{t\in Ta_i} \beta^t u(c_{it}) + \lambda \left(k_{0i} - m + \sum_{t\in Tn_i} y_{nit} + \sum_{t\in Ta_i} y_{ait} - \sum_{t=1}^{T} c_{it} \right), \qquad (3)$$

where u denotes utility from consumption; c denotes consumption with time subscript $t \in \{1,2,\ldots, T\}$; T denotes for the end of life; Tn (Ta) denotes periods when an individual lives in New Zealand (Australia); q denotes the utility of living in New Zealand; ko denotes the initial wealth; m denotes monetary moving cost (including the return trip with present value adjustment); y denotes income with subscript n (a) that represents income earned in New Zealand (Australia); β denotes discount rate; and λ denotes the Lagrange multiplier for the life-time budget constraint.

[38] The following analysis actually uses a stochastic version of this set-up, but the same arguments apply.

78. Assuming that the monetary cost of moving m, utility from consumption u, discount rate β, and income streams are more or less the same for all the people in the same occupational category, difference of emigration decision of each individual reflects q, his utility of living in New Zealand. Here, the wage difference represents the utility of living in New Zealand of marginal emigrants.[39] The monetary value of utility of living in New Zealand can be calculated as a present value of the wage difference for a period of living in Australia with a correction for moving costs:

Utility of living in NZ = PV of wage difference – monetary cost of moving.

79. This section calculates this value only for year 2000 for working age emigrants, who account for about 70 percent of total emigrants. The interest rate is assumed to be 6 percent, which is the average of New Zealand Treasury bond rate in 2000. Information on the 2000 tax rates is taken from the 2001 Tax Review. After applying these to hourly earnings estimates, after-tax wage differences turns out to be $NZ 6.7, $NZ 5.8, and $NZ 5.3 for the high-, mid-, and low-skilled workers. The one-way cost of moving is assumed to be either $NZ 16000 or $NZ 900; the former is the relocation payment by the New Zealand Ministry of Foreign Affairs and Trade for a single diplomat who moved out of Wellington to Canberra in 2000, and the latter is the one-way coach class airfare (full-fare ticket based on round-trip) from Auckland to Sydney in January 2002. As for the number of years that emigrants spend in Australia, there is no information, and the values are calculated for 5, 10, 15, and 20 years of residence in Australia. Since the utility loss is reported below in annualized numbers, the years of residence are relevant only to discount the price of future return tickets.

80. The upper part of Table II.2 shows the results of these calculations. Assuming a monetary cost of moving of $NZ 16000, the income difference increases steeply with the residency period. On the other hand, with $NZ 900 moving cost, there is only a small income difference between assumed residency periods. With a cost of moving of $NZ 900, the annualized income difference—the utility of living in New Zealand—for these marginal emigrants in 2000 was about $NZ 7500.[40]

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[39] In the presence of different sized income risks between New Zealand and Australia, the wage difference could be partially explained by riskiness of the income streams, but this case seems unlikely because downside risks in both countries are likely to be a similar level owing to the mutual income support arrangement between two countries.

[40] Multiplying this figure by the number of emigrants, the price to stop their emigration decision is calculated about $NZ 170 million. The total cost to bring back all emigrants who live in Australia in 2000 is about $NZ 1.3 billion, if one price is paid for all emigrants.

Elasticity of Emigration to Tax and Social Security

81. As shown in the individual maximization problem (3), with an assumption of fully developed financial markets, a $NZ 1 decrease in New Zealand wage and a $NZ 1 increase in Australia wage affects the residency decision in exactly the same way. Thus, a regression analysis of the log change of emigration flows on the difference of after-tax wage[41] between New Zealand and Australia would capture the elasticity of emigration to a tax rate change (an exogenous change in income).

82. However, three problems can be pointed out in this simple regression analysis of emigration:

- *Simultaneity problem*: In theory, the idea would be to measure the effect of an exogenous change in tax rates (or in the after-tax income) on emigration. In practice, however, the coefficient on the change in the income differential captures the factor that more migration outflow implies less number of workers, and thus causes an increase of New Zealand wage.

- *Stationarity*: The regression equation having the change of emigrant flows as the dependent variable implies that, given the fixed wage difference, the same number of people would migrate out every year. This would happen only with a homogeneous population with which the wage difference will vanish eventually. On the other hand, if a heterogeneous population in terms of preference or skills is assumed, a different equilibrium exists for each wage difference. In other words, given a fixed wage difference, emigration eventually stops, and marginal emigrants become indifferent between staying and leaving the country.[42] From this more realistic point of view, the dependent variable must not be the change in emigration flows but the change in emigration stocks.

- *Self-selection bias*: If the utility level of living in New Zealand is correlated with their wage level, the coefficient of the change in the New Zealand income (or its difference from Australia) is affected by marginal distribution of the utility level. In other words, the number of marginal emigrants at given New Zealand wage level may be increasing or decreasing with the wage. This effect would exacerbate or mitigate the effect of tax on the emigration decision.

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[41] In the following regression analysis, after-tax wages are corrected for chance of employed (i.e., one minus unemployment rate).

[42] Here, to be more precise, new inflow and outflow to working age population should be corrected.

83. In the absence of microeconomic data, these problems can only partially be overcome by making several adjustments. First, as argued above, the Australian wage affects the emigration decision exactly the same way (with the opposite sign) as the New Zealand wage. Besides, with the large labor market in Australia relative to New Zealand emigrants, there is unlikely to be a major simultaneity bias, or self-selection bias. Second, any remaining concern about the self-selection bias is likely to be mitigated by the inclusion of the gross stock of emigrants in the regression.[43] With these corrections, the coefficient of the change in the Australian wage on the change in emigration will capture the effect of marginal change in the New Zealand tax on emigration.

84. The benchmark regression equation is now written as follows:

$$d\ln L_t = \alpha_0 + \alpha_1 d\ln y_{nt} + \alpha_2 d\ln y_{at} + \alpha_3 d\ln s_{nt} + \alpha_4 d\ln r_{nt} + \alpha_5 L_t + \varepsilon_t, \qquad (4)$$

where t denotes the time subscript; n (a) denotes the location subscript, New Zealand (Australia); L denotes the gross emigration stock; y denotes hourly earnings after corrected for tax rate and unemployment rate; s denotes the ratio of social security benefits to income (i.e., social security transfer from central government to households divided by GDP); and r denotes the interest rate (on 10 year treasury bonds). The interest rate is included as a proxy for the discount rate.

85. In estimation, fourteen years of data from 1986 to 1999 are used. This small sample restricts the number of variables, and affects the hypothesis testing.[44] The tax variable is defined as the direct tax revenue of the central government from households divided by GDP. The social security variable is defined as transfers from the central government to households divided by GDP. Note that New Zealand pension system has been pay-as-you-go (i.e., social security benefits are paid from the budget each year). This implies that the tax variable is related to social security transfers, and thus regression results are also reported without the social security variable.

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[43] This gross emigration stock is estimated by adding eight years of gross flows to the 1986 net emigrants stock estimate, and adding the gross flows to this value in the following years. Below, the relationship between this gross emigration stock and its growth rate is assumed to be linear. This is a specific assumption, but necessary one to escape from one of difficulties associated with small sample size.

[44] In Table II.3, simple t-statistics are reported in parenthesis, and robust (heteroskedasticity-corrected) t-statistics are reported in square brackets. Their significance levels are determined using the Student t-distribution, not the normal distribution. The robust t-statistics are based on 5000 simulations of parametric bootstrap (Boot 3 method in Cribari-Neto and Zarkos (1999), originally from Wu (1986)), because White's estimation method for robust standard errors is inaccurate in small samples.

86. Moreover, another transfer variable is constructed to isolate the part of income transfers that is correlated with fluctuations in the unemployment rate. First, the social security variable is regressed on the unemployment rate. Then, the residual of this regression is used as a proxy for the social transfer variable and named as the pension variable.

87. Table II.3 shows results of regressions, which are summarized as follows:

- As expected, the coefficients of the emigrants stock variable are always significantly different from zero, when a constant term is included. Statistical significance of a constant term might imply that the utility distribution is well captured by the emigrant stock variable with the constant term.[45]

- Also as expected, the coefficients of New Zealand income variable are not significantly different from zero, but their signs are consistent with a view that higher New Zealand income is a negative factor for emigration.

- Coefficients of Australian income variables are always significantly different from zero. Their values are quite robust to different specifications for the regressions, broadly around 0.2 percent.

- Coefficients of the interest rate are not always significantly different from zero, but, even when not, they are close to 10 percent level of significance. With higher interest rate, the marginal migrants discount future income more, and hence income difference becomes smaller, when sizable moving costs exist. This suppresses emigration.

- Though the sign of the coefficient suggests that large transfers discourage emigration, both New Zealand transfer and pension variables are not significant in explaining emigration. This result, however, is somewhat expected. Since the population consists of contributors and beneficiaries, more transfers should discourage beneficiaries from moving out the country, and encourage contributors. In aggregate, the effect can be expected to be mixed.[46]

- Overall, the goodness of fit of the regressions is good.

Calibration of Welfare Cost of Migration and Policy Implication

88. True welfare cost is only created by distortion of incentives to emigrate. Since these distortions may be already present, this section presents estimates of the marginal change of

[45] It seems consistent with insignificant emigration stock variables without a constant term.

[46] Further analysis with more detailed data may be needed to further pin down this composition effect of social transfer on emigration.

true welfare cost for a 1 percent reduction of income tax. Let D denote the wage differential and M denote the number of emigrants (stock number). A hat denotes current values and an asterisk denotes values under a new policy. These variables without a hat or an asterisk represent hypothetical values when there is no distortion. With these notations, the current welfare cost is written[47] as $(\hat{M}-M)\hat{D}/2$, and the welfare cost after new tax rate is $(M^*-M)D^*/2$. Then, the change in the welfare cost by a new policy is given as:

$$\hat{D}(\hat{M}-M^*)/2+(\hat{D}-D^*)(M^*-M)/2. \tag{5}$$

89. Here, all variables can be computed except for the original, undistorted, level of emigrants number M. Parameterizing the last parenthesis as

$$\theta M^* = (M^*-M), \tag{6}$$

the change of welfare costs are reported under three scenarios, $\theta=1$, ½, and ¼. This parameter represents how many people have decided to emigrate because of policy distortions. For example, the last case represents the situation where three quarters of all emigrants in Australia under the new policy would still have migrated if New Zealand slashed income tax to zero.

90. The lower part of Table II.2 shows these calculations.[48] Although the results vary with moving costs, the number of planned years abroad, the elasticity of emigrants to Australian income variable, and the number of emigrants with distorted decisions, the parameter θ is the one that has the largest influence on the results. With $\theta=1$, 30 percent of the revenue loss from a 1 percent income tax reduction[49] would be compensated as the welfare gain of migration. With $\theta=$½, the number is about 14-18 percent, and with $\theta=$¼, 8-11 percent.[50]

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[47] By the same argument of the Harberger triangle, these are divided by 2.

[48] Since 1 percent change of Australian income variable is more than 1 percent change of New Zealand income change, the true magnitude on change of New Zealand income smaller. This difference was 0.63 percent in 2000. In the case of elasticity 0.21 percent to Australian income, 1 percent exogenous change of New Zealand wage would decline emigrants by 0.35 percent. Moreover, as mentioned above, the New Zealand emigrants in Australia is about two-thirds of total emigrants abroad. Using this number, Table II.2 reports estimates for welfare gain of total emigrants by 1 percent income tax reduction.

[49] A 1 percent direct tax on households (OECD data) is about $NZ 163 million.

[50] As mentioned above, the calculated welfare cost captures only the partial ones, even without considering the dead-weight loss of labor market participation. In a dynamic general

(continued...)

91. Cross-country data, Table II.4, shows that New Zealand levies the highest level of direct tax in terms of its GDP ratio among OECD countries, along with Denmark and Sweden. While New Zealand collected about 20-22 percent of its GDP in direct tax in 1990's, popular destination countries for emigrants collected substantially less. Australia and Canada's number is about 15-18 percent of GDP, while the United States and the United Kingdom collected about 12-14 percent.

92. Apart from purely economic costs, there are also fiscal costs of migration. The main concern is a free rider problem. As noted by BC-GC, "There is a risk that New Zealanders will go overseas and avoid the tax that could be expected to fund these costs, and return to New Zealand for health care or for superannuation at the cost of the New Zealand taxpayer." Although this should not be viewed as a component of the welfare cost, clearly some taxpayers see it as an undisputable cost levied by their contemporary member of the society.[51]

E. Conclusion

93. Free labor mobility does not adversely affect New Zealand nationals and immigrants. New Zealand nationals have experienced significant income growth during 1990s, which has exceeded the growth of per capita GDP growth, and which has been comparable to that achieved by residents of the United States and the United Kingdom.

94. However, emigration induced by the tax and social security system involves true economic waste. In an economy with highly mobile labor, the welfare cost of migration should be taken into consideration when reforming tax and social security system. In particular, a high income tax burden could have strongly negative effects on GDP and the welfare of the nation. As much as 8 percent to 30 percent of cut in taxes will be offset by the reduction of the welfare cost of migration. Though further investigation is needed to assess the effects of social security system on migration, it is likely the case that the current pay-as-you-go system contributes to retaining beneficiaries and providing incentives for contributors to move out New Zealand.

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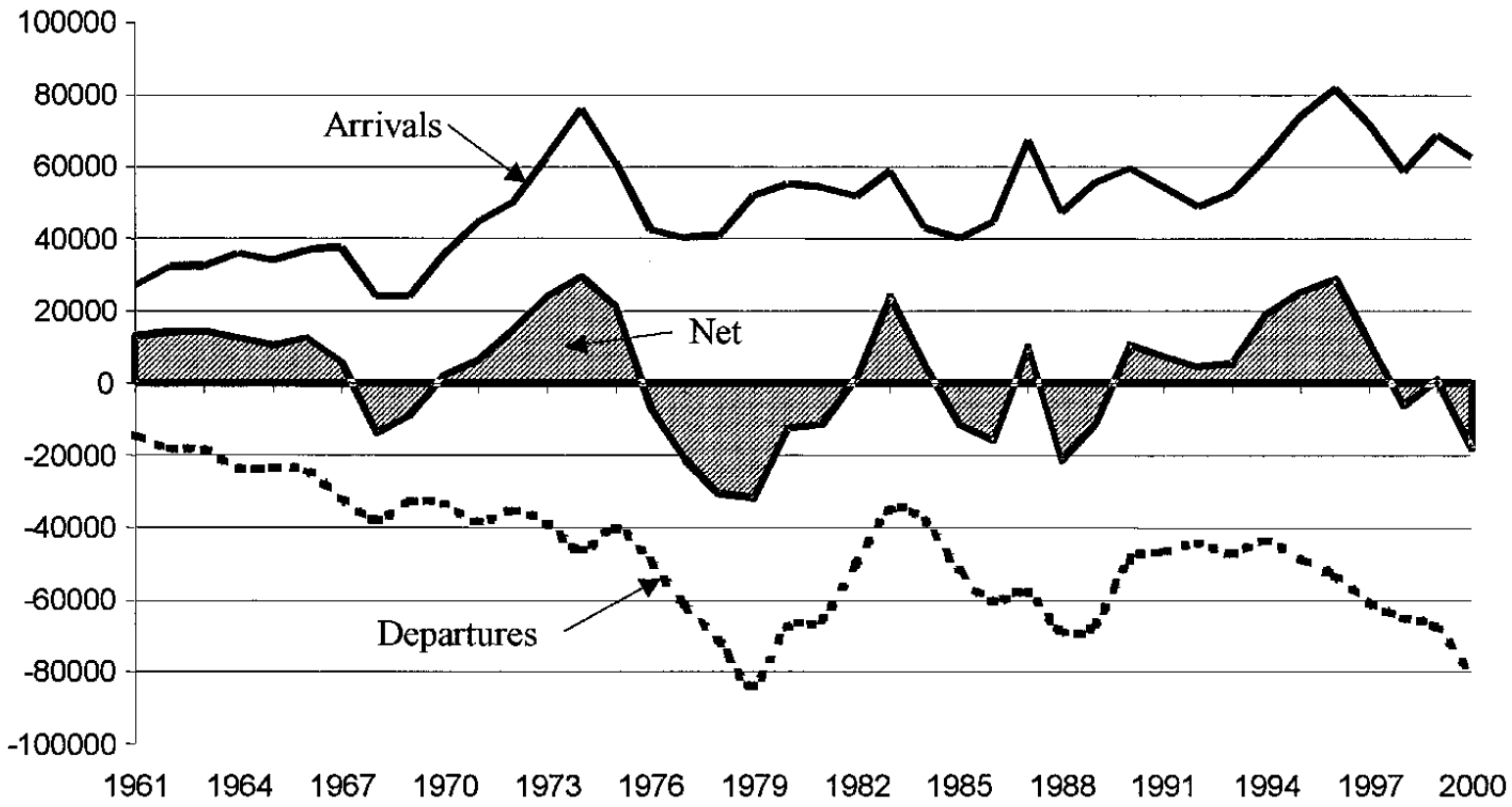
equilibrium setting, long-run effect of policy distortion would be much larger. In this sense, it may be surprising to have this large effect of welfare loss (gain) associated with tax rate.

[51] BC-GC also argue that there is a free rider problem on education, because the emigrants received highly subsidized New Zealand education service. However, this argument is not so clear as in the case of pension system. To the extent that there is an expectation that recipients of subsidized education should be future taxpayers, emigrants could entail some notional fiscal costs. In contrast, there is much less of a free rider problem, because the decision to emigrate is not directly affected by availability of subsidized education.

95. As for special incentives to attract high-skilled workers, the proposed introduction of Talent Visa, with which employers will be able to recruit high-skilled foreign individuals easily, is expected to enhance the competitiveness of New Zealand firms. Also, tax incentives for specific immigrants might be worth trying to attract high-skilled individuals, but there could be a concern about tax competition.[52] Ongoing efforts to better integrate immigrants into productive society will contribute further to the New Zealand economy and welfare.

[52] OECD (2001) concludes that the integration of labor markets within the OECD member countries appears to be proceeding via competition among host countries rather than through cooperation.

Figure II.1. Total Arrivals, Departures and Net Migration
(Years to September, adjusted data)



Source: Bushnell and Choy (2001).

Figure II.2. Hourly Earnings Index Estimates (NZ Low-Skilled = 1.0)

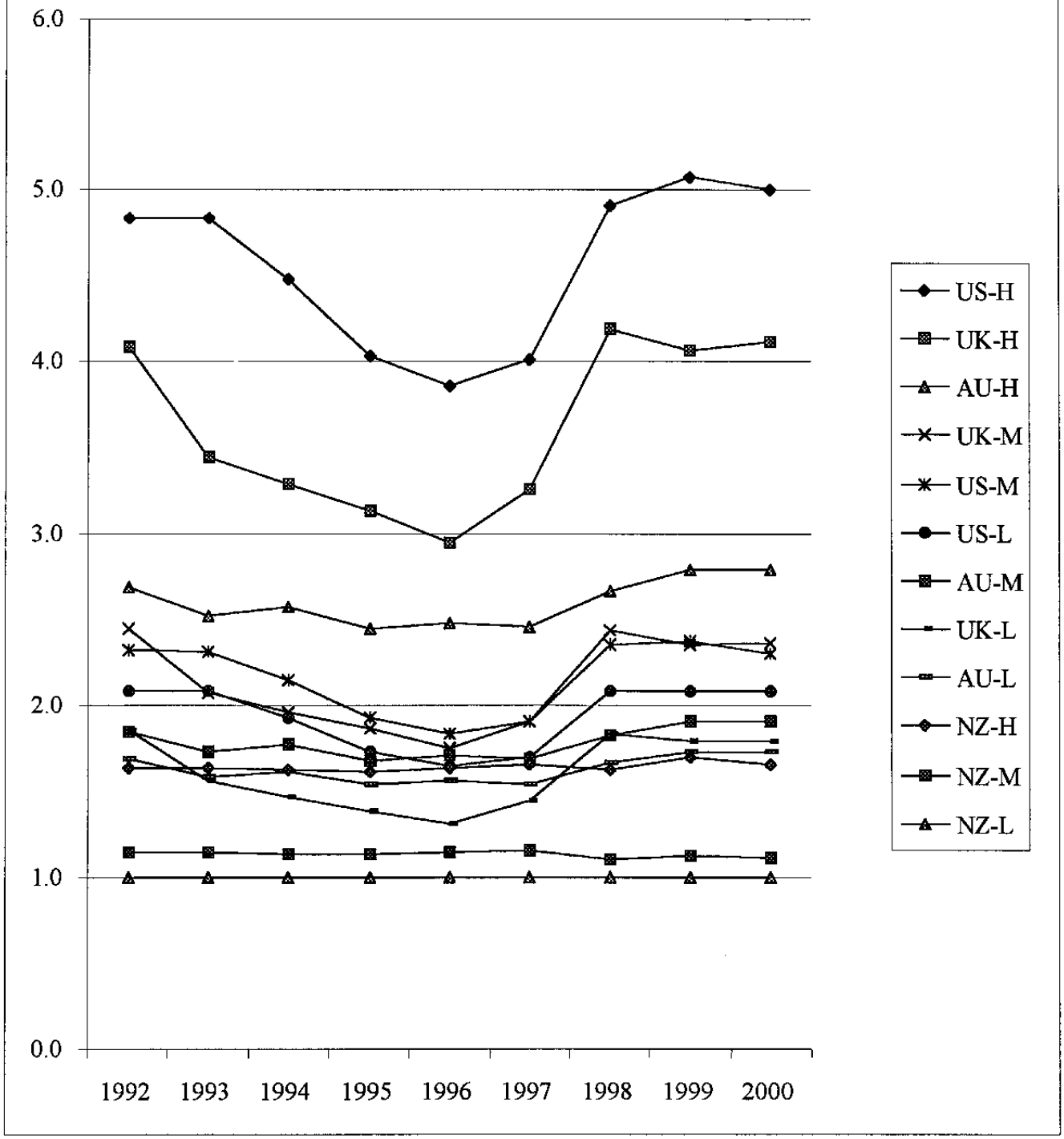


Table II.1. Gross Migration-Corrected Product

	1992	1993	1994	1995	1996	1997	1998	1999	2000	*1992-2000 Average*
					(In billions of New Zealand dollars)					
Nominal										
GMP	87.7	93.5	99.9	105.5	111.0	114.8	118.4	124.0	133.4	*109.8*
GDP	74.1	79.8	85.7	91.2	96.4	99.3	100.0	103.2	109.1	*93.2*
Quantity effect	9.8	10.3	10.7	10.8	10.9	11.5	12.7	14.3	17.0	*12.0*
Wage effect	3.8	3.4	3.5	3.5	3.7	4.0	5.7	6.4	7.2	*4.6*
Real										
GMP	92.7	96.8	102.2	106.1	109.4	112.1	114.2	120.1	126.4	*108.9*
GDP	79.0	83.1	88.0	91.7	95.0	97.1	97.0	100.7	104.5	*92.9*
Quantity effect	10.4	10.7	11.0	10.9	10.8	11.2	12.3	14.0	16.3	*11.9*
Wage effect	3.2	3.1	3.3	3.4	3.6	3.8	4.9	5.4	5.7	*4.1*
					(In thousands of New Zealand dollars)					
Real per capita										
GMP	24.0	24.8	25.9	26.6	27.1	27.5	27.6	28.6	29.6	*26.9*
GDP	22.4	23.3	24.3	25.0	25.5	25.8	25.5	26.4	27.2	*25.1*
					(Growth rate, in percentage point)					
Nominal										
GMP	n.a.	6.5	6.9	5.6	5.2	3.4	3.2	4.7	7.6	*5.4*
GDP	n.a.	7.7	7.4	6.5	5.7	3.0	0.7	3.2	5.7	*5.0*
Real										
GMP	n.a.	4.5	5.5	3.8	3.1	2.5	1.9	5.2	5.2	*4.0*
GDP	n.a.	5.2	5.8	4.3	3.6	2.2	-0.1	3.8	3.7	*3.6*
Real per capita										
GMP	n.a.	3.4	4.4	2.6	2.0	1.3	0.5	3.7	3.4	*2.7*
GDP	n.a.	3.9	4.4	2.7	2.0	1.0	-0.9	3.3	3.2	*2.5*
Memorandum items:										
Nationals growth	n.a.	1.1	1.1	1.1	1.1	1.2	1.4	1.4	1.8	*1.3*
Population growth	n.a.	1.2	1.4	1.6	1.5	1.2	0.7	0.5	0.5	*1.1*
GMP-a 1/										
Real growth	n.a.	4.5	5.5	3.8	3.1	2.5	1.9	5.2	5.2	*4.0*
Real per capita growth	n.a.	3.4	4.4	2.6	2.0	1.3	0.5	3.7	3.4	*2.7*
GMP-b 1/										
Real growth	n.a.	4.5	5.5	3.8	3.1	2.5	1.8	5.2	5.2	*4.0*
Real per capita growth	n.a.	3.4	4.4	2.6	2.0	1.3	0.5	3.7	3.4	*2.7*

Source: Staff estimates.

1/ While benchmark GMP is calculated under the assumption that half of the unknown-occupation immigrants from developing countries are low-skilled, and other half has the same occupational distribution as the known ones, GMP-a is calculated under the assumption that they are all low-skilled, and GMP-b is under the assumption that all of them have the same occupational distribution as the known ones.

Table II.2. Welfare Cost for NZ Emigrants in 2000

Expected Period of Residency in Australia	$16000 Moving Cost				$900 Moving Cost			
	5-Year	10-Year	15-Year	20-Year	5-Year	10-Year	15-Year	20-Year
Gross market-valued cost								
	(In New Zealand dollars)							
Cost per emigrant who left for Australia in 2000	2404	4716	5556	5977	7344	7474	7521	7545
	(In millions of New Zealand dollars)							
Total cost for emigrants who left for Australia in 2000	54.9	107.6	126.9	136.4	167.6	170.6	171.7	172.2
Total cost for all emigrants who live in Australia in 2000	422.2	836.9	987.6	1063.2	1308.2	1331.6	1340.0	1344.3
Welfare gain by 1 percent income tax reduction								
(i) Gain for all emigrants with elasticity to AUS income 0.15	45.3	46.9	47.4	47.8	48.7	48.8	48.8	48.8
Ratio to 1 percent tax reduction (percentage point)	*27.8*	*28.8*	*29.1*	*29.3*	*29.9*	*29.9*	*29.9*	*30.0*
(ii) Gain for all emigrants with elasticity to AUS income 0.22	45.9	48.1	48.9	49.4	50.7	50.8	50.8	50.9
Ratio to 1 percent tax reduction (percentage point)	*28.1*	*29.5*	*30.0*	*30.3*	*31.1*	*31.2*	*31.2*	*31.2*
(iii) Gain for half of emigrants with elasticity to AUS income 0.15	23.5	25.1	25.6	25.9	26.9	27.0	27.0	27.0
Ratio to 1 percent tax reduction (percentage point)	*14.4*	*15.4*	*15.7*	*15.9*	*16.5*	*16.5*	*16.6*	*16.6*
(iv) Gain for half of emigrants with elasticity to AUS income 0.22	24.1	26.3	27.2	27.6	28.9	29.0	29.1	29.1
Ratio to 1 percent tax reduction (percentage point)	*14.8*	*16.2*	*16.7*	*16.9*	*17.7*	*17.8*	*17.8*	*17.8*
(v) Gain for quarter of emigrants with elasticity to AUS income 0.15	12.6	14.2	14.7	15.0	16.0	16.1	16.1	16.1
Ratio to 1 percent tax reduction (percentage point)	*7.7*	*8.7*	*9.0*	*9.2*	*9.8*	*9.9*	*9.9*	*9.9*
(vi) Gain for quarter of emigrants with elasticity to AUS income 0.22	13.2	15.5	16.3	16.7	18.0	18.1	18.2	18.2
Ratio to 1 percent tax reduction (percentage point)	*8.1*	*9.5*	*10.0*	*10.2*	*11.0*	*11.1*	*11.2*	*11.2*

Source: Staff estimates.

Table II.3. Regression Results 1/

	Constant	NZ Income	AU Income	NZ Transfer	NZ Pension	NZ Interest	NZ Emigrant Stock	*Adj. R^2*
(i)	0.13	-0.03	0.15	n.a.	n.a.	-0.12	-0.35	*0.90*
	(3.53**)	(-0.73)	(3.73**)	n.a.	n.a.	(-1.72)	(-3.00**)	
	[2.41**]	[-0.54]	[4.43**]	n.a.	n.a.	[-1.55]	[-2.03*]	
(ii)	0.11	0.00	0.15	0.19	n.a.	-0.15	-0.32	*0.90*
	(2.88**)	(-0.05)	(3.66**)	(0.90)	n.a.	(1.89)	(-2.56**)	
	[2.55**]	[-0.05]	[3.48**]	[0.76]	n.a.	[-2.09*]	[-2.14*]	
(iii)	0.12	-0.03	0.16	n.a.	0.08	-0.13	-0.35	*0.89*
	(3.24**)	(-0.61)	(3.53**)	n.a.	(0.35)	(-1.65)	(-2.79**)	
	[2.39**]	[-0.47]	[3.84**]	n.a.	[0.31]	[-1.72]	[-2.03*]	
(iv)	n.a.	-0.03	0.22	n.a.	n.a.	-0.22	0.05	*0.78*
	n.a.	(-0.41)	(3.85**)	n.a.	n.a.	(-2.10*)	(1.07)	
	n.a.	[-0.30]	[3.56**]	n.a.	n.a.	[-1.98*]	[1.42]	
(v)	n.a.	0.04	0.20	0.43	n.a.	-0.24	0.03	*0.81*
	n.a.	-0.49	(3.73**)	(1.56)	n.a.	(-2.49**)	-0.66	
	n.a.	[0.30]	[3.03**]	[1.06]	n.a.	[-1.99*]	[0.54]	
(vi)	n.a.	-0.02	0.22	n.a.	0.20	-0.23	-0.04	*0.76*
	n.a.	(-0.29)	(3.68**)	n.a.	(0.56)	(-2.10*)	(-0.90)	
	n.a.	[-0.21]	[3.17**]	n.a.	[0.74]	[-2.01*]	[1.02]	

	Constant	NZ Unemployment Rate	*R^2*
Memorandum item:			
First Stage Regression of NZ transfer	0.00	0.13	*0.46*
on NZ unemployment rate	(0.41)	(2.85**)	
	[0.41]	[3.00**]	

Source: Staff estimates.

1/ Numbers reported in parenthesis are standard t-statistics, and those in square brackets are t-statistics, corrected for heteroskedasticity using parametric bootstrap.
Two stars ** means more than 5 percent significance level, and one star * means more than 10 percent.

Table II.4. General Government: Taxes on Income, Profits, and Capital Gains for OECD Countries, 1990-99

(In percent of GDP)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Australia	16.8	15.5	15.0	14.8	15.6	16.3	16.9	16.9	17.5	...
Austria 1/	10.3	10.8	11.3	11.5	10.5	11.1	12.1	12.7	13.0	12.7
Belgium 1/	16.2	15.9	15.8	15.7	17.1	17.3	17.4	17.8	18.0	17.6
Canada	17.5	17.2	16.1	15.7	15.8	16.5	16.9	18.0	18.2	...
Czech Republic	...	...	...	10.9	10.3	9.9	9.2	8.5	8.9	8.4
Denmark 1/	27.6	27.8	28.3	29.4	30.4	30.0	30.2	30.1	29.3	29.8
Finland 1/	19.3	19.1	19.6	17.1	18.9	18.0	19.7	19.1	19.1	19.1
France 1/	6.9	7.3	6.9	7.1	7.1	7.1	7.6	8.2	10.5	11.0
Germany 1/	10.6	11.7	12.1	11.7	11.3	11.6	10.7	10.4	10.9	11.2
Greece 1/	5.8	5.9	5.8	5.9	6.8	7.2	7.1	7.7	...	...
Hungary	...	12.7	10.0	9.6	9.2	8.9	9.0	8.5	8.7	8.6
Iceland	9.2	9.1	9.5	10.2	10.3	10.6	11.2	11.3	13.0	13.8
Ireland 1/	12.4	13.1	13.4	13.9	14.3	13.0	13.5	13.6	13.4	13.7
Italy 1/	14.2	14.2	15.7	16.3	14.4	14.5	14.8	15.7	13.9	15.5
Japan	15.0	14.2	12.3	11.6	10.5	10.4	10.3	10.2	9.1	8.2
Korea	6.2	5.4	6.1	5.9	6.2	6.5	6.5	5.9	6.9	6.3
Luxembourg 1/	16.0	14.8	13.5	15.2	16.1	16.2	16.9	16.3	15.9	15.2
Mexico	4.7	4.7	5.2	5.5	5.2	4.1	4.0	4.6	4.7	4.9
Netherlands 1/	13.8	15.1	14.1	14.7	12.0	11.1	11.2	10.9	10.6	...
New Zealand	22.0	20.4	20.8	21.4	22.0	22.8	21.0	21.4	20.2	...
Norway	14.7	15.0	13.4	13.5	14.3	14.6	15.0	16.1	16.2	15.0
Poland	...	8.3	12.3	13.5	12.5	12.2	11.7	11.4	11.2	...
Portugal 1/	7.6	8.5	9.5	8.6	8.4	8.6	9.3	9.6	9.9	10.0
Spain 1/	10.1	10.3	10.3	10.0	9.5	9.6	9.4	10.0	9.6	9.9
Sweden 1/	22.4	19.2	18.8	19.8	20.7	19.7	20.4	21.2	21.2	21.4
Switzerland	12.8	12.6	13.0	12.6	13.2	12.6	13.0	12.6	13.3	12.8
Turkey	6.7	7.3	7.3	7.3	6.6	6.4	6.7	7.6	9.4	9.8
United Kingdom 1/	14.2	13.4	12.3	11.6	12.0	12.8	12.8	13.1	14.3	14.3
United States	12.1	11.9	11.6	12.0	12.2	12.6	13.2	13.7	14.3	...
Unweighted average	13.3	12.9	12.9	12.9	12.9	12.8	13.0	13.2	13.6	13.1

Source: Revenue Statistics Database (OECD).

1/ European Union countries.

METHODOLOGY AND DATA ISSUES TO CALCULATE GMP

To simplify the calculation of GMP further from the definition (2), this paper ignores the difference of demography, the labor force participation and the unemployment rate for emigrants in countries other than Australia, the United Kingdom, and the United States, and for immigrants from industrial countries. This assumption changes (2) to

GMP = GDP

+ income of emigrants in Australia, the United Kingdom, and the United States

+ GDP per capita × emigrants in other countries

– income of immigrants from developing countries

– GDP per capita × immigrants from industrial countries. (A1)

Income of each emigrant worker in Australia, the United Kingdom, the United States can be written as sum of New Zealand's GDP per worker and the wage difference between New Zealand and these three countries. Total income of emigrants in Australia, the United Kingdom, and the United States is defined by multiplying the number of emigrant workers by the income of each emigrant worker. Similarly, income of each immigrant from developing countries can be represented as sum of GDP per worker and wage differences. Hence, equation (A1) is now written as

GMP = GDP

+ GDP per capita × total number of emigrants

– correction for workers population for emigrants in Australia, the United Kingdom and the United States

+ wage difference × emigrants in Australia, the United Kingdom and the United States

– GDP per capita × total number of immigrants

+ correction for workers population for immigrants from developing countries

– wage difference × immigrants from developing countries (A2)

It is also useful for analytical purposes to decompose the difference between GMP and GDP into quantity and wage effects:

GMP = GDP + Quantity Effect + Wage Effect, (A3)

where

Quantity effect ≡ GDP per capita × total number of emigrants

– correction for workers population for emigrants in Australia, the United Kingdom and the United States

– GDP per capita × total number of immigrants

+ correction for workers population for immigrants from developing countries, (A4)

and

Wage effect ≡ wage difference × emigrants in Australia, the United Kingdom and the United States

– wage difference × immigrants from developing countries. (A5)

Since GMP is a variant of GDP with correction terms, compensation for employees[53] in the national accounts is the income concept suitable for this paper's analysis. However, there are several difficulties in obtaining suitable earnings data:

- The occupational breakdown of the compensation is not available for the relevant countries.
- Although the labor cost index by occupation is available, statistics are not completely comparable due to definitional differences. Moreover, it is often the case that only index numbers, not underlying level data, are available.
- International Labor Organization (ILO) had a major revision of occupational classification in 1988 from its 1968 version. Under the revised one, occupations are supposed to be classified according to skills. Each country has been adopting this classification gradually over time. New Zealand has adopted it partially in 1990, and last updated 1996. Australia has adopted it in 1996, and the United Kingdom in 1991. The United States has not, but provides detailed data. However, the detailed data from other countries are not usually available, and subcategories are sometimes defined slightly different ways, even though their names are the same.

Although labor costs are not available for all occupational categories, the U.S. Bureau of Labor Statistics (BLS) does provide a comparable data on international labor costs for

[53] Compensation for employees is calculated based on labor costs in a broad sense, not only wage, but also benefits such as employers' payment of social security contribution for their employees.

production workers from 1975-1999 using market exchange rates. For GMP calculation in this paper, occupations are classified into three categories based on required skills/educations in the ILO 1988 classification—high-skilled for category 1 (managers and legislators) and category 2 (professionals), low-skilled for category 8 (production workers) and category 9 (elementary workers), and medium-skilled for the remaining categories. BLS data is used as hourly earnings for low-skilled workers, and then the hourly earnings data for high- and middle-skilled workers are constructed using individual country data.[54]

Another component to calculate GMP is the emigrants (immigrants) who currently live in foreign countries (New Zealand). Since only flow data is available, the stock numbers of migrants needs to be estimated. According to an estimate of Statistic New Zealand, which is reported in Bushnell and Choy (2001), about 15 percent of New Zealand population lived outside of the country in 2000—10 percent in Australia, 1.5 percent in the United Kingdom, and 0.5 percent in the United States and Canada. Using this stock estimate, the number of emigrants living in each country in each year is "back cast" using each year's flow. The occupational composition at the end of 2000 is assumed to be the same as average of occupational composition of emigration flows from 1992-2000. There is no information about the naturalization rate of emigrants in destination countries. However, with the presence of a pay-as-you-go pension system, together with Australia's admission of dual citizenship, and the United Kingdom's granting work permit for those with British grandparents, naturalization rates should be quite low. Indeed, the assumption of a very low naturalization rate is needed to generate emigration stock estimates that are consistent with the recent surge of emigration flows. Thus, this paper assumes zero naturalization rate of emigrants.

All immigrants are able to apply for New Zealand citizenship after three years of residency. As is the case with emigrants, there is no information available about how many of them apply after three years. Immigrants from developing countries, however, are likely to apply for it to access the same benefits that the New Zealand nationals access.[55] Hence, this paper assumes all immigrants become New Zealand citizens three year after they arrive. Note that GMP will be underestimated if some immigrants do not apply for citizenship after three years.

As noted above, there are a number of people who do not report about their occupation. For the purpose of calculating GMP, assumptions need to be made about the occupations of the

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[54] In some cases, either interpolation or extrapolation is needed for missing values with additional information. Tables II.I.1 and Table II.I.2 summarize the data sources and occupational codes for each country.

[55] Immigrants can access to compulsory education and student loans immediately after they arrive, and to welfare benefits after two years of legal residency. The only effective change that comes with citizenship is a NZ passport, which includes free entry to Australia.

large unreported group. This paper assigns the same distribution of occupations as those who report to the half of the unreported immigrants from developing countries. The other half are all assumed to be low-skilled. For all unreported emigrants to Australia, the United Kingdom, and the United States, their occupation are assumed to have the same distribution as those who do report. To check its robustness, two alternative cases are reported: (i) half of the emigrants to Australia, the United Kingdom, and the United States are assumed to be low-skilled, and (ii) all the immigrants from developing countries has the same distribution of occupations as those who report. As it turned out, the assumed distributions make almost no difference to the empirical results.

Table II.1.1. Classifications of Occupations

Name of Classification System	Skill 1/	ILO ISSCO88	New Zealand NZSCO90 (Minor update in 95 and 99)	Australia ASCO Second Edition (Introduced in 1996, major change from the first edition)	United Kingdom SOC1990 (Minor update to SOC2000)	United States NCS-SOC 4/
Major Group 1	n.a.	Legislators, Senior Officials and Managers	Legislators, Administrators and Managers	Managers and Administrators	Managers and Administrators	Executive, Administrative, and Managerial
Major Group 2	4	Professionals	Professionals	Professionals	Professional Occupations	Professional Specialty 4/
Major Group 3	3	Technicians and Associate Professionals	Technicians and Associate Professionals	Associate Professionals	Associate Professional and Technical Occupations	Technical
Major Group 4	2	Clerks	Clerks	Advanced Clerical and Service Workers 2/	Clerical and Secretarial Occupations	Administrative Support including Clerical
Major Group 5	2	Service Workers and Shop and Market Sales Workers	Service and Sales Workers	Intermediate Clerical, Sales and Service Workers 2/; Elementary Clerical, Sales and Service Workers 2/	Personal and Protective Service Occupations 3/; Sales Occupations 3/	Sales; Service
Major Group 6	2	Skilled Agricultural and Fishery Workers	Agriculture and Fishery Workers	Omitted. (Farmers and Farm Managers are included in Major Group 1, and Skilled Agricultural and Horticultural Workes are in Major Group 7.)	Omitted. (Farmers and Farm Managers are included in Major Group 1, and other workes are in Major Group 9.)	Farmers are excluded. (Nonfarm agricultural workers and their supervisors are included in major group 9.)
Major Group 7	2	Craft and Related Trades Workers	Trades Workers	Trades Persons and Related workers	Craft and Related Occupations	Precision Production, Craft, and Repair
Major Group 8	2	Plant and Machine Operators and Assemblers	Plant and Machine Operators and Assemblers	Intermediate Production and Transport Workers	Plant and Machine Operatives	Machine Operators, Assemblers, and Insectors; Transportation and Material Moving
Major Group 9	1	Elementary Occupations	Elementary Occupations (Elementary laboreres in agricultural and manufacturing, if any, are included in Major Group 6 and 8 (or 7), respectively.)	Labourers and Related Workers	Other Occupations	Handlers, Equipment Cleaners, Helpers, and Laborers (Street vendors are included in Major Group 5, and cleaning and building services worker are included in Major Group 5.)
Major Group 0	n.a.	Armed Forces	Omitted. (Armed Forces are included in Major Group 5.)	Omitted. (Armed Forces are basically classified together with their civillian equivalents.)	Omitted. (Armed Forces are included in Major Group 1.)	Excluded.

Sources: *International Standard Classification of Occupations*, ILO, 1990: "Establishment of Community-Wide Occupational Statistics," Peter Elias and Margaret Birch, IER, University of Warwick, (The Statistical Office of the European Communities), 1994; "New Zealand Standard Classification of Occupations *(1999)," www.stats.govt.nz.; Australian Standard Classification of Occupations Second Edition*, W. McLennan, Australian Bureau of Statistics, 1997; U.K. Standard Occupational Classification Codes 1995 and 2000, available at www.statistics.gov.uk; and U.S. National Compensation Survey home page, www.bls.gov/ncs, and private correpondence from BLS.

1/ According to ILO (1990), basically, 1 stands for elementary school education, 2 for some level of high school education, 3 for higher than high school but not equivalent to university degree, and 4 for university degree or higher. Major group 1 and 0 are not assigned their skill level. See further discussions in ILO (1990) and Elias and Birch (the Statisical Office of the European Communities, 1994).

2/ ASCO Second Edition does not distingush between ISCO88's Major Group 4 and 5. Instead, ASCO has three different skill-based classification: Advanced Clerk and Service Workers; Intermediate Clerk, Sales and Service Workers; and Elemetary Clerk, Sales and Service Workers.

3/ SOC1990 distinguishes these two occupations.

4/ U.S. classsification system is quite different from ISCO88, but has detailed classifications. Each survey has slightly different grouping, and this table follows the classification used in the National Compensation Survey. It excludes farmers and armed forces. Professional speciality includes some of associate professionals. One of the big difference lies in Major Group 9. It includes agricultural workers together with their supervisors. However, it does not include typical cleaning and building service occupations, which are included in Major Group 5 together with their supervisors. This classification system gives downward bias on wages of skill level 4, 3, and 2, and upward bias on 1.

Table II.1.2. Data for Estimates of Occupational Earnings Curve

	International	New Zealand	Australia	United Kingdom	United States
Estimation Method	BLS data is used to compare hourly compensation of production workers in manufacturing. Among countries, it is better to compare on compensation rather than wage, because fringe benefits are systematically different among countries (but not within a country).	Income Survey data is used for relative earnings after 1997. Before 1997, earnings changes are assumed to be the same as Labour Cost Index. Each year's number of employed data is used to calculate weighted average for each year.	Labour Statistics data is used for relative earnings in 1996. After 1996, earnings changes are assumed to be the same as Wage Cost Index. Number of employed data of 1996 is used to calculate weighted average before 1996, and 1999 for 2000 calculation.	Straightfoward from the data	National Compensation Survey data is used for relative earnings after 1997. Before 1997, earnings changes are assumed to be the same as Employment Cost Index. Each year's number of employed data is used to calculate weighted average for each year.
Earnings Level Data					
Data Name	n.a.	Income Survey	Employee Earnings and Hours	New Earnings Survey	National Compensation Survey
Periods available		Annually, 1997-present	Annually, 1996-present 2/	Annually, 1991-present	Annually, 1997-present
Data series used for this paper	n.a.	Total mean hourly earnings from wage and salaried jobs	Total average weekly earnings, full-time employee 3/	Total mean hourly earnings	Mean hourly earnings, private industry and State and local government 5/
Earnings Change Data					
Data Name	BLS 1/	Labour Cost Index	Wage Cost Index	n.a.	Employment Cost Index
Periods available	1975-1999	Quarterly, March 1991-present	Quarterly, September 1997-present	n.a.	Annually, 1986-present
Data series used for this paper	Hourly compensation	Salary and ordinary wage	Total hourly wage, excluding bonuses	n.a.	Hourly compensation
Employment Data					
Data Name	n.a.	Household Labour Force Survey	ILO database 4/	Labour Force Survey	ILO database 4/
Periods available		Quarterly, March 1991-present	1996-1999 2/	Annually, 1985-present	1990-1999 6/
Data series used for this paper	n.a.	Number of employed	Number of employed	Number of employed	Number of employed

1/ International Comparisons of Hourly Compensation Costs for Production Workers in Manufacturing, 1975-1999. Supplementary Tables for BLS News Release USDL00-25, September 7, 2000.
2/ Data before 1996 are also available, but they use older and quite different version of classification of occupation--ASCO first edition or ISCO68.
3/ Part-time workers' weekly earnings are available, but substantially lower than full-timers'. Part-timers' hours worked data are not available in each occupation. Weekly earnings data are corrected to hourly earnings data using hours worked data for each occupation.
4/ Data is submitted from national authorities. Data is available at www.ilo.org.
5/ Excludes tips and overtime pay. Also excludes farmers and federal government employees such as armed forces.
By excluding tips, earnings of service workers (skill level 2) is under-estimated.
6/ National Compensation Survey gives 2000 number of employed. This 2000 NCS's relative sizes between professional and technical, and among crafts, machine operators, and transportation are applied for the previous years, where ILO data does not provide these breakdowns due to ISCO68 classification.

References

Auckland City, 2001, "Asian Communities Needs," Report to the City Advocacy Committee, Auckland City, June 13, 2001.

Basu, Susanto and John G. Fernald, 1996, "Returns to Scale in U.S. Production: Estimates and Implications," Board of Governors of the Federal Reserve System, International Finance Discussion Papers No. 546.

Beine, Michel, Frédéric Docquier, and Hillel Rapoport, 2001, "Brain Drain and Economic Growth: Theory and Evidence," *Journal of Development Economics*, Vol. 64, pp. 275-289.

Bushnell, Peter, and Wai Kin Choy, 2001, "Go West, Young Man, Go West!?," New Zealand Treasury Working Paper 01/07.

Cribati-Neto, Francisco, and Spyros G. Zarkos, 1999, "Bootstrap Methods for Heteroskedastic Regression Models: Evidence on Estimation and Testing," *Econometric Reviews*, Vol. 18, pp. 211-228.

Glass, Hayden, and Wai Kin Choy, 2001, "Brain Drain or Brain Exchange?" New Zealand Treasury Working Paper 01/22.

Hatton, Timothy J., "A Model of U.K. Emigration, 1870-1913," *The Review of Economics and Statistics*, Vol. 77, pp. 407-415.

Jones, Charles I., 1998, "Growth: With or Without Scale Effects?," *American Economic Review*, Vol. 89, pp 139-44.

Klenow, Peter J., and Andrés Rodríguez-Clare, 1997, "The Neoclassical Revival in Growth Economics: Has It Gone Too Far?," *NBER Macroeconomics Annual*, pp 73-102.

Mountford, Andrew, 1997, "Can a Brain Drain be Good for Growth in the Source Economy?," *Journal of Development Economics*, Vol. 53, pp. 287-303.

Organization for Economic Co-operation and Development, 2001, "The Employment of Foreigners: Outlook and Issues in OECD Countries," Chapter 5, *Employment Outlook.*

Tokarick, Stephen, 1999, "Brain Drain from Canada to the United States," Chapter V, *Canada: Selected Issues*, IMF Staff Country Report, No. 99/14.

Wu, C.F.J., 1986, "Jacknife, Bootstrap, and Other Resampling Methods in Regression Analysis," *Annals of Statistics*, Vol. 14, pp 1261-1295.

III. Exchange Rate Pass-Through and Inflation in New Zealand[56]

A. Introduction and Summary

96. The main question motivating this paper is the extent to which fluctuations in exchange rates affect inflation. This topic has been subject to considerable debate and remains a major concern in the conduct of monetary policy. Over the past decade, most of the advanced economies have achieved a remarkable stabilization of inflation at very low rates despite wide fluctuations in exchange rates and import prices. While many competing explanations have been put forward—from favorable price shocks (such as that associated with the Asian crisis) to structural changes (such as information technology and inventory management)—Taylor (2000) argues that, in a low-inflation environment, firms tend to reduce the degree to which they "pass through" cost and price increases due to exchange rate movements. This hypothesis would suggest that domestic inflation may be permanently rather than transitorily insulated from fluctuations in exchange rates and foreign prices, which may have important consequences for monetary policy.

97. In line with the experience in large advanced economies, inflation in New Zealand has been low and relatively stable during the past decade. However, in contrast to the experience in some of the large advanced economies (mainly the United States), where exchange rate shocks were primarily disinflationary, exchange rate shocks in New Zealand seem to have been largely of an inflationary nature since 1997. For a small open economy like New Zealand, it is somewhat puzzling that such large changes in the exchange rate have not been passed on fully to domestic prices.

98. Several factors may have contributed to change the price-setting behavior:

- First, the commitment to keep inflation low, together with the high credibility of the inflation targeting framework, may have induced firms to change their price-setting behavior. Inflation targeting limits firms' "pricing power" by reducing permanently their room to accommodate changes in costs or by inducing them to pass these changes less quickly onto prices. As noted by Taylor, a low inflation environment would lower the perceived persistence of changes in costs, and therefore, limit the pass-through of changes in costs associated with exchange rate fluctuations.

- Second, New Zealand underwent significant structural reforms during the late 1980s and early 1990s which may have heightened the uncertainty about the equilibrium level and growth rate of potential output and the equilibrium exchange rate. Increased uncertainty on the underlying strength in domestic economic conditions and the business cycle may have influenced firms' decisions on profit margins and the extent

[56] Prepared by Martin Cerisola (x38314) who is available to answer questions.

of pass-through, as they may have become less inclined to pass-through changes in costs—especially those caused by exchange rate changes—onto prices.

- Third, the volatility of the exchange rate and the nature of the exchange rate shocks seem important, as firms facing highly volatile exchange rates would likely tend to smooth the adjustment on domestic prices.

- Fourth, increased competitive pressures in sectors (such as retail) may also have limited the ability of firms to pass-through these fluctuations.

- Finally, the lack of exchange rate pass-through may have only been a "mirage" in the sense that firms may have been able to absorb changes in costs induced by an exchange rate depreciation because of cost savings arising from the use of new technology and productivity gains.

99. This paper explores empirically the role of supply, demand, and exchange rate shocks in driving fluctuations in inflation in New Zealand. In particular, the estimation aims at assessing these effects, especially those associated with exchange rate pass-through, at different stages of the distribution chain: import prices and consumer prices. The exchange rate pass-through to import prices (the "first stage" pass-through) and from import prices to consumer inflation (the "second-stage" pass-through) are assessed using error correction models in the context of a "long-run PPP hypothesis" and a "mark-up model," such as those of de Brouwer and Ericsson (1995) and Dwyer and Leong (2001), respectively. The paper assesses the second-stage pass-through following a somewhat different approach, by estimating explicitly the direct impact of exchange rate changes, rather than import price changes, on consumer price inflation. In addition, the paper presents additional evidence on whether these effects have differed across tradable and nontradable goods. The empirical evidence for New Zealand is compared with that for Australia and Canada.

100. The paper shows that the exchange rate pass-through to consumer prices has varied considerably during the 1990s in New Zealand. While the estimated models explain the fluctuations in inflation and the impact of the exchange rate reasonably well, this relationship appears to be far from clear across countries. Nevertheless, some important conclusions can be drawn:

- The three economies experienced a small exchange rate pass-through to import and consumer prices during the 1990s. The first and second stage pass-through has fluctuated significantly during the 1990s, particularly in New Zealand.

- The decline in the short-term exchange rate pass-through to import and consumer prices in New Zealand appears to have been largely transitory in nature and may be attributed to the impact of sequential and highly persistent shocks. Moreover, the recent rebound in the short-term exchange rate pass-through seems to be primarily a tradable-good phenomenon, and in the case of New Zealand, it does not appear to be

related to changes in the conduct of monetary policy that were introduced in early 1999.

- The small exchange rate pass-through to domestic inflation reflects a "decoupling" of non-tradable goods inflation from the exchange rate, which may be partly explained by the high credibility of the inflation targeting framework. This seems to be particularly the case in New Zealand, where permanent shocks to the exchange rate do not appear to have had major impact on non-tradable good inflation.

- Positive supply shocks, particularly a subdued growth in unit labor costs, have helped to contain inflation by increasing the scope to absorb large exchange rate fluctuations; a common feature in the three economies.

101. This paper is organized as follows: the next section reviews the main stylized facts of the exchange rate pass-through to inflation in New Zealand, and compares it with those of Australia and Canada; section C describes the empirical methodology and the main estimation results; section D briefly discusses their implications for the conduct of monetary policy in New Zealand.

B. Stylized Facts on the Exchange Rate Pass-Through

102. Following the adoption of inflation targeting in New Zealand, measuring and forecasting the impact of changes in the exchange rate on domestic prices became very important for conducting monetary policy. As noted by the Reserve Bank of New Zealand (1999), the "direct effect" of the exchange rate on inflation declined markedly during the 1990s, a phenomenon that has also been observed in other advanced open economies, such as Australia and Canada. This has raised some questions about the underlying factors driving the lack of pass-through, its sustainability over time, and the implications for inflation.[57]

103. The first stage pass-through appears to have varied considerably in New Zealand and Canada, but less so in Australia (Figure III.1). In the case of New Zealand, the exchange rate experienced wide fluctuations since 1993, but import prices did not vary as much. The exchange rate appreciated markedly between 1994 and mid-1997, but import prices remained largely unchanged. In the wake of the Asian crisis, the sharp depreciation was not followed by a similar rise in import prices. However, since mid-1999, the 12-month percent change in the exchange rate and import prices has been very similar. In the case of Canada, there are

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[57] For example, the Reserve Bank of New Zealand (RBNZ, 2000) notes that "...while the first stage of pass-through (from the exchange rate to import prices) was very much dampened between 1994 and 1999, it seems to have returned in the third and fourth quarter of 2000...At the second stage of pass-through (from import prices to consumer prices), the pass-through relationship is even less clear...."

some episodes in the past where the pass-through to import prices also appears to have been significantly less than expected. However, since early 2000, fluctuations in the exchange have been largely similar to those in import prices. As for Australia, there seems to be less of a divergence between exchange rate and import price fluctuations.

104. The second-stage pass-through has also varied substantially during the 1990s and seems to have been significantly smaller than for import prices across the three economies (Figure III.2). The second-stage pass-through in New Zealand appears to have been largely absent between mid-1991 and late 1999. Since early 2000, the correlation between inflation in import and consumer prices increased sharply. In Australia, the correlation between fluctuations in import and consumer prices has also risen markedly since the second half of 1999. In Canada, the pass-through to consumer prices has been muted, as the correlation between the 12-month change in import prices and core consumer prices (excluding energy and other volatile components) has remained low.

105. A closer examination of the second-stage pass-through to tradable and nontradable consumer prices in New Zealand shows that tradable goods inflation remained largely stable despite wide fluctuations in import prices throughout most of the 1990s, while inflation in nontradable goods seems to have been closely associated with the trend in the output gap (Figure III.3). Between mid-1991 and mid-1999, tradable good inflation stabilized at about 1 percent (12-month rate), only to accelerate to 5 percent by end-2000. In contrast, inflation in nontradable goods has been more volatile and seems to have been determined by "demand-pull" conditions, particularly since early-1993, as the correlation between the output gap and nontradable good inflation stood at 80 percent.

C. Some Casual Empiricism on the Underlying Factors

106. The decline in exchange rate pass-through might seem to be puzzling because these economies have experienced a marked increase in "import penetration" since the late 1980s. Between 1987 and 2000, the increase in import penetration has been broadly similar between New Zealand and Australia, although it was still higher in New Zealand by end-2000. Canada has experienced the fastest growth in import penetration during this period, largely reflecting the effects of trade liberalization under the FTA and NAFTA, with the average share of imports being almost twice as high as in Australia and roughly 30 percent higher than in New Zealand. The rise in

A Comparison of Imports to Domestic Demand
(In percent)

	New Zealand	Australia	Canada
1987-2000 1/	27.2	18.1	32.7
1987-1990 2/	23.3	15.3	25.9
1991-1996 3/	27.1	17.7	31.4
1997-2000 4/	30.9	21.4	40.9

Source: staff estimates based on national authorities' data.

1/ Second quarter of 1987 to fourth quarter of 2000.
2/ Second quarter of 1987 to fourth quarter of 1990.
3/ First quarter of 1991 to fourth quarter of 1996.
4/ First quarter of 1997 to fourth quarter of 2000.

the share of imports in domestic demand would suggest that the pass-through to domestic prices of fluctuations in exchange rates and import prices should have risen instead of declining in these economies.[58]

107. An additional factor which tends to influence the extent of pass-through is the business cycle and the uncertainty in aggregate demand. Mann (1986) noted that firms may be reluctant to raise prices and prefer to adjust profit margins when the underlying strength in domestic economic conditions is uncertain. Therefore, the exchange rate pass-through would tend to diminish when aggregate demand is more volatile. Using the volatility of the output gap as a proxy for uncertainty in aggregate demand, it seems evident that the uncertainty rose between 1991 and 1998 in New Zealand (although it declined somewhat between 1996 and 1998), whereas it declined in Australia, and remained almost unchanged in Canada. Since 1999, the uncertainty in aggregate demand declined further in all countries and, as expected from the earlier discussion, there seems to be more evidence of higher pass-through, particularly in New Zealand. As noted by Orr et al (1998), firms may have been under less pressure to pass on the effects of an appreciating currency when domestic conditions were strong, and vice versa when the exchange rate depreciated.

A Comparison of Aggregate Demand Uncertainty
(Standard deviation of output gap, in percent)

	New Zealand	Australia	Canada
1987-2000 1/	1.65	1.21	2.88
1987-1990 2/	0.62	0.98	1.45
1991-1998 3/	2.03	0.88	1.38
1999-2000 4/	1.15	0.74	0.76

Source: staff estimates, OECD, national authorities' data.
1/ Second quarter of 1987 to fourth quarter of 2000.
2/ Second quarter of 1987 to fourth quarter of 1990.
3/ First quarter of 1991 to fourth quarter of 1998.
4/ First quarter of 1999 to fourth quarter of 2000.

108. Whether exchange rate volatility may have influenced the extent of first-stage pass-through differently across countries remains somewhat uncertain. In the early 1990s, New Zealand experienced a marked increase in the volatility of the exchange rate, possibly reflecting the effects of macroeconomic and structural reforms in the economy. As Governor Brash (1999) noted, in the years following the deregulation, both interest rates and the exchange rate were very volatile, and the Reserve Bank had "little sense of what 'normal' levels for these prices were...." However, exchange rate volatility in New Zealand was not higher on average in the 1990s than in the pre-reform period and was not significantly different than that observed in other industrial countries during the past decade. Nevertheless, exchange rate volatility increased markedly between 1991 and 1994 and subsequently, during

[58] The sharp rise in import penetration experienced in New Zealand, Australia, and Canada, would suggest that the direct effect of the changes in the exchange rate to consumer prices should have increased proportionately with the share of imported goods in the consumer price index. For example, see the Bank of Canada, Monetary Policy Report, Technical Box 2, November 2000. However, increased import penetration may result in more competition vis-à-vis domestic producers, limiting their ability to pass higher costs onto prices.

the Asian crisis (Figure III.4).[59] In contrast, Australia and Canada did not experience a significant change in their levels of exchange rate volatility during the 1990s. Australia's exchange rate volatility has been high since the late 1980s, whereas in Canada it was relatively low.[60] Therefore, the increased volatility in exchange rate shocks may have influenced for some time the extent of exchange rate pass-through in New Zealand, as these shocks may have raised the uncertainty about the underlying sources of exchange rate fluctuations, inducing firms to reduce the "first-stage" pass-through.

D. Estimation Framework and Econometric Evidence

109. This section describes the conceptual framework supporting the empirical analysis of exchange rate pass-through to inflation and also presents the results of its main determinants in New Zealand, Australia, and Canada. The evidence is based on two different methodologies. A vector autoregressive (VAR) model is used to decompose the variance of inflation rates at different stages of distribution in order to measure the explanatory power of exchange rate shocks in the fundamental determinants of inflation. Also, an error correction model is used to assess the exchange rate pass-through to inflation. In particular, the model is used to examine the exchange rate pass-through to import prices under the assumption that the law of one price holds, while the second-stage exchange rate pass-through is also examined by estimating a price mark-up error correction model (see de Brower and Ericsson, 1995, and Dwyer and Leong, 2001) for consumer inflation. These models help to assess the relative importance of the fundamental determinants of inflation, and the magnitude and stability of the exchange rate pass-through to inflation at different levels of the distribution chain (primarily import and consumer prices) over the short- and long-term.

Variance Decomposition

110. The main purpose of decomposing the variance of inflation rates is to assess the importance of shocks in the fundamental determinants of inflation at different stages of the distribution chain. In doing so, the variance decomposition may help to better assess the role of exchange rate shocks in driving fluctuations in inflation in the short-term and over the

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[59] Alternatively, proxying exchange rate volatility as deviations in the NEER from a trend estimated by using the Hodrick-Prescott filter shows that volatility rose sharply after 1991, and even rose further after 1994, only to decline from 1999 on. However, these deviations should be interpreted with caution as they do not appear to be stationary.

[60] Arora and Jeanne (2000) note that the Canadian dollar has fluctuated by less against the U.S. dollar than have several other floating currencies, such as those of Australia and New Zealand. The low relative volatility seems to be consistent with the behavior of official interest rates and foreign reserves (an indicator of market intervention), both of which have fluctuated more in Canada.

medium-term. To decompose the forecast variance of inflation, a VAR model is estimated for domestic import and consumer price inflation for each country.[61]

111. The variance decomposition for import prices for New Zealand, Australia, and Canada shows that exchange rate shocks account for a significant proportion of the forecast variance of domestic import prices in the short- and medium-term. In the case of New Zealand, the importance of exchange rate shocks appears to be significant and stable over time, as it accounts for about 50 percent of import price fluctuations within one year and three years, respectively. In the case of Australia, exchange rate shocks account for about 75 percent of import price fluctuations within a quarter, but their importance fades with the forecast horizon, accounting for about 65 percent of the CPI inflation variance beyond one year. In Canada, exchange rate shocks account for roughly 45 percent of fluctuations in domestic import prices.

Variance Decomposition of Prices

Forecast Horizon (in quarters)	Percentage of Forecast Variance Attributed to the Exchange Rate: Import Prices	Consumer Prices	Tradable Goods	Nontradable Goods
		A. New Zealand 1/		
1	51.3	36.2	36.2	20.7
4	49.0	33.7	55.9	30.1
8	47.6	30.5	50.6	37.9
12	47.4	30.5	49.5	37.4
		B. Australia 1/		
1	78.9	9.1	1.3	6.4
4	67.6	20.9	38.4	16.5
8	64.6	16.0	39.3	10.7
12	64.4	15.6	40.3	9.7
		C. Canada 1/		
1	51.7	2.0	...	...
4	46.1	9.8	...	...
8	44.0	8.2	...	...
12	43.7	8.4	...	...

Source: Staff estimates based on official sources.

1/ Based on a VAR model using variables in first differences. In New Zealand, domestic import prices include oil.

112. The results for the variance decomposition for consumer price inflation supports the view that exchange rate shocks appear to have modest effects on inflation. These shocks account for only 30 percent of the CPI inflation forecast variance in New Zealand, and only 15 percent and 10 percent for Australia and Canada, respectively. A breakdown of consumer price inflation into tradable and nontradable goods reveals that exchange rate shocks account

[61] Most of the variables are nonstationary, and the Augmented Dickey Fuller tests for stationarity suggest that most of them are difference stationary, with the exception of unit labor costs. Nevertheless, the VAR models were specified and estimated in first differences given that the models in levels did not meet the stability conditions specified by Lutkepohl (1991). While this specification may entail a potential significant loss of information on the long run relationships, it may preserve the efficiency of the estimates. However, differencing the data would imply imposing the restriction that all shocks tend to be permanent, which may not necessarily be the case for some of the variables used in the VAR. Moreover, the reduced form residuals from the VAR were orthogonalized using a Choleski decomposition to identify the shocks. Since the order of the variables affect the results, the order chosen was as follows: output gap, unit labor costs, foreign inflation, exchange rate, and prices. The variance decomposition results were relatively robust to different orderings in these variables. See Annex III.I for a detailed description of data.

for a larger share of price fluctuations in New Zealand for tradable and nontradable goods than in Australia and Canada.

A Model for Import Prices

113. As explained in Dwyer and Leong (2001), estimating the first-stage pass-through is usually based on the assumption that the law of one price for tradable goods holds, which implies that the price of a traded good, when expressed in a common currency, should be the same in the domestic and foreign economies. In particular, the assumption in a log-linear form implies that:

$$p = p^* + e$$

where p is the domestic price of imports, p^* is the foreign price of imports, and e is the nominal effective exchange rate measured as domestic currency per unit of foreign currency. The first stage pass-through is represented by the elasticity of the domestic import price with respect to the exchange rate. For small open economies such as New Zealand, Australia, and Canada, the first stage pass-through should be complete over the long-run. An error correction representation would be as follows:

$$\Delta ip_t = a_0 + a_1 \Delta er_t + a_2 \Delta fip_t + a_3 \Delta ogap_t + \alpha(ip - \eta \cdot er - \beta fip)_{t-1} + a_4 ogap_{t-1} + \varepsilon_t$$

where linear price homogeneity (or PPP) would imply that η and β should each be equal to 1. The model also incorporates the output gap to allow for the mark-up on imports to vary with the business cycle. In estimating an import price equation for New Zealand, King and Steel (1998) noted that, under conditions of imperfect competition, foreign exporters may set their price above their costs of production depending on many factors such as demand conditions in the domestic as well as the foreign economies. Including the output gap aims at capturing some form of "pricing to the market" by exporters to New Zealand.

114. The estimated error correction models for import price inflation in New Zealand, Australia, and Canada are presented in Table III.1. In the case of New Zealand, two sets of regressions are estimated for import prices (including and excluding oil prices) to allow for a more precise estimation of the exchange rate pass-through. In both equations for New Zealand, linear price homogeneity or long-run PPP is imposed. The estimated models explain between 40 percent and 75 percent of the fluctuation in domestic import prices and suggest the following:

- *The first stage short-term pass-through (a_1) varies between 0.5 and 0.6 in New Zealand depending on whether import prices include or exclude oil prices* (Figure III.5).[62] The results seems to be consistent across economies, as the estimated

[62] The results also suggest that the estimated first stage short-term pass-through to import price inflation does not differ when long-run PPP is not imposed in the model.

elasticities for Australia and Canada are close to 0.6, respectively. While the short-term pass-through has been remarkably stable for Australia and Canada since 1994, it declined markedly in New Zealand in the early 1990s, and between 1994 and late 1999, it rebounded to levels more comparable to the early 1990s and to those estimated in other countries such as Australia.[63]

- *The speed of adjustment from "PPP-disequilibrium" (α) is very small, varying between 1 percent (Canada) and 25 percent (Australia) per quarter* (Figure III.6). The estimated speed of adjustment for New Zealand import prices is less than 5 percent, somewhat below the estimation by King and Steel (1998), and does not vary significantly when oil prices are excluded. In addition, the speed of adjustment seemed to have declined markedly in all three economies during the early 1990s, following the adoption of inflation targeting. The speed of adjustment remained stable in New Zealand but has declined somewhat in Australia and Canada following the Asian crisis (1997-1999) and has stabilized at very low levels subsequently.

- *The decline in the first-stage pass-through in New Zealand possibly reflects the confluence of several temporary shocks which have been sequential and relatively persistent in nature.*[64] In particular, the fluctuations in the currency and the uncertainty associated with the underlying nature of its fluctuations; the uncertainty about the equilibrium exchange rate level following the wide range of macroeconomic and structural reforms in the first half of the 1990s, as evidenced by the significance of the output gap, and shocks associated with the Asian and Russian crises, may have triggered a temporary but long-lasting change in the pricing behavior of exporters. These factors appear to have played out differently, to some extent, in New Zealand than in Australia and Canada. In fact, as noted by Orr et al (1998), the recent direct effect of exchange rate changes on tradable good prices became more muted than in the early years of inflation targeting, possibly reflecting several factors, including the adaptation to large swings in the value of the domestic currency, the increased globalization of trade, which made firms more willing to smooth out the impact of exchange rate fluctuations on prices, and the underlying strength in domestic conditions, which may have influenced the extent of exchange rate pass-through.

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[63] In addition, the increased reliance by firms on foreign exchange risk hedging may have also contributed to reduce the degree of first-stage exchange rate pass-through.

[64] The estimated pass-through coefficient declined from about 0.65 (0.76 excluding oil) in early 1991 to 0.5 (0.43) in early 1999, and has risen to about 0.6 (0.52) in the third quarter of 2001.

A Mark-Up Model for Consumer Price Inflation

115. De Brouwer and Ericsson (2000) explain that the mark-up model of inflation has had a long-standing and continuing presence in efforts to explain the main determinants of inflation. The model is based on the idea that, in the long-run, the domestic general price level is basically determined as a mark-up over total costs, which are primarily represented by unit labor costs and import prices. Therefore, the long-run relationship of the price level to its fundamental determinants could be represented in a log-linear form as follows:

$$p = \ln(m) + \gamma \cdot ulc + \delta \cdot ip$$

where m is the mark-up over unit labor costs (ulc) and import prices (ip), with γ and δ representing the elasticities of the price level to unit labor costs and import prices, respectively. Linear homogeneity implies that $\gamma + \delta$ should sum up to 1. An interesting feature of error correction models is that they allow the estimation of not only the long-run relationship between prices and its fundamental determinants, but also the short-run dynamics of the inflationary process and its fundamentals and how disequilibrium in the long-run relationship feeds back onto inflation in the short-run. The framework presented in de Brouwer and Ericsson (1995) and in Dwyer and Leong (2001) is modified to explicitly assess the direct impact of the exchange rate on consumer price inflation by decomposing domestic import prices into the exchange rate and foreign import prices.[65] The error-correction model for consumer price inflation was estimated as follows:[66]

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[65] In doing so, the estimated coefficient for the second-stage pass-through is not strictly comparable to more traditional estimates of the pass-through, which are based on the impact of import prices on consumer price inflation.

[66] This model was extended and estimated to assess the long-term impact on consumer prices of terms of trade and of the upward trend in import penetration, and whether these variables affected the estimated exchange rate pass-through. Terms of trade shocks influence the intratemporal substitution of consumption between tradable and nontradable goods, as well as private savings and the current account. Cashin and McDermott (2001) find that terms of trade shocks induce large and significant intratemporal and intertemporal substitution effects in Australia, New Zealand, Canada, United Kingdom, and the United States. In addition, a higher share of imported goods in the CPI would tend to increase the direct effects of exchange rate changes on the CPI. Including proxies for both variables in the model support the hypothesis that the increased share of imports in the basket of goods comprising the consumer price index has positively affected the exchange rate pass-through in the long-term, but these proxies do not appear to significantly affect the short-term exchange rate pass-through. When including these proxies, the estimation is subject to multicollinearity with other long-term determinants, such as unit labor costs, making it difficult to interpret the long-run relationship between these determinants and the price level.

$$\Delta p_t = a_0 + a_1 \Delta ulc_t + a_2 \Delta fip_t + a_3 \Delta neer_t + a_4 \Delta ogap_t$$

$$+ \alpha(p - \gamma ulc - \lambda fip - \eta e)_{t-1} + a_5 ogap_{t-1} + \upsilon_t$$

where α measures the speed of adjustment from the long-run disequilibrium (α<0 for dynamic stability to hold).

Econometric Results

116. This section presents the results of the estimated models of consumer price inflation for New Zealand, Australia, and Canada.[67] The results (Table III.2) suggest the following:

- *The short-term exchange rate pass-through to consumer price inflation, as well as the speed of adjustment in the long-term disequilibrium, have been small and relatively similar in New Zealand and Australia.* The estimated short-term pass-through from changes in the exchange rate was about 10 percent in New Zealand and Australia, and significantly higher than in Canada. The long-term exchange rate pass-through has been higher in Canada (69 percent) than in New Zealand (27 percent), and slightly higher in New Zealand than in Australia (17 percent), supporting the view that the pass-through tends to be higher in more open economies.[68]

- *The short-term exchange rate pass-through to consumer price inflation has fluctuated markedly during the 1990s in all these economies* (Figure III.7). In New Zealand, the short-term pass-through has declined markedly since the early 1990s, appears to have bottomed out by mid-1999, and has risen since then to 1993 levels, much in line with the behavior of the first stage pass-through. To some extent, the rebound in the pass-through reflects the large real depreciation that took place in 2000. In Australia and Canada, the short-term pass-through has also declined somewhat from the levels in the early 1990s, and has rebounded modestly in Australia and Canada since late 1998.[69]

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[67] The estimation for Australia is based on the consumer price index and differs from that in Dwyer and Leong (2001), since theirs is based on the price index which excludes volatile components.

[68] In the case of New Zealand, the estimated speed of adjustment does not appear to be statistically significant, suggesting the lack of a long-term relationship between these variables. However, this result does not appear to be robust to a decomposition of consumer prices into tradable and nontradable good prices, which suggests the existence of a long-term relationship.

[69] In the case of Australia, when excluding the volatile components of the consumer price index, the exchange rate pass-through was significantly more stable during the 1990s.

- *The degree of response of consumer price inflation to a permanent exchange rate shock has also been remarkably low since 1994 but has risen somewhat in the past few years in New Zealand and Canada.* The stability of the impulse response function to a permanent 1 percent shock in the exchange rate (Figure III.8)[70] indicates that such response over six quarters has been less than 10 percent in these economies since 1994. In the case of New Zealand, the impulse response of consumer price inflation to exchange rate shocks has declined between 1994 and mid-1999, suggesting that there has been an increased tendency by price-setters to perceive exchange rate shocks as relatively transitory. However, more recent exchange rate shocks appear to be perceived as more permanent, as reflected by the modest rebound of the impulse response function. A relatively similar trajectory is estimated for Canada, where the exchange rate shocks between 1997 and early 1999 appear to have been perceived as largely transitory. In the same vein, the impulse response function has risen since 1999, suggesting that these shocks may be now perceived as more permanent by price setters. As noted by Dwyer and Leong (2001), the impulse response function in Australia has been largely stable since 1994, with a modest decline since mid-1997.

- *Favorable shocks to unit labor costs have been an important influence in stabilizing consumer price inflation during the 1990s; however, the deterioration in productivity since 2000 may have contributed to increase the exchange rate pass-through in all these economies.* The models do not find a significant impact of changes in unit labor costs on inflation in the short-term but the long-term elasticity appears to be quite high across countries. For New Zealand and Australia, the estimated elasticities of inflation to unit labor costs were roughly 40 percent, while that for Canada exceeds one.[71] Productivity improvements between 1993 and 1999 in New Zealand, Australia, and Canada have allowed price setters to absorb the trend depreciation of the exchange rate and contributed markedly to the stabilization of the inflation processes (Figure III.9).

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[70] The impulse response function traces the extent to which adjustment to a 1 percent shock to the exchange rate is estimated to have occurred by the period shown. For example, each point in time traces the effects of a shock that took place in the past four and six quarters.

[71] The sensitivity of the long-term elasticity to unit labor costs may be influenced by the inclusion of the output gap. Also, the specification based on core inflation results in a more reasonable long-run elasticity for unit labor costs in Canada.

Is the Exchange Rate Pass-Through Different Across Goods?

117. Burstein, Eichenbaum, and Rebelo (2002) examined empirically the behavior of inflation and the real exchange rate after large devaluations for several countries.[72] Their main conclusions indicated that while CPI inflation tends to be very low relative to exchange rate depreciation, there were important differences in the behavior of the pass-through between tradable and non-tradable goods. In particular, they noted that the relative price of nontradable goods tends to fall after large devaluations and that the rise in tradable good prices is significantly lower than it would be expected from a PPP relationship. This is largely due to the presence of distribution services for tradable goods and by the substitution in consumption away from imports to local goods, which are usually classified as tradable goods but which are produced mainly for domestic consumption and are inferior substitutes for imports.[73]

118. The mark-up error correction model is estimated for the tradable and non-tradable components of the consumer price index for New Zealand and Australia.[74] The results (Tables III.3 and III.4) suggest the following:

- *Much of the increased short-term exchange rate pass-through to inflation has primarily been a tradable-good phenomenon in New Zealand and Australia.* The pass-through has been small and relatively similar in both economies during the 1990s. Since 1999, the estimated coefficients have risen to about 10 percent.

- *The short-term pass-through to non-tradable good inflation is very small and has declined steadily in New Zealand during the 1990s.* The estimated pass-through was about 15 percent in 1992 and has declined to about 5 percent in 2001 (Figure III.7).

- *New Zealand has experienced a remarkable change in the responsiveness of non-tradable goods inflation to exchange rate shocks, which may be explained by the increased credibility of the inflation targeting framework.* The impulse response of non-tradable goods inflation to exchange rate shocks has declined sharply since 1994 (Figure III.10). This decline may not only reflect the impact on inflation of the response from monetary and fiscal policies but also the increased credibility of the inflation targeting framework, as the impact of exchange rate shocks on non-tradable

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[72] The countries included were Finland, Sweden, Mexico, Brazil, Korea, Indonesia, Philippines, Thailand, and Malaysia.

[73] Therefore, the prices for these local goods tend to be determined mainly by domestic factors and may be largely immune to changes in the exchange rate.

[74] The results for Canada are not presented as models for tradable (goods) and non-tradable (services) consumer price inflation were highly rejected.

sectors has been increasingly perceived as transitory. This may be primarily attributed to the increased credibility of the inflation targeting regime, as price setters realized that the monetary framework in place increasingly left less scope to accommodate the direct effects of exchange rate shocks on non-tradable prices. The estimated impulse response functions for Australia differ from that for New Zealand; however, they still show a very limited pass-through to non-tradable prices, and are consistent with a high credibility of the inflation targeting framework adopted.

E. Implications for Monetary Policy

119. In conducting monetary policy, New Zealand policymaker's views about the relationship between fluctuations in the exchange rate and inflation has evolved over time, mainly as a result of their increased experience with the inflation targeting regime that was adopted in 1990. As noted by Orr et al (1998), in the early stages of the inflation targeting framework, the Reserve Bank tended to rely heavily on those aspects of the transmission mechanism which it had traditionally identified with relatively good precision, specifically, the direct effect of the exchange rate on prices. This was done primarily to bolster the credibility and ensure the success of the inflation targeting framework.

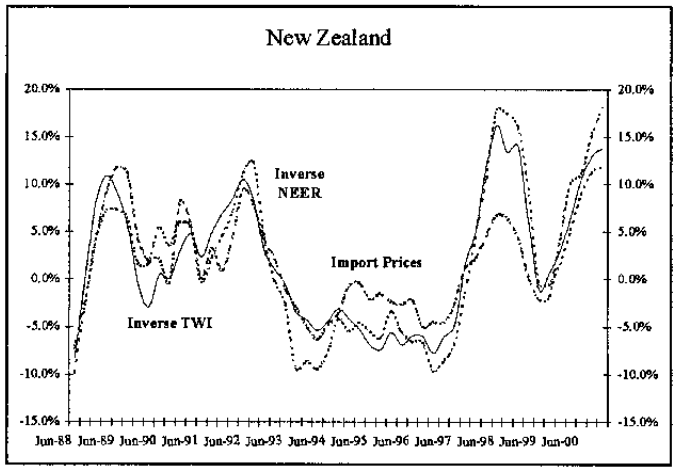
120. This focus has since evolved, and as experience with the new framework was gained, the Reserve Bank introduced several important changes to its conduct of monetary policy which, in principle, may have increased the scope for accommodating the direct impact of exchange rate fluctuations. The Reserve Bank lengthened the horizon over which the inflation is targeted from about 6-18 months to about 18-24 months and also modified the Policy Target Agreement (PTA) by widening the target range from 0-2 percent to 0-3 percent in 1996. The econometric evidence presented in this paper does not show that these changes had any significant impact on the exchange rate pass-through to domestic inflation.

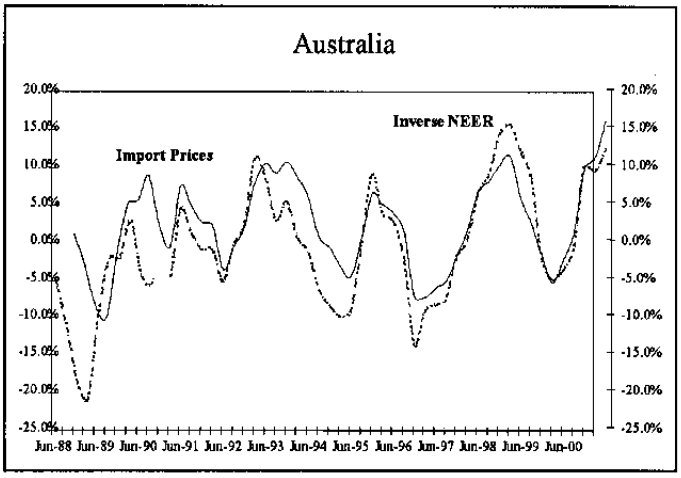
121. However, the decision by the Reserve Bank to use a monetary conditions index (MCI) in implementing monetary policy between mid-1997 and March 1999 may have influenced the exchange rate pass-through. As explained by Svensson (2001), during this period, changes in interest rates were automatically triggered by fluctuations in the exchange rate, irrespective of the underlying nature of the exchange rate shocks. Svensson notes that this policy may have contributed to interest rate variability and may have caused undue output volatility. This policy was abandoned in March 1999 and was replaced by the official cash rate as the main instrument for monetary policy.

122. A question arises as to whether the decision to implement and subsequently abandon the MCI target may have had some influence on the exchange rate pass-through in New Zealand, as the exchange rate pass-through should be endogenous to the existing monetary policy framework. One could argue that the use of an MCI may have contributed to reduce the exchange rate pass-through in the short-term, as price setters realized that exchange rate depreciations would tend to be offset by higher interest rates. Likewise, abandoning the MCI could have been perceived as increasing the scope for passing-through exchange rate shocks onto prices in the short-term.

123. While the empirical results in this paper show that the short-term pass-through has risen somewhat since 1999, there is no compelling evidence to link such a rise to the Reserve Bank's decision to abandon the MCI targeting, as several sequential and highly persistent shocks make this identification difficult. The analysis suggests that while the relationship between the exchange rate and the inflation rate may have changed during the 1990s, it is likely to have been primarily the result of the increased credibility of the inflation targeting framework. The increased credibility has made, on balance, the conduct of monetary policy easier for the RBNZ. Moreover, the change in the observed relationship between exchange rate changes and inflation should have no major implications for the way the RBNZ conducts monetary policy in the current framework.

Figure III.1
Exchange Rate and Import Prices
(12-month percent change)





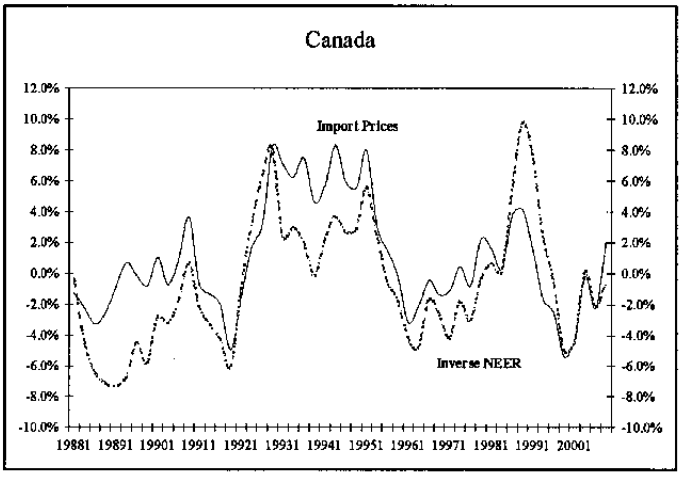
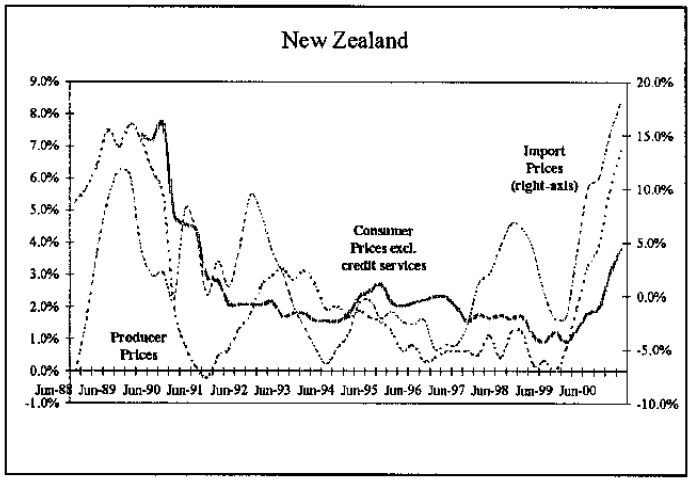
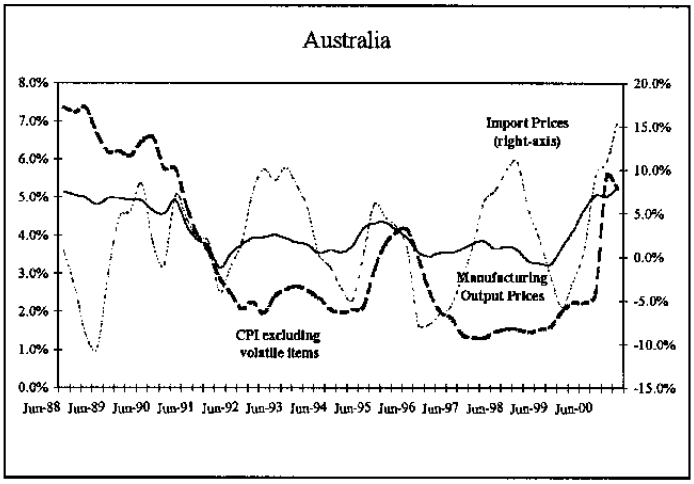


Figure III.2
Inflation and Pass-Through
(12-month percent change)





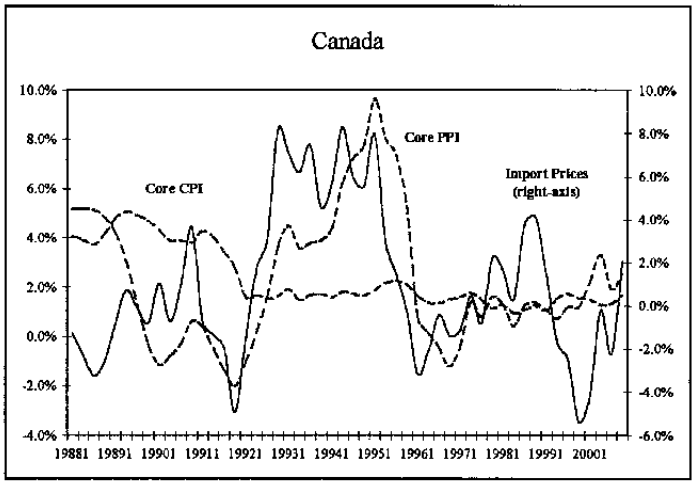
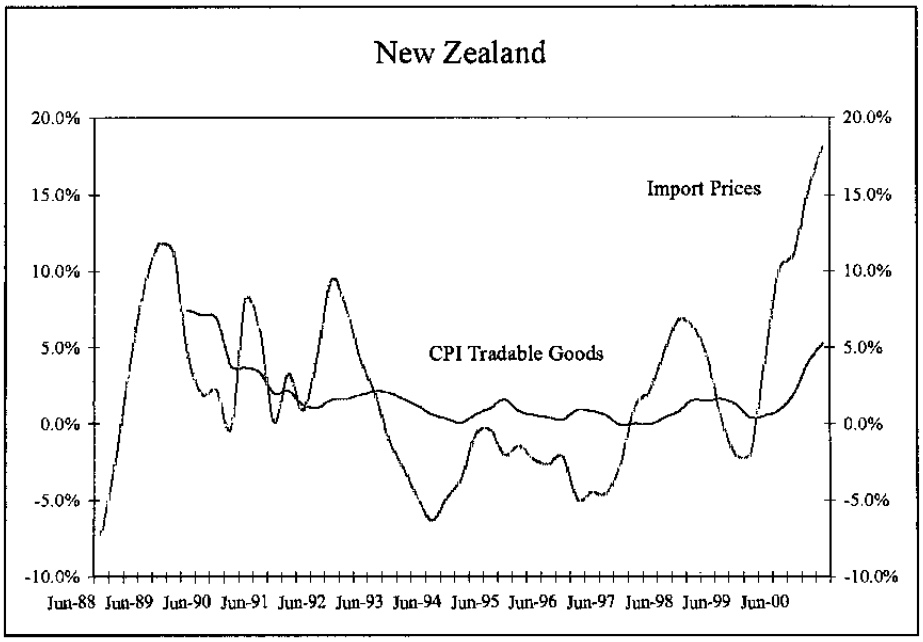


Figure III.3
Import Prices and Tradable and Nontradable Good Prices
(12-month percent change)



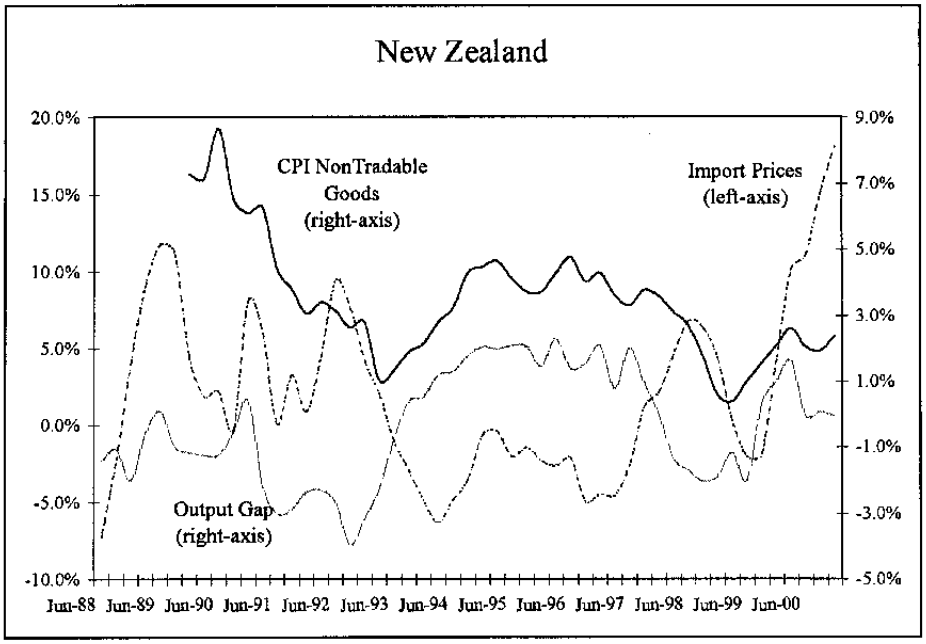


Figure III.4

Exchange Rate Volatility
(Six-quarter rolling percent standard deviation of change in exchange rate)

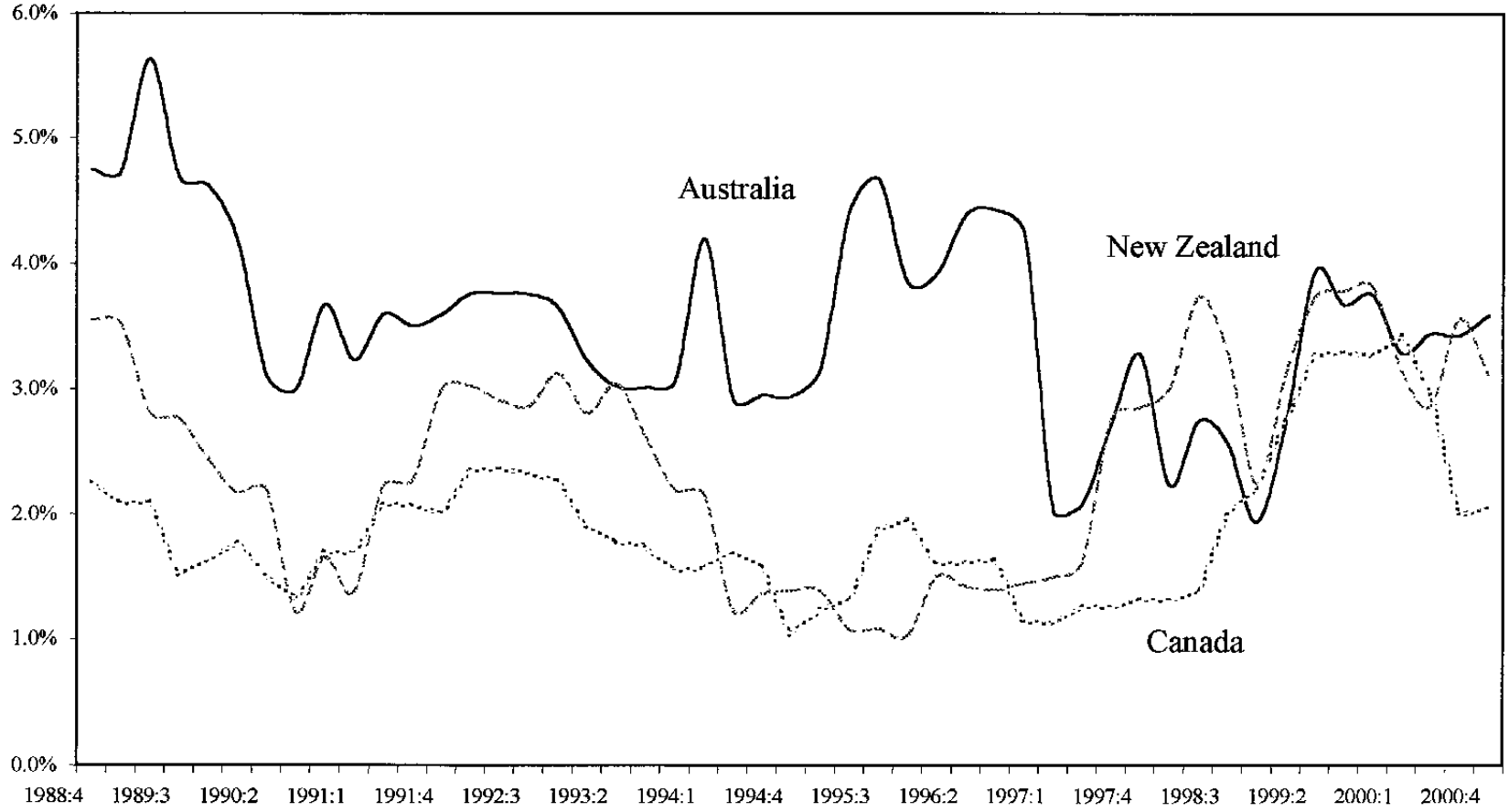
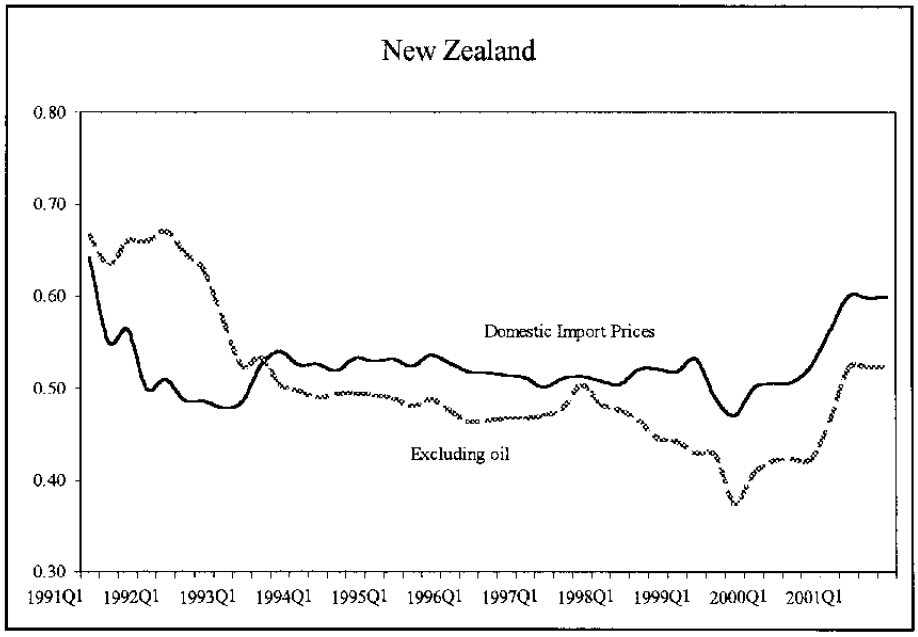


Figure III.5
First Stage Short-Term Pass-Through
(from exchange rate to import prices)



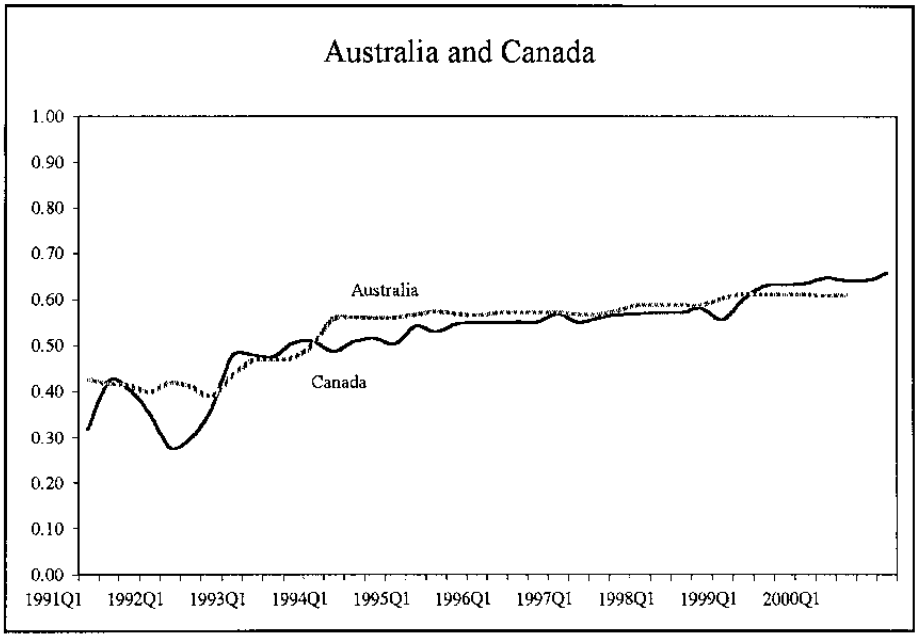
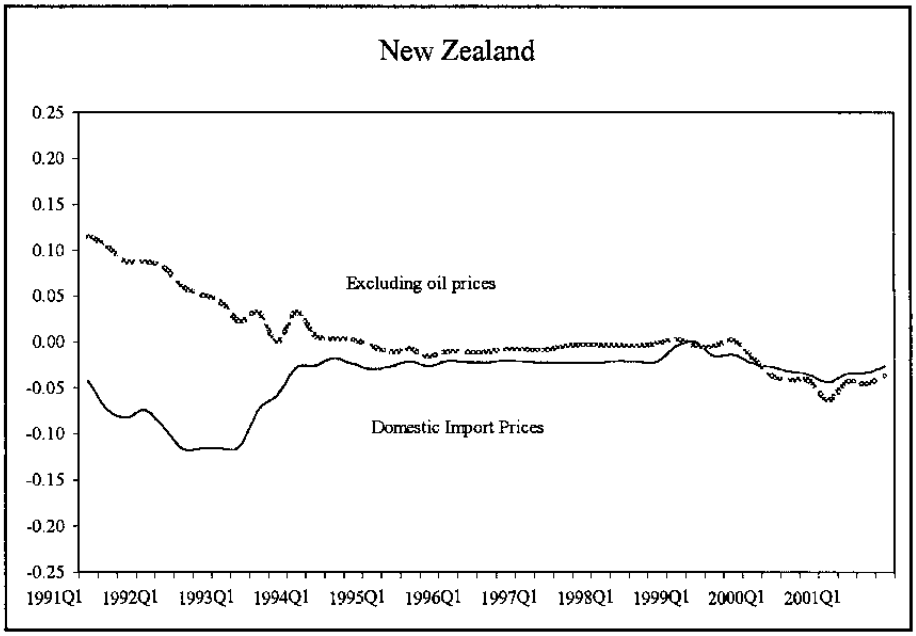


Figure III.6
Speed of Adjustment
First Stage Pass-Through
(from exchange rate to import prices)



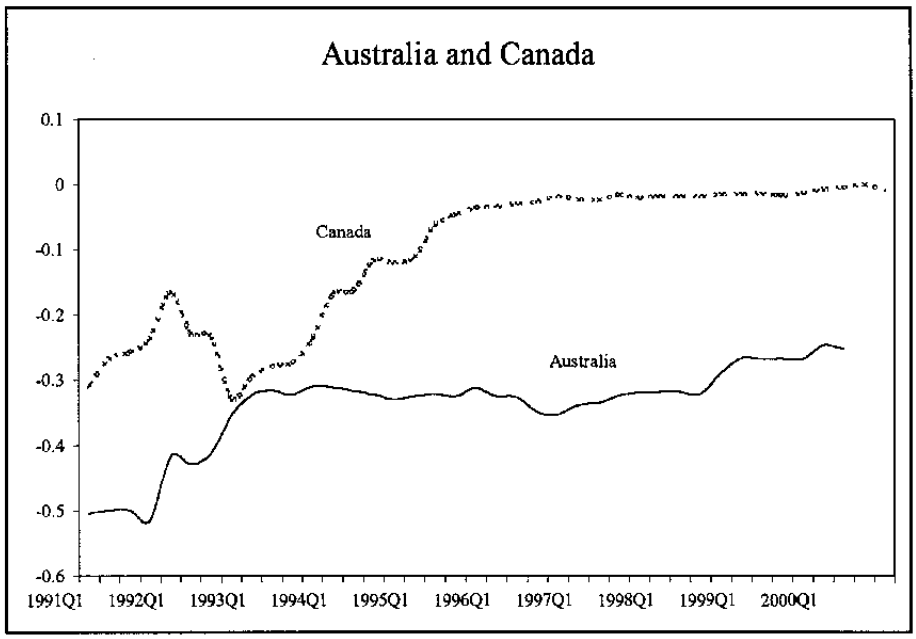
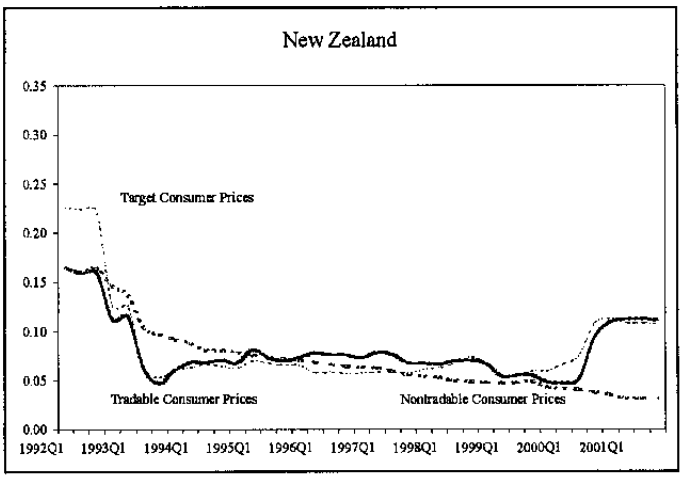
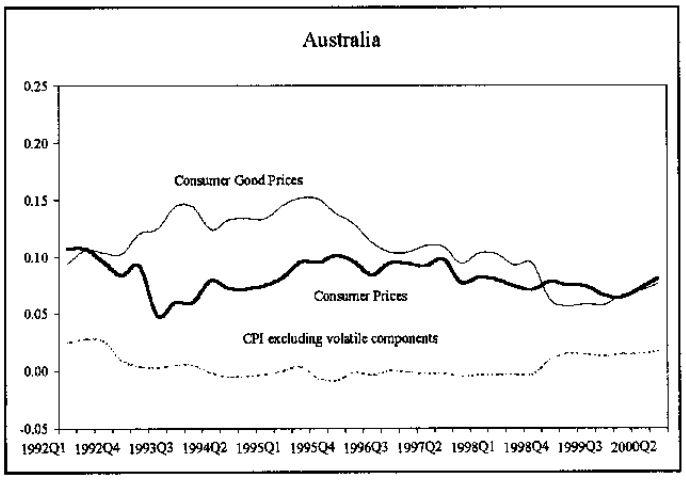


Figure III.7
Short-Term Second Stage Pass-Through
(from exchange rate to consumer prices)





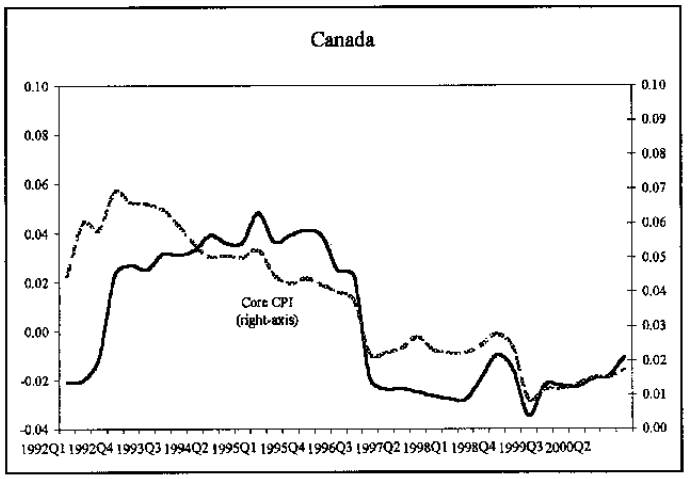
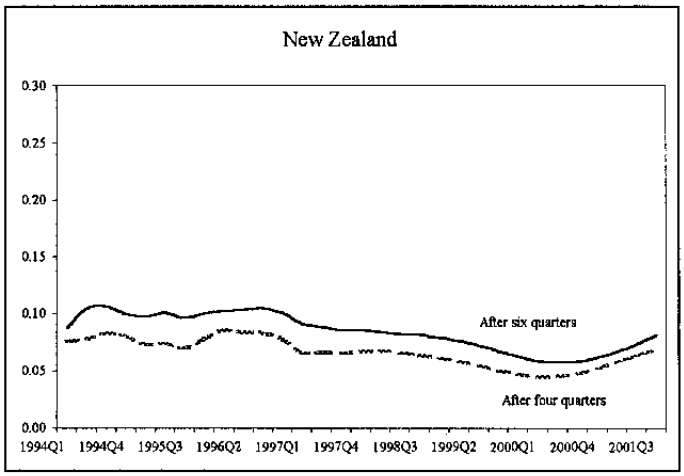
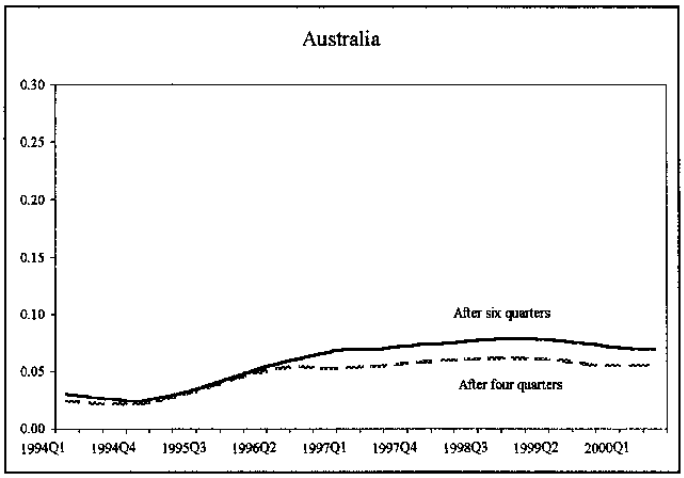


Figure III.8
Impulse Response to a Permanent Shock: Stability Test
(from exchange rate to consumer prices)





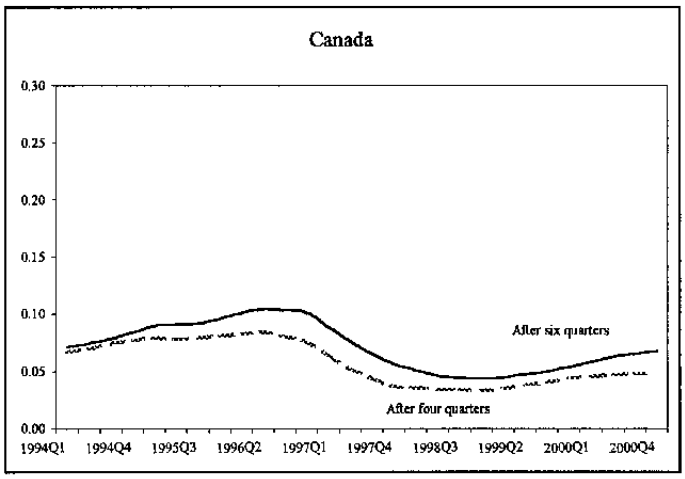
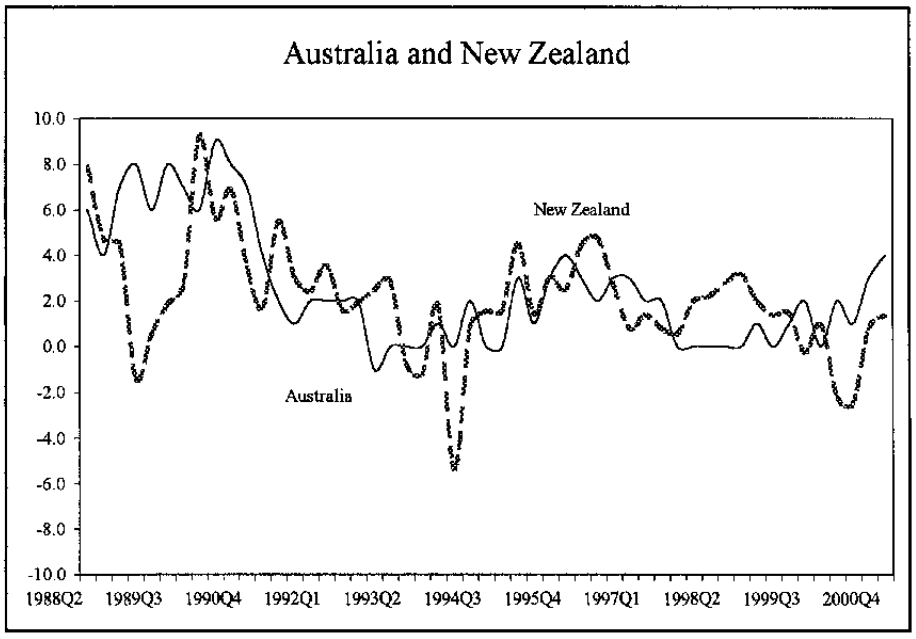


Figure III.9
Unit Labor Costs
(year on year percent growth rate)



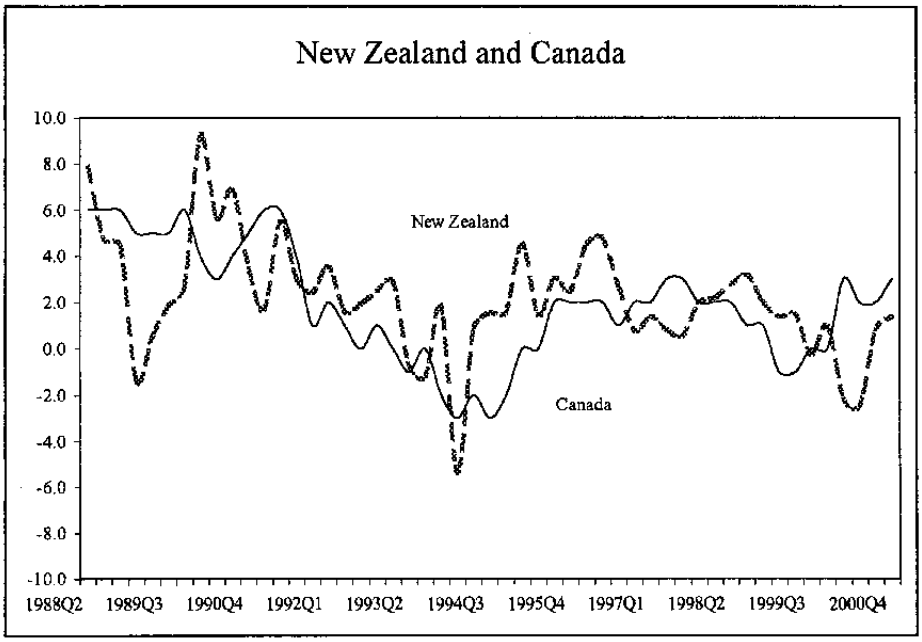
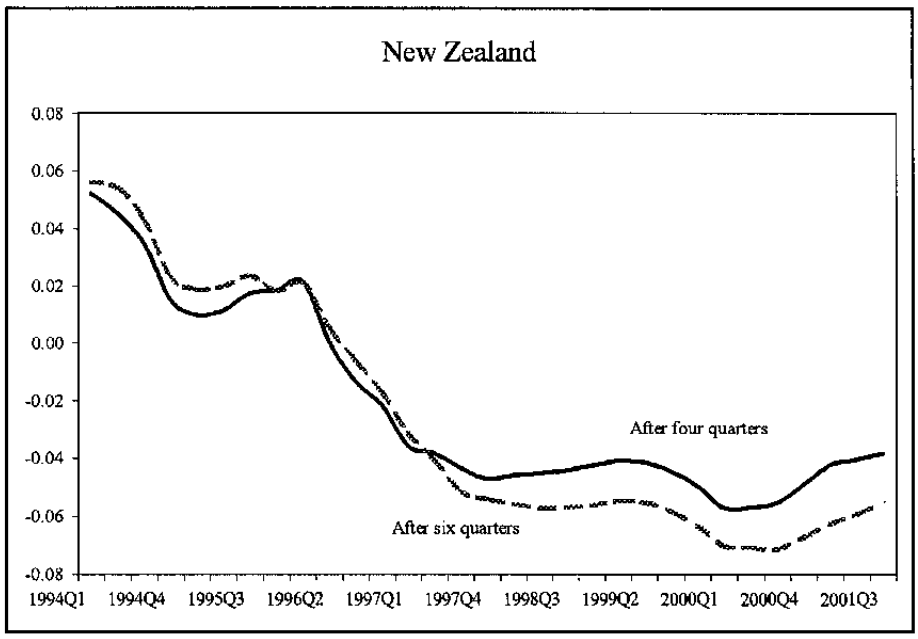


Figure III.10
Impulse Response to a Permanent Shock: Stability Test
(from exchange rate to non-tradable consumer prices)



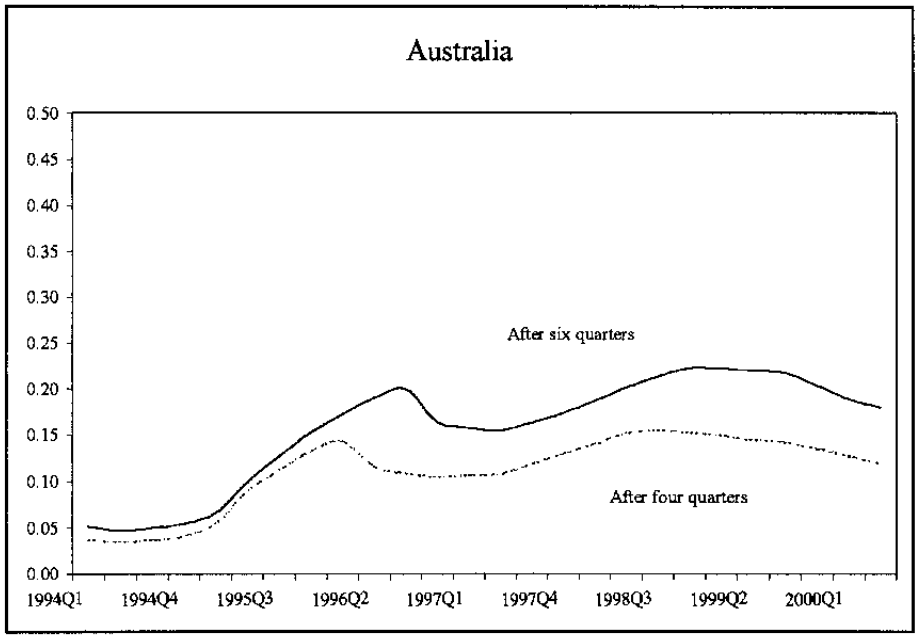


Table III.1. An Error Correction Model for Import Prices

Dependent Variable: Change in Log Import Prices 1/

Estimation Period	New Zealand 1987:3 to 2001:3		Australia 2/ 1987:3-2000:2	Canada 1987:2-2000:4
	Total Import Prices	Import Prices Excluding Oil		
Short-term dynamics				
Constant	0.18	0.24	1.19	0.04
	(0.17)	(0.28)	(0.34)	(0.06)
Change in NEER	0.60	0.52	0.61	0.64
	(0.09)	(0.11)	(0.05)	(0.08)
Change in foreign inflation	0.49	0.22	0.55	0.31
	(0.31)	(0.24)	(0.30)	(0.18)
Change in output gap	0.40	0.06	0.18	0.51
	(0.24)	(0.25)	(0.29)	(0.20)
Dummy 3/	...	...	-0.02	-0.01
			(0.004)	(0.002)
Long-term dynamics				
Adjustment coefficient	-0.03	-0.04	-0.25	-0.01
	(0.03)	(0.04)	(0.07)	(0.01)
NEER 4/	1.00	1.00	1.00	1.00
	...	...	...	...
Foreign prices 4/	1.00	1.00	1.00	1.00
	...	...	...	...
Output gap	3.19	2.16	1.40	5.41
	(0.10)	(0.13)	(0.14)	(0.05)
Trend 5/	...	...	-0.003	...
			(0.0008)	
Trade dummy 6/	...	...	...	-0.002
	...	...	...	(0.003)
Adjusted R-squared	0.51	0.40	0.75	0.59
Serial correlation 7/	0.80	0.10	0.59	0.39
ARCH 7/	0.93	0.73	0.12	0.65
Normality 7/	0.88	0.84	0.19	0.58
Phillips-Perron Cointegration 8/	-8.27	-9.58	-7.93	-9.00

Sources: Staff estimates.

1/ Heteroskedastic-autoregressive corrected standard deviations in parenthesis.
2/ Based on model by Dwyer and Leong (2001).
3/ The dummy captures price undercutting by Asian exporters following the Asian crisis, as suggested by Dwyer and Leong (2001). The variable was not significant for New Zealand but was significant for Australia and Canada.
4/ Linear homogeneity has been imposed in all the estimated equations.
5/ As in Dwyer and Leong (2001), the trend is intended to capture a shift in imports towards lower-priced goods from non-G-7economies. In New Zealand and Canada, the trend was not significant.
6/ The dummy intends to capture price effects following the FTA and NAFTA agreements in 1987 and 1994.
7/ Prob-values.
8/ Based on critical values for cointegration tests from McKinnon. The tests reject the null hypothesis of no cointegration for all equations.

Table III.2. An Error Correction Model for Consumer Price Inflation

Dependent Variable: Change in Log Consumer Prices 1/

Estimation Period	New Zealand 1989:1-2001:3	Australia 1987:3-2000:2	Canada 1987:2-2000:4
Short-term dynamics			
Constant	0.25	-0.09	0.26
	(0.27)	(0.115)	(0.15)
Change in foreign import prices	0.08	0.095	0.013
	(0.04)	(0.06)	(0.04)
Change in NEER	0.106	0.081	-0.011
	(0.03)	(0.03)	(0.03)
Change in unit labor costs	0.02	0.125	0.011
	(0.04)	(0.08)	(0.07)
Change in output gap	-0.05	0.20	-0.32
	(0.08)	(0.13)	(0..22)
Long-term dynamics			
Adjustment coefficient	-0.08	-0.11	-0.02
	(0.07)	(0.05)	(0.02)
Unit labor costs	0.42	0.35	1.94
	(0.07)	(0.04)	(0.04)
Foreign import prices	0.31	0.49	-1.63
	(0.07)	(0.02)	(0.02)
NEER	0.27	0.16	0.69
	(0.06)	(0.01)	(0.01)
Output gap	1.58	2.45	3.78
	(0.07)	(0.13)	(0.02)
Adjusted R-squared	0.40	0.56	0.51
Serial correlation 2/	0.50	0.85	0.08
ARCH 2/	0.10	0.19	0.78
Normality 2/	0.000**	0.56	.000**
Phillips-Perron Cointegration Test 3/	-5.88	-7.81	-6.50

Sources: Staff estimates.

1/ Consumer Price Index excluding credit services in New Zealand. Heteroskedasticity and autocorrelation consistent standard deviations in parenthesis.

2/ Prob-values. One and two asterisks denote rejection at the 5 and 1 percent level of significance, respectively.

3/ Based on critical values for cointegration tests from McKinnon. The tests reject the null hypothesis of no cointegration for all equations.

Table III.3. An Error Correction Model for Tradable Goods Inflation

Dependent Variable: Change in Log Consumer Good Prices 1/

	New Zealand	Australia
Estimation Period	1989:1-2001:3	1987:3-2000:2
Short-term dynamics		
Constant	1.29	0.02
	(0.29)	(0.11)
Change in foreign import prices	0.03	0.24
	(0.03)	(0.10)
Change in NEER	0.110	0.078
	(0.04)	(0.05)
Change in unit labor costs	0.09	0.19
	(0.04)	(0.11)
Change in output gap	0.04	0.26
	(0.09)	(0.10)
Long-term dynamics		
Adjustment coefficient	-0.32	-0.05
	(0.09)	(0.09)
Unit labor costs	0.47	0.86
	(0.04)	(0.04)
Foreign import prices	0.23	0.06
	(0.07)	(0.03)
NEER	0.31	0.07
	(0.02)	(0.02)
Output gap	0.77	2.05
	(0.07)	(0.06)
Adjusted R-squared	0.49	0.37
Serial correlation 2/	0.48	.0095*
ARCH 2/	0.60	0.99
Normality 2/	0.000**	0.83
Phillips-Perron		
Cointegration test 3/	-6.32	-10.61

Sources: Staff estimates.

1/ Consumer Price Index excluding credit services in New Zealand. Heteroskedasticity and autocorrelation consistent standard deviations in parenthesis.
2/ Prob-values. One and two asterisks denote rejection at the 5 and 1 percent level of significance, respectively.
3/ Based on critical values in McKinnon. The tests reject the null hypothesis of no cointegration.

Table III.4. An Error Correction Model for Non-tradable Goods Inflation

Dependent Variable: Change in Log Consumer Service Prices 1/

Estimation Period	New Zealand 1989:1-2001:3	Australia 1987:3-2000:2
Short-term dynamics		
Constant	0.26	-0.08
	(0.17)	(0.19)
Change in foreign import prices	0.08	0.03
	(0.03)	(0.12)
Change in NEER	0.077	0.058
	(0.02)	(0.06)
Change in unit labor costs	0.07	0.12
	(0.05)	(0.14)
Change in output gap	-0.03	0.16
	(0.10)	(0.25)
Long-term dynamics		
Adjustment coefficient	-0.11	-0.07
	(0.02)	(0.06)
Unit labor costs	1.09	-0.56
	(0.04)	(0.10)
Foreign import prices	0.00	1.13
	(0.04)	(0.04)
NEER	-0.09	0.43
	(0.01)	(0.02)
Output gap	1.98	6.67
	(0.05)	(0.10)
Adjusted R-squared	0.49	0.54
Serial correlation 2/	0.37	0.19
ARCH 2/	0.11	0.70
Normality 2/	0.000**	0.73
Phillips-Perron Cointegration test 3/	-8.33	-6.90

Sources: Staff estimates.

1/ Consumer Price Index excluding credit services in New Zealand. Heteroskedasticity and autocorrelation consistent standard deviations in parenthesis.
2/ Prob-values. One and two asterisks denote rejection at the 5 and 1 percent level of significance, respectively.
3/ Based on critical values in McKinnon. The tests reject the null hypothesis of no cointegration.

DATA DESCRIPTION

Common Variables

Foreign inflation: proxied by the total trade weighted consumer price index for trading partners, as estimated by INS. Foreign import prices for New Zealand include an average effective tariff rate on imports. In addition, in the case of the import price model which excludes oil, foreign inflation was proxied by the U.S. producer price index excluding energy.

New Zealand

Import prices: implicit price deflator for all imports, and for all imports excluding petrol prices. Source: Statistics New Zealand.

Output gap: based on calculations by Reserve Bank of New Zealand.

Terms of trade: ratio of ANZ's commodity price index to import price of manufacturing goods.

Exchange rate: the reciprocal of the nominal effective exchange rate weighted by import and export shares of major trading partners. An increase in the index denotes a depreciation of the domestic currency. Source: IMF.

Consumer prices: price index excluding housing and credit services, seasonally adjusted. Source: Statistics New Zealand.

Unit labor costs: total economy, seasonally adjusted, based on calculations by Reserve Bank of New Zealand.

Australia

Import prices: price deflator for merchandise imports. Base 1989/90 = 100.

Output gap: natural logarithm of real GDP minus the trend component based on the Hodrick-Prescott filter.

Terms of trade: Calculated as the ratio of the Reserve Bank of Australia commodity price index in Australian dollars to the domestic import price of manufacturing goods.

Exchange rate: the reciprocal of the nominal effective exchange rate weighted by import shares of major trading partners. An increase in the index denotes a depreciation of the domestic currency. Source: IMF.

Consumer prices: price index for all groups, and goods and services components, seasonally adjusted, 1989/90 = 100.

Unit labor costs: nominal for the non-farm sector, calculated as the ratio of nominal hourly labor costs (non-farm compensation of employees plus payroll tax and fringe benefits tax less employment subsidies, per hour worked by non-farm wage and salary earners) to average hourly productivity (real gross non-farm product per hour worked by all employed persons). Base for index: 1998-99 = 100. Source: Department of the Treasury.

Canada

Import prices: Paasche price deflator for imports of all goods, seasonally adjusted, index 1992 = 100. Source: Statistics Canada.

Output gap: natural logarithm of real GDP minus the trend component based on the Hodrick-Prescott filter.

Terms of trade: calculated as the ratio of the Bank of Canada commodity price index excluding energy to the import price for manufactured goods. Source: staff calculations based on official data.

Exchange rate: the reciprocal of the nominal effective exchange rate weighted by import shares of major trading partners. An increase in the index denotes a depreciation of the domestic currency. Source: IMF.

Consumer prices: price index excluding food, energy, and the effects of indirect taxes, seasonally adjusted, 1992 = 100.

Unit labor costs: for the business sector. Source: Statistics Canada.

References

Bank of Canada, *Monetary Policy Report*, November 2000.

Brash, Donald T., "The New Zealand Dollar and the Recent Business Cycle," address to the Canterbury Employers' Chamber of Commerce, January 29, Reserve Bank of New Zealand Bulletin, 1999, Vol. 62, No. 1.

Burstein, A. Eichenbaum, M. and Rebelo, S., 2002, "Why are Rates of Inflation so Low After Large Devaluations?, unpublished manuscript.

Canada: Selected Issues, 2001, IMF Staff Country Report No. 01/157, September.

Cashin, Paul and John McDermott, 2001, "Intertemporal Substitution and Terms of Trade Shocks," unpublished manuscript.

Dwyer, Jacqueline and Leong, Kenneth, 2001,"Changes in the Determinants of Inflation in Australia," Research Discussion Paper 02, Reserve Bank of Australia, May.

De Brouwer, Gordon and Ericsson, Neil, 1995, "Modeling Inflation in Australia," *International Finance Discussion Papers*, No. 530, Board of Governors of the Federal Reserve System, November.

King, Alan and Douglas Steel, 1998, "Import Prices and Exchange Rate Pass-Through in New Zealand" Economic Discussion Papers, No. 9805, University of Otago, New Zealand.

Mann, Catherine, 1986, "Prices, Profit Margins, and Exchange Rates," *Federal Reserve Bulletin*,No. 72, 366-79.

McCarthy, Jonathan, 2000, "Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies" Federal Reserve Bank of New York, Working Paper.

Orr. A., Alasdair Scott, and Bruce White, 1998, "The Exchange Rate and Inflation Targeting," Reserve Bank of New Zealand, *Bulletin*, September, Vol. 61 No. 3, pp.183-191.

Reserve Bank of New Zealand, *Monetary Policy Statement*, May 2001.

Reserve Bank of New Zealand, *Bulletin*, 1999, Vol. 62, No. 1 and No. 3.

Svensson, L., 2001, "Independent Review of the Operation of Monetary Policy in New Zealand: Report to the Minister of Finance," Reserve Bank of New Zealand, February.

Taylor, J. ,2000, "Low Inflation, Pass-Through, and the Pricing Power of Firms," *European Economic Review*, forthcoming.