

**Commerce Division
Discussion Paper No. 103**

**HOW DO AUSTRALIAN MACROECONOMICS
SHOCKS TRANSMIT TO NEW ZEALAND**

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May 2005

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Abstract

New Zealand and Australia are highly interdependent in many ways. However, New Zealand is more reliant on Australia than Australia is on New Zealand. Given high economic relation, business-cycle transmission is expected to be found between these two countries. This paper analyses the shock-transmission channels, including trade, monetary policy, and exchange rates, from Australia to New Zealand over the period 1986Q1 to 2002Q2. If New Zealand and Australia trade less, have more similar monetary policies structures, or have less similar economic structures they would have stronger economy correlation. The highly integrated banking systems between Australia and New Zealand are additional avenue for shock transmission between these two countries.

JEL Classification: *E40, E42, E44*

Key words: *shock-transmission channels, bilateral trade, monetary policy, exchange rate pass-through*

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1. Introduction

Business-cycle synchronization across two economies might be caused by the endogenous shock transmission between these two countries or by common exogenous influences. For example, the economic prosperity from 1960 through 1973 in Japan caused the mineral boom during the same period in Australia, because Japan needed the agricultural goods and mineral resources imported from Australia to accommodate this expansion (Selover and Round, 1996). This is an example of endogenous shock transmission that results in synchronization across economies. Similarly, when a common shock impacts two countries at the same time, the two countries might also be synchronized. For example, the oil shock in 1973 caused both Japan and Australia into recession.

New Zealand and Australia are highly interdependent in many ways. However, New Zealand is more reliant on Australia than vice versa. Australia is the biggest trade partner of New Zealand providing 22.10% of New Zealand's total imports and taking 20.30% of New Zealand's total exports in 2002 (International Monetary Fund, 2003). In contrast, New Zealand only provides 3.82% of Australian total imports and takes 6.51% of Australian total exports during the same period (see Tables 1 and 2). Given such close economic relations, business-cycle transmission is expected to be found between these two countries. For example, Selover and Round (1995) found that macroeconomic shocks are more likely to transmit from Australia to New Zealand than from New Zealand to Australia. The authors claimed that 15.9% of the variance in New Zealand's Gross Domestic Product (GDP) was from Australia, while only 8.4% of the variance in Australian GDP was accountable by New Zealand between 1969Q1 to 1994Q1.

Glick and Rose (1999) argued that a negative shock in an economy may spill over to other countries if the countries are interdependent through international trade, foreign investment and other linkages supported by Hull (2002). Hull showed that linkages between New Zealand and Australia, in the form of trade and financial links and immigration policies, served as a propagation mechanism so that an external shock in one country would shift to another country.

This paper examines how Australian shocks propagate to New Zealand economy through bilateral trade, exchange rate pass-through phenomenon, and monetary policy from 1986Q1 to 2002Q2. The paper employs the Augmented-Dicky-Fuller test (ADF), cointegration test,

Granger-Causality test, impulse response analysis, and variance decomposition analysis to analyse the transmission effects.

2. Background

The role of trade in transmission mechanisms of international shocks is ambiguous. Some researchers claimed that trade intensity does not impact business cycle transmission at all. For example, Imbs (2000) employed the shares of employment in each sector of the economy to measure economy structure and demonstrated that it is the degree of similarity of economic structures rather than trade itself caused synchronization among OECD countries. Crosby (2003) found similar results using the trade intensity to examine the business cycle correlations in Asia-Pacific region.

However, Canova and Dellas (1993) and Frankel and Rose (1998) argued that trade helps shocks propagate from one region to other regions through demand linkages because in recession the demand of an economy for exports decreased and thus led the output in other countries to fall. The elementary trade repercussion model in Dornbusch (1980) indicated that macroeconomic fluctuations are more likely to be transmitted from an importing country to the country that supplies the imports, unless these exporters have monopolized their positions. Kraay and Ventura (1995) found the GDP growth rate correlation averaged about 45% among the OECD countries over the period 1965-1990. The authors presented evidence that it is the commodity trade that transmitted economic fluctuations across economies and caused the high degree of synchronization in growth rates. More recently, Rose and Engel (2000) compared the business cycle synchronization within currency union countries with countries not in currency unions. The authors found that currency union countries trade more and consequently are more synchronized. Similarly, Clark and van Wincoop (2001) noted that the trade relation within States in the U.S. is closer than that within countries in European Economic Community (EEC) and thus led the business cycle are more synchronized across States than across European countries.

Eichengreen (1992) and Krugman (1993) believed that trade results more specialization and larger differences between economies. In this case, an industry-specific shock in an economy would be less likely transmitted to other economies. To counter Eichengreen and Krugman's argument, Gruben, Koo and Millis (2002) split the trade data into intra- and inter-industry

trade to test whether specialization reduces business cycle correlation among 21 countries. The authors showed that specialization does not negatively affect international transmission. However, Shin and Wang (2004) found opposing views when the authors investigated the output co-movements among the five East Asian countries and regions, including China, Hong Kong, Japan, Korea and Taiwan. The authors explained that when trade occurs mainly across different industries, higher specialization would induce the industrial structures of the various countries to diverge, resulting in less synchronized movements of business cycles. However, Calderon et al. (2002) claimed that the shock transmission depends on which dominant force is driving the economy: demand or industry-specific shocks. If demand shocks outweigh industry-specific shocks, trade intensity helps shocks transmit to other economies. Otherwise, the more trade between countries, the less shocks would be spilled over across economies.

Exchange Rate Pass-Through (ERPT) phenomenon may cause import prices shocks and further increases domestic inflation rate. Hampton (2001) found that a 10% increase in New Zealand import prices would cause New Zealand consumer prices to increase by 0.5% during the first three months and by 1.5% in the long run. This reflects that ERPT phenomenon is an avenue for exogenous shocks to influence domestic economy, especially inflation levels.

Campa and Goldberg (2002) regressed import prices on exchange rate, exporter costs and real domestic GDP to investigate the ERPT of twenty-five OECD countries. The authors found that New Zealand short-run and long-run ERPT are 58.2% and 76.7% during the period 1975-1999, respectively. In addition, the short-run pass-through elasticity for New Zealand in 1999 decreased to 0.39 from 0.47 in 1989 while the long-run fell to 0.53 from 0.62 in 1989. Furthermore, the authors argued that the real reason causing the ERPT level to decrease is the shift in the composition of import bundles of OECD countries because manufacturing and food products have partial pass-through rate while energy and raw material imports have nearly 100% pass-through elasticities. However, Lee (2004) examined the transmission of exchange rate fluctuations of import price in Korea comparing the ERPT during pre-crisis period (1980-1997) with post-crisis period (1997-2003) and found that both the short-run and long-run pass-through elasticities increased contradicting to Campa and Goldberg (2002) findings.

ERPT differs across countries.. For example, Feenstra, Gagnon and Knetter (1993) demonstrated that foreign firms with high market share have fewer competitors and are able to shift cost shocks including exchange rate fluctuations to import prices. Their findings are

similar to Jabara and Schwarts (1987) findings. Jabara and Schwarts analyzed commodity price adjustments on exchange rate changes for five agricultural commodities exported from the US to Japan. The authors concluded that an exchange rate decline (JPY/USD) was completely passed through to Japan, but an exchange rate increase was incomplete

Faruqee (1996) observed the behavior of real exchange rates by analyzing the structure of international trade. The author showed that similar countries trading similar goods under two-way intra-industry trade have lower pass-through and less persistent real exchange rate because of their stronger linkages in international prices. Similarly, Yang (1996) claimed that exchange rate pass-through is greater for more differentiated products.

There are several researches on monetary policy transmission within a country focusing on the domestic channels through which monetary policy affects the local economy (see Meltzer, 1995; Mishkin, 1995; Mishkin, 2001).

For example, in Obstfeld-Rogoff (1995) two-country model, optimal monetary policy is implemented with sticky nominal prices. The authors found that monetary and fiscal policies could lead international transmission of welfare. Their finding indicates that there is no need for the coordination of monetary policies across countries. Betts and Devereux (2000) incorporated the pricing-to-market (PTM) into Obstfeld-Rogoff model and claimed that welfare transmission from optimal monetary policy is dependent on firms pricing behaviors. When firms practice pricing-to-market, monetary policy influenced welfare transmission negatively. Betts and Devereux's finding showed the international coordination of monetary policies is necessary.

3. Methodology, Theoretical Model and Data

The model consists of three equations; Macroeconomic-Interdependence equation, Shock-Transmission equation and ERPT-Analysis equation. The data consists of quarterly time series covering 66 quarters from 1986:Q1 and ending at 2002:Q2.

3.1 Macroeconomic-Interdependence Equation (Equation I)

The Macroeconomic-Interdependence equation (I) examines the impact of the Australian economy on the New Zealand economy. The equation is a modified version of Selover and Round (1995), which examined the interdependence between Japan and Australia. Thus equation I shows the degree of Australian shocks transmit to New Zealand:

$$Z_t = \delta + \sum_{i=1}^p \phi_i Z_{t-i} + \sum_{i=1}^6 LOIL_{t-i} + \varepsilon_t \quad (I)$$

and $Z_t = (LY_N, LCPI_N, BLR_N, OCR, LY_A, LCPI_A, BLR_A, CR, LEXC)$

where

L stands for a logarithm indicating that equation I is a double-log equation;

Sub-N denotes New Zealand, while sub-A denotes Australia;

Y is GDP (since GDP is in log form the coefficients can be translated into income elasticities);

CPI is consumer price index;

BLR denotes bank-lending rates;

OCR indicates New Zealand Official Cash Rate, while CR is Australian Cash Rate;

EXC is the bilateral exchange rate (NZD/AUD); and

OIL stands for the world crude oil spot price, which is an exogenous variable

3.2 Business-Cycle Transmission Equation (Equation II)

Business-Cycle equation (II) decomposes the economic synchronization between New Zealand and Australia into three transmission channels, i.e. trade, exchange rate and monetary policy. The equation is a modified version of Crosby (2003). The equation examines and compares the influences of these three channels on international economic correlation.

Equation II is given as follows:

$$|\Delta Y_n - \Delta Y_a|_t = \alpha + \beta \max\left(\frac{Trade_{na,t}}{Y_{n,t}}, \frac{Trade_{an,t}}{Y_{a,t}}\right) + \gamma |OCR_n - CR_a|_t + \lambda |EMP_n - EMP_a|_t + \delta LEXC_t + \phi \sum_{i=1}^6 LOIL_{t-i} + \varepsilon_t \quad (II)$$

where

$|\Delta Y_n - \Delta Y_a|_t$ is the absolute value of the difference in GDP growth rate between New Zealand and Australia, measuring the economic correlation between New Zealand and Australia. A higher economic correlation reflects shocks are more likely to transmit across these two countries;

$\max\left(\frac{Trade_{ij}}{Y_i}, \frac{Trade_{ji}}{Y_j}\right)$ is the trade intensity;

$|OCR_n - CR_a|_t$ is the absolute value of the difference between New Zealand OCR and Australian cash rate (CR), measuring the similarity of monetary policy;

$|EMP_n - EMP_a|_t$ is the absolute value of the difference in the ratio of employment numbers in tradable industry to total employment numbers between these two economies, measuring the similarity of economy structure;

LEXC is the logged value of the bilateral exchange rate (NZD/AUD); and

LOIL is an exogenous variable denoting the logged value of world oil prices.

3.3 ERPT-Analysis Equation (Equation III)

The ERPT analysis explains the role of bilateral exchange rates in economic shock transmission from Australia to New Zealand. According to Hampton (2001), a 10% increase in New Zealand import prices would cause New Zealand consumer prices to increase by 0.5% during the first three months and by 1.5% in the long run. Hampton's finding indicates that ERPT is a potential channel for exogenous shocks to impact domestic economy, especially inflation rate.

The ERPT-Analysis equation (III) is adopted from Lee (2004), where the sum of marginal cost and markup was used to measure the import prices. Equation III calculates the ERPT level, i.e. the degree to which bilateral exchange rate fluctuations are passed into New Zealand import prices.

$$p_t^m = a + be_t + cw_t^{ex} + d\phi_t^m + \varepsilon_t \quad (III)$$

Equation III is a double-log

Where:

p^m denotes New Zealand import prices;

e stands for the bilateral exchange rate (NZD/AUD);

ϕ^m is New Zealand market demands, presented by the Index of Industrial Production (IIP);

w^{ex} is Australian wage market; and b shows the long-run ERPT elasticity into New Zealand's import prices.

The calculated value of 'b' shows how much exchange rate fluctuations are spilled over to New Zealand import prices. Following Campa and Goldberg (2002) and Lee (2004), w^{ex} is calculated as follows:

$$w^{ex} = \frac{NEE_t^{ex} P_t^{ex}}{REE_t^{ex}} \quad (1)$$

where NEE^{ex} is Australian nominal effective exchange rate; REE^{ex} is Australian real effective exchange rate; and P^{ex} is Australian CPI.

According to Otani, Shiratsuka and Shirota (2003) and Lee (2004), the first difference form of equation III is adopted when no cointegration relation is found among time series variables. This is shown in equation (2), where γ represents the short-term ERPT elasticity into import prices, and $\theta = \frac{\gamma}{1-\beta}$ captures the long-term ERPT elasticity.

$$\Delta p_t^m = \alpha + \beta \Delta p_{t-1}^m + \gamma \Delta e_t + \delta \Delta w_t^{ex} + \lambda \Delta \phi_t^m + \eta_t \quad (2)$$

This paper employs the Augmented-Dickey-Fuller test (ADF), cointegration test, Granger-Causality test, impulse response analysis, and variance decomposition analysis in analyzing the data. The ADF is used to test for the unit root and order of integration for all time series variables. Following this, maximal eigenvalue and trace statistic tests are used to test for cointegration relation among variables, respectively in each equation. If cointegration relation is found, the vector error correction model (VECM) is established to investigate the long

equilibrium relation among variables. Otherwise, nonstationary variables are transformed into the differenced form. The Granger-Causality test and Impulse-Response-Analysis will be tested for the equations I and II. Variance decomposition analysis is used to examine shock transmission in dynamic process for equation I. In addition, the sample period is split into pre-1991 (1986Q1-1990Q4) and post-1991 (1991Q1-2002Q2) sub-periods to compare the level of ERPT across time based on equation III.

4. Empirical Analysis

Long-run equilibria are found in equations I and II and thus the VECMs are estimated. For equation III, the first difference form is used because no long-run equilibrium is found among the variables.

4.1 Macroeconomic-Interdependence Equation (Equation I)

a. ADF Test

Table 1 shows the result of ADF test on equation I. The six variables (LY_n , LY_A , BLR , OCR_N , CR and $LEXC$) are found to be integrated of order one, i.e., $I(1)$. $LCPI_N$, BLR_A and the exogenous variable $LOIL$ are found to be stationary. The results for $LCPI_N$ and BLR_A are unexpected and are probably Type I error. Thus, the ADF test is unable to distinguish between a unit root and near unit root process (DeJong, et al., 1992). Furthermore, $LCPI_A$ is found to be integrated of order two, i.e., $I(2)$ and is consistent with Selover and Round (1995) findings.

Table 1
ADF Test Results (Equation I)

Lag Length: 0 (Automatic based on SIC, MAXLAG=10)							
	Levels I(0)			First differences I(1)			Order
	Exogenous	ADF test statistics	P-value	Exogenous	ADF test statistics	P-value	
LY _n	Constant and trend	-2.3246	0.4149	Constant	-9.3609	0.0000	I(1)
LY _A	Constant and trend	-1.2377	0.8939	Constant	-6.6793	0.0000	I(1)
LCPI _N	Constant and trend	-6.5310	0.0000				I(0)
LCPI _A	Constant and trend	-2.9316	0.1599	Constant	-3.1427	0.1057	I(2)
BLR _N	Constant and trend	-2.1594	0.5034	Constant	-7.9952	0.0000	I(1)
BLR _A	Constant and trend	-3.5029	0.0476				I(0)
OCR	Constant and trend	-3.1044	0.1140	Constant	-7.7924	0.0000	I(1)
CR	Constant and trend	-1.9846	0.5984	Constant	-6.7345	0.0000	I(1)
LEXC	Constant	-2.059	0.2602	Constant	-6.4376	0.0000	I(1)
LOIL	Constant	-3.4626	0.0124				I(0)

b. Johansen Cointegration Analysis

Table 2 reports the results of Johansen cointegration rank tests for the whole system, including LY_N, LCPI_N, BLR_N, OCR, LY_A, LCPI_A, BLR_A, CR, and LEXC with the exogenous variable LOIL. The result indicates that there exist long run relations among the time series variables in equation I.

Table 2
Johansen Cointegration Rank Test Results (Equation I)

H ₀	Eigenvalue	Trace Statistic	Max-Eigen Statistic	5% Critical Value*	
				Trace	Maximal
None **	0.735950	330.2059	79.89696	192.89	57.12
At most 1 **	0.662661	250.3089	65.20004	156.00	51.42
At most 2 **	0.596172	185.1089	54.40603	124.24	45.28
At most 3 **	0.517143	130.7029	43.68209	94.15	39.37
At most 4 **	0.452638	87.02077	36.15869	68.52	33.46
At most 5 *	0.362534	50.86208	27.01529	47.21	27.07
At most 6	0.220108	23.84679	14.91597	29.68	20.97
At most 7	0.120718	8.930820	7.718952	15.41	14.07
At most 8	0.019995	1.211868	1.211868	3.76	3.76
*(**) denotes rejection of the hypothesis at the 5%(1%) level					
Trace test indicates 6 cointegrating equation(s) at the 5% level					
Max-eigenvalue test indicates 5 cointegrating equation(s) at the 5% level					
*The critical values are taken from Osterwald-Lenum, M. (1992)					

c. VECM Estimation

The Johansen cointegration analysis shows that there is long run equilibrium among variables in equation I and VECM will be estimated. Table 3 presents the estimates for the speed of adjustment coefficients (α) and the cointegration vector (β) with standard errors in

parentheses. Based on the results in Table 3, the long run equilibrium found in VECM estimates is as follows:

$$LY_N = 1.6249 + 0.5244*LY_A + 1.9362*LCPI_N - 0.0141*BLR_N - 0.0015*OCR - 1.4016*LCPI_A - 0.0090*BLR_A + 0.0105*CR - 0.9790*LEXC \quad (3)$$

The estimated coefficient of LY_A in equation (3) represents the long run elasticity of income transmission, which indicates that a one unit change in Australian GDP would cause New Zealand GDP to change by 0.52 units.

Table 3
VECM Estimation (Equation I)

Variable	(α)	(β)
LY_N	-0.0740 (0.0558)	1. 0000
LY_A	0.0170 (0.0219)	-0.5244 (0.1866)
LCPI_N	0.0677 (0.0148)	-1.9362 (0.8119)
BLR_N	-0.7617 (3.356)	0.0141 (0.0047)
OCR	-15.2226 (7.3012)	0.0015 (0.0035)
LCPI_A	0.0756 (0.0192)	1.4016 (0.7424)
BLR_A	-4.8708 (3.1830)	0.0090 (0.0102)
CR	-10.6204 (3.5341)	-0.0105 (0.0088)
LEXC	-0.2150 (0.0963)	0.9790 (0.1214)
C		-1.6249

d. Granger Causality Test

No Granger Causality relation is found in either direction between New Zealand and Australian GDP (see Table 4). The result demonstrates that there is a lack of business cycle transmission between New Zealand and Australia.

Table 4
Granger Causality Test Results (Equation I)

Descriptions	Chi-sq statistics	P-Value
D(LY_A) does not Granger Causality D(LY_N)	2.2743	0.1315
D(LY_N) does not Granger Causality D(LY_A)	1.5996	0.2060

e. Impulse Response Analysis

According to Sims (1980), the Impulse-Response-Analysis is the most effective method of checking for Granger non-causality. The impact of New Zealand and Australian GDP on each other is examined by the Impulse-Response-Analysis as the impacts diffuse through the entire system. From figures 1 and 2, one standard deviation innovations of Australian GDP caused NZ GDP to change by 0.024 units. In contrast, one standard deviation innovations of New Zealand GDP caused Australia GDP to change by 0.004 units. This indicates that Australian GDP is more likely to influence New Zealand future GDP values. Therefore, shocks are more likely to be shifted from Australia to New Zealand than otherwise.

Figure 1

Response of LY_N to Non-factorized One Standard Deviation Innovations of LY_N and LY_A

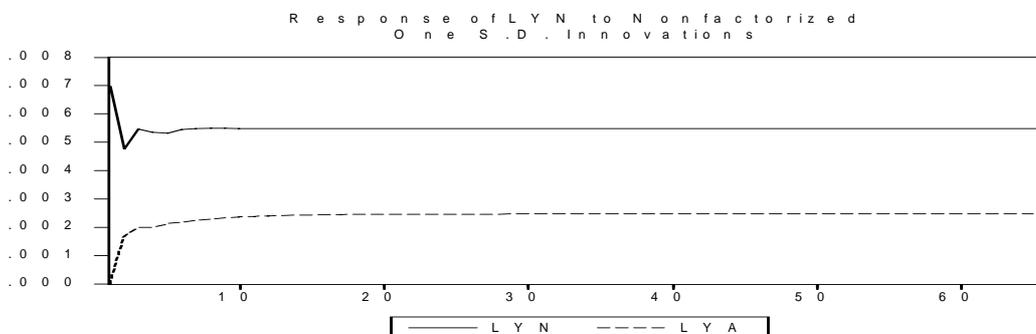
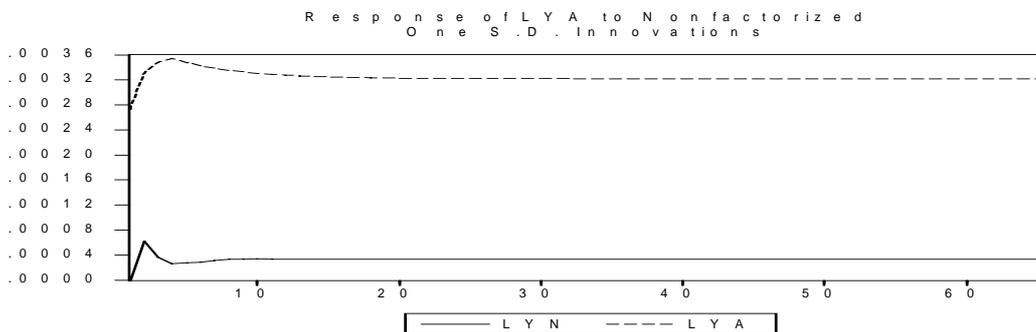


Figure 2

Response of LY_A to Non-factorized One Standard Deviation Innovations of LY_N and LY_A



f. Variance Decomposition Analysis

This paper followed Selover-Round (1996) approach in selecting the five-variable in equation I (LY_N , $LCPI_N$, BLR_N , OCR , and LY_A). The Cholesky order is also similar to Selover and Round (1996), i.e., LY_N , $LCPI_N$, BLR_N , OCR , and LY_A . The findings are reported in Tables 5 and 6, which show that after eight quarters, 7.43% variance in New Zealand GDP is due to Australian GDP, while only 5.54% variance in Australian GDP is from New Zealand GDP. This finding is consistent with Selover and Round (1995) findings indicating that macroeconomic shocks are more likely to transmit from Australia to New Zealand than in the opposite direction.

Table 5
Variance Decomposition of LY_N
(in percentage terms)

Due to	Quarters Since Shock								
	1	4	8	12	16	20	40	60	66
LY_N	100	92.70	91.94	91.97	92.07	92.19	92.54	92.69	92.72
LY_A	0.00	6.66	7.43	7.42	7.32	7.21	6.86	6.71	6.68

Table 6
Variance Decomposition of LY_A
(in percentage terms)

Due to	Quarters Since Shock								
	1	4	8	12	16	20	40	60	66
LY_N	0.57	5.01	5.54	5.80	5.97	6.10	6.44	6.60	6.59
LY_A	93.95	83.12	81.43	80.78	80.39	80.12	79.47	79.23	79.18

4.2 Businesses-Cycle Transmission Equation (Equation II)

a. ADF Test

In equation (II), three of the six variables are found to be integrated of order one, i.e. I (1), including $\max\left(\frac{Trade_{ij}}{Y_i}, \frac{Trade_{ji}}{Y_j}\right)$, $|EMP_n - EMP_a|_t$ and LEXC. In contrast $|\Delta Y_n - \Delta Y_a|_t$, $|OCR_n - CR_a|_t$ and LOIL are found to be stationary (see Table 7). The results about

$|OCR_n - CR_a|_t$ are insignificant, since the ADF test has lower power to distinguish between a unit root and near unit root process (DeJong, et al., 1992).

Table 7
ADF Test Results (Equation II)

Lag Length: 0 (Automatic based on SIC, MAXLAG=10)							
	Levels I(0)			First differences I(1)			Order
	Exogenous	ADF test statistics	P-value	Exogenous	ADF test statistics	P-value	
$ \Delta Y_n - \Delta Y_a _t$	Constant	-9.2604	0.0000				I(0)
$\max\left(\frac{Trade_{ij}}{Y_i}, \frac{Trade_{ji}}{Y_j}\right)$	Constant and trend	-2.043	0.5665	Constant	-12.5167	0.0000	I(1)
$ OCR_n - CR_a _t$	Constant and trend	-3.1042	0.0311				I(0)
$ EMP_n - EMP_a _t$	Constant and trend	-2.7261	0.2301	Constant	-13.8531	0.0000	I(1)
LEXC	Constant	-2.059	0.2602	Constant	-6.4376	0.0000	I(1)
LOIL	Constant	-3.4626	0.0124				I(0)

b. Johansen Cointegration Analysis

Table 8 reports the finding of Johansen cointegration rank tests for the whole system,

including $|\Delta Y_n - \Delta Y_a|_t$, $\max\left(\frac{Trade_{ij}}{Y_i}, \frac{Trade_{ji}}{Y_j}\right)$, $|OCR_n - CR_a|_t$, $|EMP_n - EMP_a|_t$, LEXC with

LOIL as an exogenous variable. The result shows that there exist long run relations among the time series variables in equation (II), reflecting that the dependent variable $|\Delta Y_n - \Delta Y_a|_t$ is not exogenous to this system.

Table 8
Johansen Cointegration Rank Test Results (Equation II)

H_0	Eigenvalue	Trace Statistic	Max-Eigen Statistic	5% Critical Value*	
				Trace	Maximal
None **	0.497027	99.89617	41.23316	68.52	33.46
At most 1 **	0.373354	58.66301	28.04241	47.21	27.07
At most 2 *	0.276884	30.62060	19.451117	29.68	20.97
At most 3	0.138031	11.16943	8.912191	15.41	14.07
At most 4	0.036922	2.257239	2.257239	3.76	3.76
*(**) denotes rejection of the hypothesis at the 5%(1%) level					
Trace test indicates 3 cointegrating equation(s) at the 5% level					
Max-eigenvalue test indicates 2 cointegration at the 5% level					
* The critical values are taken from Osterwald-Lenum, M. (1992).					

c. VECM Estimation

The above Johansen cointegration rank tests (see Table 8) show the existence of cointegration relation among variables in equation II. As a result, the VECM is estimated. Table 9 presents the estimates for the speed of adjustment coefficients (α) and the cointegration vector (β) with standard errors in parentheses.

Table 9
VECM Estimation (Equation II)

Variable	(α)	(β)
$ \Delta Y_n - \Delta Y_a _t$	-1.4169 (0.2493)	1.0000
$\max\left(\frac{Trade_{ij}}{Y_i}, \frac{Trade_{ji}}{Y_j}\right)$	0.0077 (0.2767)	-0.1739 (0.0940)
$ OCR_n - CR_a _t$	-14.5642 (26.1757)	-0.0012 (0.0007)
$ EMP_n - EMP_a _t$	0.3024 (0.1807)	0.3715 (0.1066)
LEXC	0.2518 (0.3049)	-0.0609 (0.0425)
C		-0.0067

The long run equilibrium found in VECM estimates is shown in equation (4) below:

$$|\Delta Y_n - \Delta Y_a|_t = 0.0067 + 0.1739* \max\left(\frac{Trade_{ij}}{Y_i}, \frac{Trade_{ji}}{Y_j}\right) + 0.0012* |OCR_n - CR_a|_t - 0.3715* |EMP_n - EMP_a|_t + 0.0609* LEXC \quad (4)$$

Equation (4) shows that if New Zealand and Australia trade less, adopt more similar monetary policy, or have less similar economic structures, these two countries would have stronger economic correlation. In addition, equation (4) also shows that the decreasing bilateral exchange rates strengthen the synchronization across these two countries.

The results show that trade intensity has the most significant power to influence the shock transmission from Australia to New Zealand, followed by the similarity of economic structures, the similarity of monetary policies and the bilateral exchange rates. If New Zealand and Australia trade less or have less similar economic structures, the two countries would have stronger economic correlation. This is because of the wide difference in economy structures between New Zealand and Australia, which causes the two economies to be specialized in different industries. Therefore, the bilateral trade between New Zealand and Australia gets more and more concentrated in inter-industry trade. A shock within a specific industry thus would be less likely transmitted across these two countries. Furthermore,

similar monetary policies would also make New Zealand and Australian economies closer because they can provide similar economic conditions stimulating the two economies to grow in similar pattern. An exchange rate (NZD/AUD) decrease strengthens the shock transmission across the two countries. The reason is that Australian exporters have high market share in New Zealand, and therefore they are able to raise products price when NZD appreciate while maintaining prices the same (or deduce prices by a small proportion).

d. Granger Causality Test

The VECM results show how transmission channels influence economy correlation between New Zealand and Australia, especially the direction (positive or negative) and degree (how much).

Table 10 reports the statistic result for Granger-Causality test on equation II indicating that all independent variables do not Granger cause the economic correlation between New Zealand and Australia ($|\Delta Y_n - \Delta Y_a|_t$). The lack of Granger-Causality relationship between $|\Delta Y_n - \Delta Y_a|_t$ and four endogenous variables is implausible given there is a cointegration relationship found among them (Granger, 1988).

Table 10
Granger Causality Test Results (Equation II)

Descriptions	Chi-sq statistics	P-Value
$\max\left(\frac{Trade_{ij}}{Y_i}, \frac{Trade_{ji}}{Y_j}\right)$ does not Granger Causality $ \Delta Y_n - \Delta Y_a _t$	0.0247	0.8751
$ OCR_n - CR_a _t$ does not Granger Causality $ \Delta Y_n - \Delta Y_a _t$	0.0099	0.9207
$ EMP_n - EMP_a _t$ does not Granger Causality $ \Delta Y_n - \Delta Y_a _t$	1.3067	0.2530
LEXC does not Granger Causality $ \Delta Y_n - \Delta Y_a _t$	0.3010	0.5833

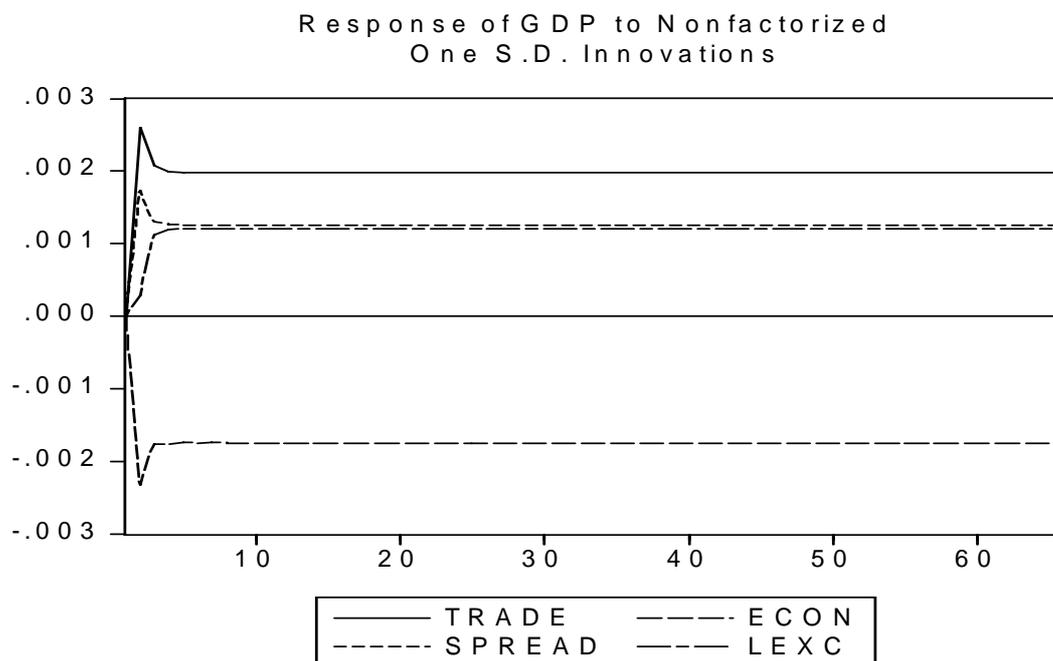
e. Impulse Response Analysis

The Impulse-Response-Analysis is conducted on the economic correlation ($|\Delta Y_n - \Delta Y_a|_t$), trade intensity ($\max\left(\frac{Trade_{ij}}{Y_i}, \frac{Trade_{ji}}{Y_j}\right)$), the similarity of monetary policies ($|OCR_n - CR_a|_t$), the similarity of economy structures ($|EMP_n - EMP_a|_t$) and the bilateral exchange rates

(LEXC). The result is plotted in figure 4, where GDP means $|\Delta Y_n - \Delta Y_a|_t$, TRADE stands for $\max\left(\frac{Trade_{ij}}{Y_i}, \frac{Trade_{ji}}{Y_j}\right)$, spreads are $|OCR_n - CR_a|_t$ and ECON denotes $|EMP_n - EMP_a|_t$

Figure 3

Response of $|\Delta Y_n - \Delta Y_a|_t$ to $\max\left(\frac{Trade_{ij}}{Y_i}, \frac{Trade_{ji}}{Y_j}\right)$, $|OCR_n - CR_a|_t$, $|EMP_n - EMP_a|_t$ and LEXC



From Figure 3, it is evident that the economic correlation between New Zealand and Australia positively responds to one standard deviation shocks in trade intensity, the similarity of monetary policies and the bilateral exchange rates while negatively to the similarity of economic structures. In addition, the trade intensity has the most significant power to influence the economic correlation between New Zealand, followed by the similarity of economic structures, the similarity of monetary policies and the bilateral exchange rates.

4.3 ERPT-Analysis Equation (Equation III)

a ADF Test

Table 11 shows all variables in equation (III) are found to be integrated of order one, i.e., I(1).

Table 11
ADF Test Results (Equation III)

Lag Length: 0 (Automatic based on SIC, MAXLAG=10)							
	Levels I(0)			First differences I(1)			Order
	Exogenous	ADF test statistics	P-value	Exogenous	ADF test statistics	P-value	
logp	Constant	-1.2092	0.6657	Constant	-7.3262	0.0000	I(1)
loge	Constant	-2.059	0.2602	Constant	-6.4376	0.0000	I(1)
logw	Constant and trend	-6.0374	0.9731	Constant and trend	-4.4123	0.0042	I(1)
logd	Constant and trend	-1.6252	0.7722	Constant	-8.3196	0.0000	I(1)

b. Johansen Cointegration Analysis

In Johansen-Cointegration-Analysis, trace test shows two cointegrating equations while Max-eigenvalue test shows one (see Table 12). The results of λ_{trace} and λ_{max} contradicts with each other. The λ_{max} test has the sharper alternative hypothesis and it usually preferred for trying to pin down the number of cointegrating vectors. To be conservative, the maxeigenvalue test result is used and assumed here is no cointegration relation between variables.

Table 12
Johansen Cointegration Rank Test Results (Equation III)

H ₀	Eigenvalue	Trace Statistic	Max-Eigen Statistic	5% Critical Value*	
				Trace	Maximal
None **	0.320924	54.88216	24.76939	47.21	54.46
At most 1 *	0.252180	30.11278	18.59795	29.68	35.65
At most 2	0.133631	11.51482	9.180428	15.41	20.04
At most 3	0.035818	2.334394	2.334394	3.76	6.65
*(**) denotes rejection of the hypothesis at the 5%(1%) level					
Trace test indicates 2 cointegrating equation(s) at the 5% level					
Max-eigenvalue test indicates no cointegration at both 5% and 1% levels					
* The critical values are taken from Osterwald-Lenum, M. (1992).					

c. Estimation for ERPT Elasticity

In order to compare the ERPT level between pre-1991 and post-1991, equation (2) was re-run three times, i.e., for full sample period, pre-1991 sample period and post-1991 sample period. Their results are shown in Tables 13, 14 and 15 respectively.

Table 13
Estimation for Equation 2 (86:Q1-02:Q2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPM(-1)	0.087249	0.095814	0.910606	0.3661
DEXC	0.709156	0.108865	6.514076	0.0000
DWET	0.394727	0.397555	0.992887	0.3248
DDEMAND	0.046925	0.155169	0.302410	0.7634
C	0.000327	0.002475	0.132044	0.8954

Table 14
Estimation for Equation 2 (86:Q1-90:Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPM(-1)	-0.127295	0.148482	-0.857306	0.4057
DEXC	0.862015	0.171405	5.029107	0.0002
DWET	-0.001273	0.909042	-0.001400	0.9989
DDEMAND	-0.222097	0.302495	-0.734217	0.4749
C	0.005871	0.007822	0.750574	0.4653

Table 15
Estimation for Equation 2 (91:Q1-02:Q2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPM(-1)	0.291594	0.128894	2.262282	0.0290
DEXC	0.579950	0.139870	4.146363	0.0002
DWET	-0.212476	0.597245	-0.355760	0.7238
DDEMAND	0.441495	0.190475	2.317860	0.0255
C	0.000828	0.002590	0.319918	0.7507

In equation (2), γ represents the short-term ERPT elasticity into import prices, and $\theta = \frac{\gamma}{1-\beta}$ catches the long-term ERPT elasticity. ERPT elasticities for different sample periods are calculated and reported in table 16.

Table 16
Estimation for ERPT Elasticity

Full Sample Pass-Through Elasticity 1986:Q1-2002:Q2		Pre 1991 Period Pass-Through Elasticity 1986:Q1-1990:Q4		Post-1991 Period Pass-Through Elasticity 1991:Q1-2002:Q2	
Short-Term	Long-Term	Short-Term	Long-Term	Short-Term	Long-Term
0.7092	0.7769	0.8620	0.7647	0.5800	0.8187

From Table 16, it is shown that Australian exporters passed-through most exchange rate fluctuations into New Zealand import price, about 71% in the short run and 77.69% in the long run. This shows that the ERPT level in New Zealand is between zero and 100%, which is identical to the findings from Yang (1998), Campa and Goldberg (2002) and Lee (2004). The calculated ERPT level is solely from Australia. It is higher than the average short-run and long-run ERPT elasticities from the rest of the world to New Zealand during the period 1975-1999, which are 58.2% and 76.7% respectively (see Campa and Goldberg, 2002). The high ERPT level can be partially explained by the fact that a great portion of New Zealand imported products from Australia are energy and raw material, which have nearly 100% pass-through elasticities (Campa and Goldberg, 2002).

For the full sample period (1986:Q1-2002:Q2) and the post-91 sample period (1991:Q1-2002:Q2), long-term ERPT elasticity is higher than short-term elasticity. This is consistent with Campa and Goldberg (2002) and Lee (2004) findings. In contrast, for the pre-91 sample period (1986:Q1-1990: Q4), the short-term ERPT elasticity is higher than long-term ERPT elasticity, contradicting Lee's (2004) findings. This is due to the significantly higher inflation rates before 1990 compared to that after 1990, because the short-run ERPT elasticity is significantly influenced by inflation environment (Taylor, 2000; Choudhri and Hakura, 2001; and Campa and Goldberg, 2002).

Furthermore, the short-term ERPT elasticity decreased dramatically, which is consistent with Campa and Goldberg (2002) finding but contradicts Lee (2004) findings. On the other hand, the long-term ERPT elasticity increased slightly, which is consistent with Lee (2004) findings but contradicts Campa and Goldberg (2002) findings.

Taylor (2000), Choudhri and Hakura (2001) and Campa and Goldberg (2002) noted that besides inflation rate, nominal exchange rate volatility also impacts ERPT level, especially the short run ERPT. Therefore, the combined force of exchange rate volatility and inflation

rates drives the changes in ERPT level. The volatilities of bilateral exchange rate (NZD/AUD) during each sample period are shown in Table 17.

Table 17
Standard Deviation of the Bilateral Exchange Rate

86:Q1-02:Q2	86:Q1-90:Q4	91:Q1-02:Q2
0.082167	0.078875	0.082316

It is clear that the bilateral exchange rate became more volatile during the post-91 sample period. According to Taylor (2000), Choudhri and Hakura (2001) and Campa and Goldberg (2002), more volatile exchange rate should result in higher ERPT. The short-run ERPT elasticity is influenced more by inflation rate, compared to the volatility of the bilateral exchange rate. The long run ERPT elasticity, on the other hand, is more driven by the force of exchange rate volatility rather than inflation rate.

5. Conclusions

This paper systematically analyses the shock-transmission channels, including trade, monetary policy, and exchange rates, from Australia to New Zealand over the period 1986Q1 to 2002Q2. It found that if New Zealand and Australia trade less, have more similar monetary policies, have less similar economic structures or have smaller exchange rates differences (NZD/AUD), these two countries would have stronger economy correlation. The highly integrated banking systems of Australia and New Zealand are additional avenue for shock transmission between these two countries.

The findings of this paper reflect the importance of international coordination of monetary policies suggesting RBA takes the impact of Australian economy on New Zealand economy into account especially when they adopt policies that would lead AUD to depreciate. This thesis also predicts that New Zealand and Australia would have closer economic correlation after the establishment of AUFTA.

New Zealand relies more on Australia in the bilateral trade and Australian banks dominate the New Zealand banking market. In addition, the results are also consistent with Selover and Round (1995) findings, which claimed that 15.9% of the variance in New Zealand's GDP is

from Australia, while only 8.4% of the variance in Australian GDP is accountable by New Zealand during the period 1969Q1 to 1994Q1.

The trade intensity has the most significant power to influence the shock transmission from Australia to New Zealand, followed by the similarity of economic structures, the similarity of monetary policies and the bilateral exchange rates. In addition, if New Zealand and Australia trade less or have less similar economic structures, these two countries would have stronger economic correlation. Wide differences in economy structures between New Zealand and Australia cause these two economies to be specialized in different industries. Therefore, the bilateral trade between New Zealand and Australia gets more and more concentrated in inter-industry trade. An industry-specific shock thus would be less likely transmitted across these two countries. More similar monetary policies would also make New Zealand and Australia move closer in economy because they can provide similar economic conditions stimulating these two economies to grow in similar pattern.

An appreciation of New Zealand currency would strengthen the shock transmission across these two countries because Australian exporters have high market share in New Zealand. This finding further demonstrates that the floating exchange rate regime cannot ensure completely that New Zealand can get rid of external economy shocks (see Devereux and Engel, 1998; Dornbusch, 1983; Lastrapes and Koray, 1990).

The long-term ERPT elasticity is higher than short-term elasticity for the full sample period (1986:Q1-2002:Q2) and the post-91 sample period (1991:Q1-2002:Q2). This is identical with Campa and Goldberg (2002) and Lee (2004) findings. However, for the pre-91 sample period (1986:Q1-1990:Q4), this study finds that the short-term ERPT elasticity is higher than long-term ERPT elasticity, contradicting Campa and Goldberg (2002) and Lee (2004) findings. The possible explanation is that the short-run ERPT level in New Zealand is more subjected to the inflation environment.

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