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Consequences of FDI in Australia- Causal Links Between FDI, Domestic Investment, Economic Growth and Trade

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Abstract: In this paper the consequences of FDI inflows in Australia, the second largest net importer of FDI in the developed world, are analysed using quarterly aggregate data for Q3/1985 to Q2/2002. The dynamic relationship between Australia's aggregate quarterly FDI inflows and a set of endogenous variables including GDP, domestic investment, imports and exports was explored by estimating a multivariate vector error correction model. Granger-causality tests and impulse response analysis were applied. FDI was found to directly increase domestic investment growth, GDP growth and FDI itself, but decrease export growth. Furthermore, through its impact on GDP growth, FDI also leads to an increase in import growth.

Key Words: FDI; Vector error correction model

JEL Classification: F21, C32

I Introduction

Increased globalisation over the last two decades has led to strong growth of international business activity and foreign direct investment (FDI), which in turn has led to extensive research on the determinants and consequences of FDI. Despite the considerable amount of research that has been undertaken, Australia – the second largest net importer of FDI in the developed world[1] – represents a country with a substantial share of foreign ownership whose FDI experience has been largely overlooked in terms of a comprehensive economic analysis. Empirical work on FDI and its determinants and consequences is still limited. This situation exists despite the fact that Australia's FDI[2] stock was worth US$ 111.1 billion in 2001, the twelfth largest in the world[3], and that Australia ranked tenth in the world in terms of most attractive investment destination.[4] Between 1990 and 2001, Australia received an average of US$ 6.5 billion in FDI inflows a year. Australia's inward FDI stock was as much as 29.2% of its GDP – larger than the average for developed economies at 17.1%.[5]

The purpose of this analysis is to determine how Australia's volatile FDI experience has affected the Australian economy.[6] While a variety of welfare effects including productivity growth, employment and wage growth and effects on industry concentration are possible and deserve further analysis, this paper focuses on how FDI in Australia affects key aggregate variables such as trade, domestic investment and GDP growth. In order to analyse the effects, new and previously unused quarterly data for FDI in Australia have been explored with some interesting results. The long-term effects of an increase in quarterly FDI inflows were an increase in domestic investment growth, GDP growth and FDI itself, but also a reduction in export growth. Through its effect on GDP growth, FDI also led to an increase in import growth. Taking indirect effects into account, FDI led to GDP growth, leading to increased domestic investment growth, GDP growth, import growth and FDI, but to reduced export growth. Hence, FDI is a favourable source of capital for the Australian economy, but it is not favourable for Australia's balance of payments position.

The paper is organised hereafter as follows. In section 2, theoretical and empirical issues related to consequences of FDI are reviewed. In section 3, the empirical results related to the consequences of quarterly FDI in Australia are discussed. Section 4 makes some concluding remarks and outlines possible directions for further research.

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[1] Australia's net imports of FDI between 1995 and 2004 were US$ 44.4 billion. OECD (2005), p.8.

[2] Australian FDI is defined as investment in overseas enterprises in which the Australian organisation has a significant influence and owns not less than 10% of the ordinary shares or equivalent. The Australian Bureau of Statistics (ABS) changed the minimum ownership level from 25% to 10% in June 1985. Source: www.abs.gov.au.

[3] UNCTAD (2002), p. 310, Annex table B.3.

[4] A.T. Kearney and Global Business Policy Council (2002), p.2, Figure 1.

[5] UNCTAD (2002), p. 320, Annex table B.6.

[6] Consequences of FDI are obviously not the only important issue. Determinants of FDI in Australia are also of great importance and have been analysed in related research by the author.

II Theoretical Issues and Related Empirical Findings

II.I General Theoretical Models and Empirical Studies of Consequences of FDI

Since FDI can be explained by a variety of competing or complementing theories (such as neoclassical trade theory, imperfect competition, Dunning's OLI framework, new trade theory and game theoretic frameworks), a wide range of potential effects exists and can be experimented with in empirical studies in order to find the actual consequences of FDI.

Factor price equalisation is the major consequence of capital mobility according to the neoclassical trade theory, though foreign investment can also benefit the Host (i.e. the country in which the investment takes place) through a larger capital stock, increased tax revenues for Host governments, production expansion, increased labour productivity, higher wages, increased employment, technology spillovers and balance of payments effects.[7]

Models viewing FDI as investment linked to imperfect competition show that FDI has beneficial effects through the transfer of managerial or entrepreneurial skills, while setting up foreign affiliates may also increase competition and improve market performance of the monopolistic industries they are based in.[8] According to Dunning's (1993) OLI framework and the theory of multinational enterprises, the welfare effects of FDI in Host countries are more difficult to define and depend on a variety of measures including technology spillover, linkages and other spillover effects, effects on the market structure, employment effects, balance of payments and trade effects, effects on economic growth and non-economic effects which in turn depend on the political, economic and cultural environment.

The new trade theory[9] explores the economic implications of increasing returns to scale, entry barriers, product differentiation, imperfect competition and transport costs. The consequences of FDI are often ambiguous. It is, for instance, inconclusive whether the inflow of FDI drives out national firms and increases monopoly power or whether it improves domestic efficiency and competitiveness. It is sometimes difficult to determine whether FDI improves the human capital and skills of the domestic population or if it merely redistributes income. FDI could lead to the diffusion of new technology in the Host, but it is also possible that it could encourage the introduction of inappropriate technologies through manipulative advertising. It is often unclear on balance whether FDI benefits the Host by introducing new efficient methods of corporate governance, or whether it negatively affects the economy by avoiding social accountability. The effects of FDI on trade depend on whether imports of intermediate inputs

[7] See Mundell (1957), MacDougall (1960), Streeten (1969) and Feenstra and Hanson (1996).
[8] See Hymer (1960), Vernon (1966), Aharoni (1966), Kindleberger (1969) and Caves (1971), Buckley and Casson (1976), Teece (1981) and Casson (1987).
[9] See Krugman (1983), Markusen (1984), Helpman (1984 and 1985), Horstmann and Markusen (1987a, 1987b and 1992) and literature related to the knowledge capital model by Markusen et al. (1996), Markusen (1997 and 2002).

increase by more or less than final good imports decrease and on whether FDI is market or export oriented and production or distribution oriented. Despite these ambiguities, the general consensus coming from the literature seems to be that the ultimate effects depend on the integration of FDI with the Host economy and the extent of spillovers in terms of technological diffusion, employment, training and competitive efficiency.

In Game Theoretic Frameworks, determinants of FDI can be a range of political or economic factors and thus depend on the relative bargaining strength of the parties involved – one commonly analysed example being the trade-off between increased tax revenue though MNE production and decreased tax revenue through incentives offered in order to attract the MNE in the first place.[10] The consequences need to be considered over a long time frame and the evaluation should occur in relation to alternative investment projects. However the distribution of gains will be indeterminate within a range of possible outcomes.

Given the variety of theories and different theoretical predictions on effects of FDI, the welfare outcome for a country is hard to predict and should best be determined empirically. In this case, aggregate quarterly data are used to test the consequences of FDI on aggregate variables such as economic growth, trade and domestic investment. The majority of previous empirical studies suggest that FDI should increase economic growth and exports, while the effect on domestic investment and imports is unclear.

Blomström et al. (1994), Borensztein et al. (1998), De Mello (1999), Zhang (2001) and Shan (2002) suggest that economic growth has a significantly positive effect on FDI. However, in a number of studies the link depends on the business environment in the Host country. Studies that did not substantiate that link include Carkovic and Levine (2000) and Chakraborty and Basu (2002). Many studies, including Van Loo (1977), Bosworth et al. (1999), De Mello (1999) and Hejazi (2002), also seem to find support for the hypothesis that FDI has a crowding-in effect on domestic investment, i.e. FDI increases domestic investment, though there are also some (such as Lipsey (2000) and Kim and Seo (2003)) that were not able to find any significant links, while others (such as Agosin and Mayer (2000) for Latin America) find evidence for a crowding-out effect, i.e. FDI reduces domestic investment. FDI is generally found to have a positive effect on exports – either by increasing exports directly (see, for instance, Wong (1988), Pain and Wakelin (1998) and Liu et al. (2001)), by establishing subsidiaries that are more export-oriented than local firms (see Lall and Streeten (1977) and Barry and Bradley (1997)) or by affecting the export orientation of local firms (Aitken et al. (1997) and Sousa et al. (2000)). The effect that FDI has on imports appears to be less clear with many studies (including Lall and Streeten (1977), Wong (1998) and Liu et al. (2001)) not being able to find a

[10] See Bond and Samuelson (1986), Haaparanta (1996), Raff and Srinivasan (1998), Barros and Cabral (2001) and Haaland and Wooton (1999, 2001a and 2001b).

significant link between FDI and imports and only one study (Graham and Krugman (1993)) finding a significantly positive effect.

II.II Australian Empirical Studies of Consequences of FDI

Empirical research of the effects of FDI on economic growth, domestic investment and trade is limited to company surveys by Brash (1966), the ABS (1998 and 2004) and econometric studies by Bora (1998), Donovan and Mai (1996), Layton and Makin (1993), Makin (1998) and Fisher et al. (1998).

Company surveys and econometric studies suggest an unclear link between FDI and trade. Brash (1966) found affiliates of US manufacturing companies to have a high imports to sales ratio, but a relatively low exports to sales ratio (i.e. foreign affiliates in Australia produced primarily to supply the local market). The ABS (2004) also found foreign-owned businesses to import more than they export, thereby increasing Australia's balance of payments deficit.[11] In contrast, the ABS (1998) and Bora (1998) found foreign affiliates to be more export-oriented than domestic firms, while Donovan and Mai (1996) used a general equilibrium model to show that foreign investment has a beneficial effect on trade, as it makes Australia more capital-intensive and thus strengthens Australia's comparative advantage in capital-intensive industries, such as mining.

Econometric studies further found foreign investment or FDI to have a positive effect on Australia's national income. Both Layton and Makin (1993) and Makin (1998) estimated economy-wide production functions and found that foreign capital flows (including FDI) during the 1980s raised Australian national income by more than would have otherwise been the case.[12] Their estimates did not include national income gains through increased productivity in the Host country due to foreign investment, which would have raised national income even more. Fisher et al. (1998) found foreign investment to increase overall investment, which, in turn, leads to increased national output, employment and income.

Overall, FDI is found to have a positive effect on output and domestic investment, but may have a negative effect on Australia's trade performance, increasing imports by more than exports. Considering the importance of the issue, research on the impact of FDI on the Australian economy is still limited and often dated. It is therefore essential to look at the effects of FDI in Australia in more detail and for a longer time period to see whether the previous results can be substantiated or whether different results emerge.

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[11] In 2002/03, foreign-owned firms in Australia exported goods and services worth A$ 61.4 billion, but imported goods and services worth A$ 93.2 billion, thereby accounting for a trade deficit of A$ 31.8 billion.

[12] According to Layton and Makin (1993), the cumulated net benefit to each Australian between 1984/85 and 1988/89 was around A$ 740 (1984/85 dollars), while Makin (1998) found the national income gain to each Australian between 1981/82 and 1991/92 to be around A$ 1,065 (1991/92 dollars).

III Framework and Results/Methodology, Data and Estimation

III.I Data

In order to explore of the consequences of Australian FDI, a dynamic relationship between FDI, domestic investment, economic growth and trade (including imports and exports) in Australia, the five time series illustrated in Figure 1, was analysed. Since economic theory is limited in its ability to determine the dynamic relationship of the five variables and provides only limited guidance to empirical work, a statistical approach was chosen to analyse their relationship and to let the data speak for themselves.

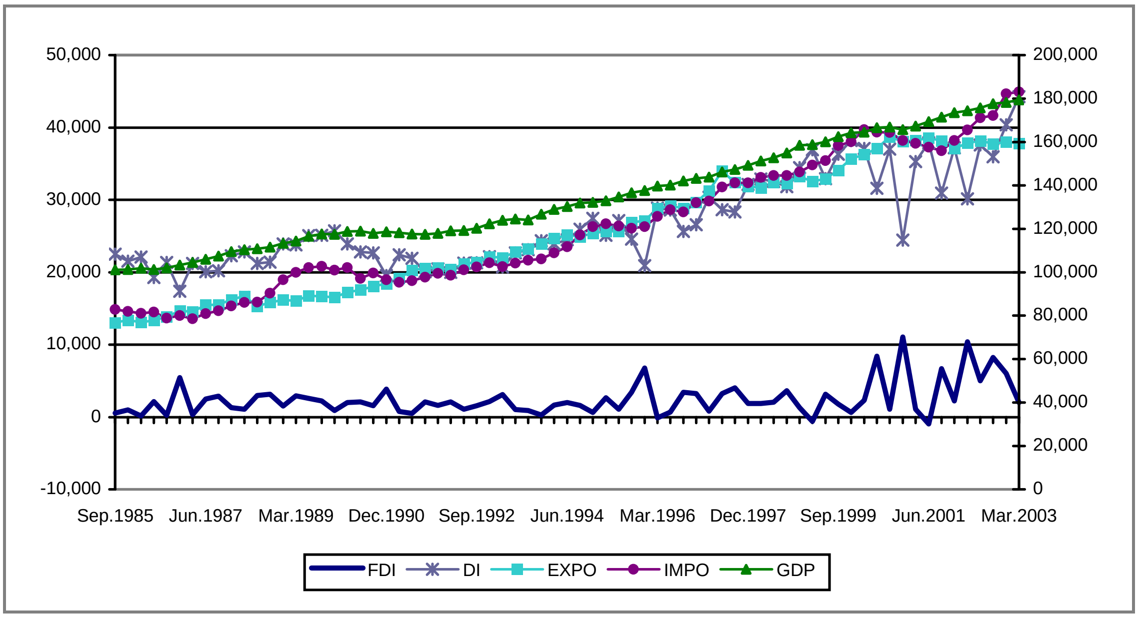

Figure 1: Quarterly data on FDI, GDP, Domestic Investment, Exports and Imports in Australia, Q3/1985 to Q1/2003

This approach was inspired by a number of studies, including Liu et al's (2001) analysis of the dynamic relationship between Chinese FDI, imports and exports, Chakraborty and Basu's (2002) structural cointegration model of Indian FDI and economic growth, Shan's (2002) VAR approach analysing the interrelationships between Chinese FDI and other economic variables including economic growth and Kim and Seo's (2003) analysis of the relationship between Korean FDI, domestic investment and economic growth (all of which were discussed in Chapter 7.1) as well as Pfaffermayr's (1994) analysis of Austrian outward FDI and exports.

For the analysis of the dynamic relationship between FDI, domestic investment, GDP, exports and imports in Australia, a multivariate Vector Autoregression (VAR) model was estimated, using quarterly real data for the period Q1/1985 to Q2/2003, giving 72 observations. The FDI series includes three negative values (in Q1/1996, Q1/1999 and Q2/2001), depicting disinvestments. The FDI and domestic investment series were deflated using the price index for private gross fixed capital expenditure (plant & equipment) with 2000/01 prices as a deflator. The GDP, exports and imports series were used in real form (in 2000/01 prices) and seasonally adjusted.

The five variables were treated symmetrically and endogenously since the possibility that FDI affected domestic investment, GDP, imports and exports and that those variables affected FDI or that the variables affected each other needed to be considered. Each variable was expressed as a linear combination of lagged values of itself and lagged values of the other variables. The lag specification seemed reasonable, since it may take a number of time periods for the dependent variables to adjust to changes in the explanatory variables.

Before setting up the model, one should have a brief look at the different explanatory variables in the VAR Model and give reasons for the predicted effect of each variable. Not all possible combinations will be discussed, since this study focuses on FDI and its effects. FDI is expected to either positively or negatively affect domestic investment (depending on whether two variables are substitutes or complements). Furthermore, FDI is expected to have a positive effect on GDP, a positive or negative effect on imports (depending on whether FDI increases intermediate good imports by more or less than it reduces final good imports) and a positive effect on exports (if MNEs are more export-oriented than domestic firms). Domestic investment could either positively or negatively affect FDI, depending on whether domestic investment is an indicator for a favourable business environment of whether it crowds out FDI inflows. Exports were expected to have a positive effect on FDI, as MNEs may switch from trade to local production, while the effect of imports is unclear. GDP was expected to increase FDI (or at least on horizontal FDI), since serving a market directly becomes more efficient relative to exporting, the larger the market is. Following the same line of thought, economic growth should encourage FDI.

III.II Model Specification and Estimation

Having discussed the relevant variables used in the analysis, the model can be stated as follows: [13]

$$\begin{bmatrix} ausrfdi_t \\ ausrdi_t \\ ausrimpo_t \\ ausrexpo_t \\ ausrgdp_t \end{bmatrix} = \begin{bmatrix} \Phi_{11}(L) & \Phi_{12}(L) & \Phi_{13}(L) & \Phi_{14}(L) & \Phi_{15}(L) \\ \Phi_{21}(L) & \Phi_{22}(L) & \Phi_{23}(L) & \Phi_{24}(L) & \Phi_{25}(L) \\ \Phi_{31}(L) & \Phi_{32}(L) & \Phi_{33}(L) & \Phi_{34}(L) & \Phi_{35}(L) \\ \Phi_{41}(L) & \Phi_{42}(L) & \Phi_{43}(L) & \Phi_{44}(L) & \Phi_{45}(L) \\ \Phi_{51}(L) & \Phi_{52}(L) & \Phi_{53}(L) & \Phi_{54}(L) & \Phi_{55}(L) \end{bmatrix} \begin{bmatrix} ausrfdi_t \\ ausrdi_t \\ ausrimpo_t \\ ausrexpo_t \\ ausrgdp_t \end{bmatrix} + \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \\ e_{5t} \end{bmatrix}$$

[13] Johnston and DiNardo (1997), p.287 and Eviews (2001), p.519.

(where $ausrfdi_t$ is the FDI series, $ausrdi_t$ is the domestic investment series, $ausrimpo_t$ is the import series, $ausrexpo_t$ is the export series and $ausrgdp_t$ is the GDP series, Φ_{11}, Φ_{12},… Φ_{55} are lag polynomials, (c_1, c_2,…c_5) are the intercepts, and (ε_{1t}, ε_{2t}, …ε_{5t}) ~ N(0, Σ) are white noise error terms).

This can also be written as:[14]

$$Y_t = \Phi_1 Y_{t-1} + \ldots + \Phi_p Y_{t-p} + c + \varepsilon_t = \sum_{i=1}^{p} \Phi_i Y_{t-i} + c + \varepsilon_t$$

(with Y_t = $ausrfdi_t$, $ausrdi_t$, $ausrimpo_t$, $ausrexpo_t$, $ausrgdp_t$, where Y_t is a (5x1) vector of [$ausrfdi_t$, $ausrdi_t$, $ausrimpo_t$, $ausrexpo_t$, $ausrgdp_t$], Φ_i is a (5x5) matrix of parameters, c is a (5x1) vector of intercepts and ε_t ~ N(0, Σ) are white noise error terms).

As a first step of setting up the model, the appropriate lag lengths of the five variables included ($ausrfdi_t$, $ausrdi_t$, $ausrimpo_t$, $ausrexpo_t$, $ausrgdp_t$) needed to be found. Generally, the Schwarz Information Criterion (SC) should be used to choose the appropriate lag lengths. The SIC was minimised for the inclusion of only one lag, as was the Hannan-Quinn Information Criterion. Since the variables may not only have short-term, but also medium- to long-term effects on other variables, the inclusion of more than one lag – since one lag in levels form is equivalent to no lag in first differences – may be a better representation of the data generating process. According to alternative measures (including the Akaike Information Criterion, the LR test statistic and the Final Prediction Error), the appropriate lag length was four lags, four lags were chosen for each variable in the model. For the estimation of the VAR in levels form see Table 1.

[14] In the error correction equation, c captures trends in variables that do have trends. Hence no further trend is included at this stage.

Table 1: Consequences of Quarterly Aggregate FDI in Australia, VAR Model Estimation

Dependent Variables: ***ausrfdi*, *ausrdi*, *ausrimpo*, *ausrexpo*, *ausrgdp***
Least Squares. Observations (adjusted): 67 (Q3/1986 to Q1/2003)

		***ausrfdi* Equation**		***ausrdi* Equation**		***ausrimpo* Equation**		***ausrexpo* Equation**		***ausrgdp* Equation**	
Variable	**Lags**	**Coeff**	**t-stat**	**Coeff**	**t-stat**	**Coeff**	**t-stat**	**Coeff**	**t-stat**	**Coeff**	**t-stat**
aurfdi	**1**	0.020	0.038	0.997**	1.762	0.167	1.019	0.332**	1.931	0.512**	2.688
	2	1.423**	2.076	-1.648**	-2.273	-0.007	-0.035	-0.424**	-1.927	-0.712**	-2.917
	3	-0.377	-0.491	0.763	0.940	-0.149	-0.633	-0.192	-0.778	-0.020	-0.072
	4	-1.154**	-1.860	1.062*	1.618	-0.043	-0.224	-0.059	-0.294	0.351*	1.588
ausrdi	**1**	0.344	0.658	0.647	1.170	0.141	0.881	0.305**	1.818	0.491**	2.638
	2	1.371**	2.078	-1.576**	-2.257	-0.001	-0.007	-0.442**	-2.082	-0.616**	-2.622
	3	-0.362	-0.497	0.707	0.916	-0.128	-0.574	-0.075	-0.319	-0.024	-0.092
	4	-0.813	-1.377	0.695	1.113	-0.017	-0.095	0.056	0.296	0.268	1.272
ausrimpo	**1**	-1.105**	-1.921	1.204**	1.979	0.662**	3.756	-0.199	-1.078	0.067	0.326
	2	-0.644	-0.950	0.689	0.960	0.313*	1.509	0.422**	1.938	0.062	0.257
	3	1.304**	1.749	-1.954**	-2.476	-0.424**	-1.856	-0.087	-0.362	-0.006	-0.022
	4	-0.599	-0.944	0.731	1.087	-0.008	-0.043	0.124	0.608	-0.044	-0.193
ausrexpo	**1**	0.036	0.078	-0.217	-0.441	0.063	0.443	0.901**	6.038	-0.128	-0.775
	2	0.807	1.250	-0.668	-0.978	-0.184	-0.929	-0.050	-0.240	0.365*	1.586
	3	-1.001*	-1.605	1.047*	1.586	0.198	1.037	-0.160	-0.796	-0.305	-1.375
	4	0.402	0.878	-0.241	-0.497	-0.100	-0.714	0.129	0.879	0.417**	2.556
ausrgdp	**1**	-0.554	-1.347	0.767**	1.762	0.105	0.834	-0.161	-1.220	0.930**	6.351
	2	-0.218	-0.379	-0.028	-0.047	0.021	0.119	0.118	0.638	-0.126	-0.616
	3	0.668	1.195	-0.471	-0.796	0.224	1.306	0.235	1.310	0.377**	1.893
	4	0.332	0.863	-0.414	-1.016	-0.166	-1.411	-0.180*	-1.459	-0.365**	-2.665
C	---	-19,596.880**	-1.778	13,772.370	1.181	-11,998.890**	-3.553	1,712.526	0.484	11,429.790**	2.912
** significant at 10% critical value, * significant at 15% critical value											
R-squared			0.459		0.999		0.996		0.995		0.916
Adjusted R-squared			0.224		0.880		0.995		0.993		0.999
S.E. of regression			2,078.869		2,199.891		637.128		668.091		740.572
Sum squared resid			199,000,000.000		223,000,000.000		18,672,892.000		20,531,903.000		25,228,523.000
F-statistic			1.951		25.194		642.708		498.238		3,193.792
Log likelihood			-594.323		-598.114		-515.088		-518.268		-525.168
Akaike AIC			18.368		18.481		16.003		16.098		16.304
Schwarz SC			19.059		19.172		16.694		16.789		16.995
Mean dependent			2,557.311		27,242.010		26,861.600		26,221.390		137,020.100
S.D. dependent			2,359.375		6,349.866		8,907.432		8,228.055		23,047.280

The five equations explained between 45.9% and 99.9% of the variation of the relevant variable. The equations of *ausrdi*, *ausrimpo* and *ausrexpo* appeared to be the best representations of the data generating process. The equation for *ausrfdi* had little explanatory power. The next step was to test whether the variables were stationary. From Figure 1 it appeared likely that some of the variables were nonstationary and should therefore not be used in levels form. The augmented Dickey Fuller test, which tests for the presence of a unit root, was used to test all variables for stationarity. For this test, it was assumed that the data generating process could be represented by the following equation:[15]

$$\Delta y_t = \mu_0 + \mu_1 t + \gamma y_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta y_{t-i} + \varepsilon_t$$

with y_t = $ausrfdi_t$, $ausrdi_t$, $ausrimpo_t$, $ausrexpo_t$ or $ausrgdp_t$; t = trend; μ, γ and δ = coefficients

Dickey-Fuller Tests can then be performed by testing combined restrictions on the coefficients in this equation. The test is applied to regressions run in the following two forms[16]:

[15] Pfaffermayr (1994), pp.340-341.

[16] The test for unit root and no intercept or trend was ignored, as it is usually reasonable to include an intercept in the equation. For completeness, the test for unit root and no intercept or trend would be

1. $$\Delta y_t = \mu_0 + \gamma y_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta y_{t-i} + \varepsilon_t$$ with H_o: $\mu_0 = \gamma = 0$ as a test for unit root and intercept,

2. $$\Delta y_t = \mu_0 + \mu_1 t + \gamma y_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta y_{t-i} + \varepsilon_t$$

with H_o: $\mu_0 = \mu_1 = \gamma = 0$ as a test for unit root, intercept and deterministic trend.

The order of autoregressive corrections ($u_t = \sum_{i=1}^{p-1} \delta_i \Delta y_{t-i} + \varepsilon_t$) was chosen automatically by Eviews). For each time series, it was initially tested whether the series was stationary when an intercept was included in the equation. When the hypothesis of a unit root was not rejected, it was tested whether the series was trend-stationary, i.e. whether it was stationary when it included an intercept and a trend. When the hypothesis was not rejected either, the time series was differenced once. It was then tested whether the series in first differences was stationary when an intercept was included in the equation, etc. Following the same procedure as for level series, the testing continued until the hypothesis of a unit root was not rejected and the time series were stationary. The test results are illustrated in Table 2.

For the FDI series, the unit root hypothesis was rejected at a 10% level when an intercept was included, indicating that the series was stationary and should be used in levels form. For the domestic investment, import, export and GDP series, the unit root hypothesis was not rejected at a 10% level when an intercept or an intercept and a trend were included. After differencing the series once, the hypothesis of a unit root was rejected at a 10% level in all four cases when an intercept was included. Hence, the variables should be used in first differences as they were now stationary. The plots of *ausrfdi, Δausrdi, Δausrimpo, Δausrexpo* and *Δausrgdp* are illustrated in Figures 2 and 3.

Table 2: Unit Root Testing (Augmented Dickey Fuller Test), VAR Model

Variables	Lag length (automatic based on SIC, maxlag = 8)	t-stat	10% CV	Prob	H_0	Result
ausrfdi	0	-8.074*	-2.590	0.000	Unit root & Intercept	*ausrfdi* is stationary
ausrdi	1	-1.888	-3.166	0.650	Unit root & trend	*ausrdi* → *Δausrdi*
Δausrdi	0	-9.496*	-2.590	0.000	Unit root & Intercept	*Δausrdi* is stationary
ausrimpo	2	-2.579	-3.166	0.291	Unit root & trend	*ausrimpo* → *Δausrimpo*
Δausrimpo	1	-3.459*	-2.590	0.012	Unit root & Intercept	*Δausrimpo* is stationary
ausrexpo	0	-2.471	-3.166	0.341	Unit root & trend	*ausrexpo* → *Δausrexpo*
Δausrexpo	0	-8.467*	-2.590	0.000	Unit root & Intercept	*Δausrexpo* is stationary
ausrgdp	0	-1.183	-3.166	0.906	Unit root & trend	*ausrgdp* → *Δausrgdp*
Δausrgdp	0	-6.623*	-2.590	0.000	Unit root & Intercept	*Δausrgdp* is stationary

* significant at 10% critical value

$\Delta_1 y_t = \gamma y_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta y_{t-i} + \varepsilon_t$ with H_o: γ=0 as a test for a unit root only.

Following the unit root testing, the possibility that a long-run relationship between some of the variables exists was considered. If this was the case, the model should not be estimated as a VAR model with variables in first differences and would be misspecified as such. It should rather be estimated as a Vector Error Correction (VEC) model, including an error correction term to correct for short-run deviations from the long-run relationship, restoring the equilibrium between the levels of the cointegrated variables.

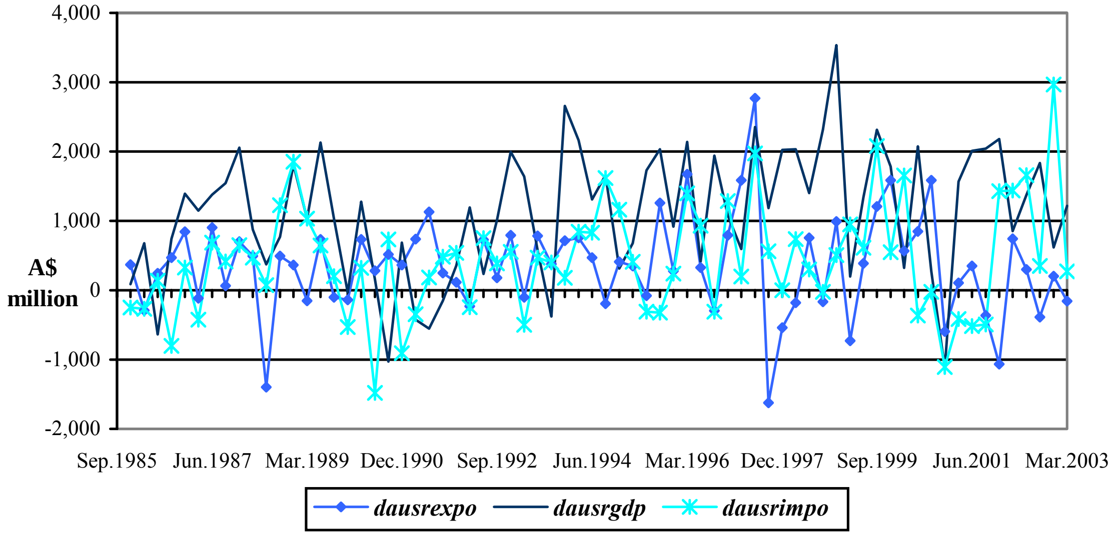

Figure 2: Quarterly data on the first Differences of GDP, Exports and Imports in Australia, Q3/1985 to Q1/2003

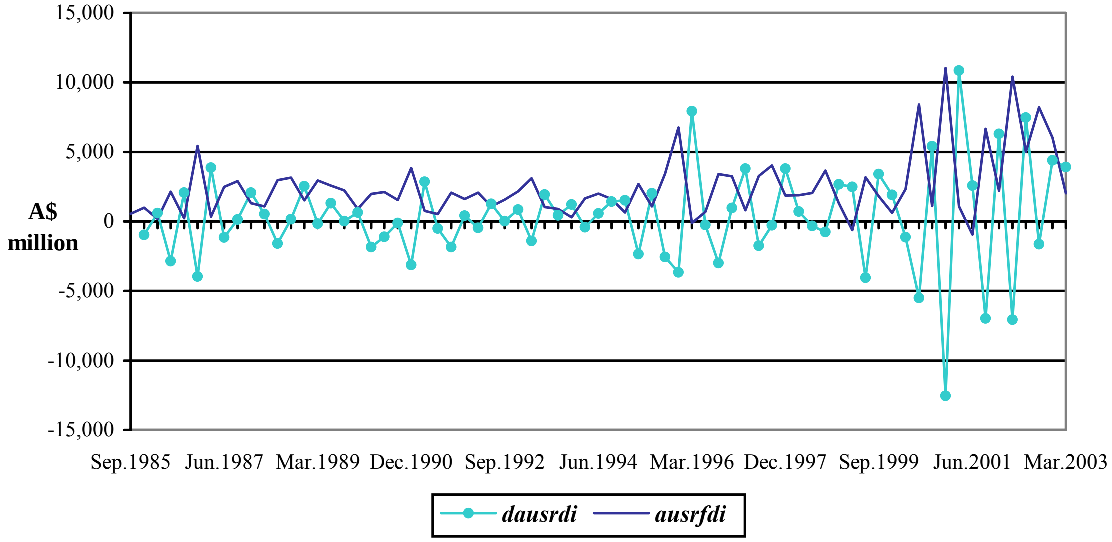

Figure 3: Quarterly data on FDI and the first Differences of Domestic Investment in Australia, Q3/1985 to Q1/2003

The VEC model – inclusive of the error correction term $\alpha\beta' Y_{t-1}$, but for simplification initially without the constant c that was part of the VAR specification – was written as:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{i=1}^{p-1} \Phi_i \Delta Y_{t-i} + \varepsilon_t$$

The term $\alpha\beta' Y_{t-1}$, consisting of a combination of the adjustment (or loading) matrix α[17], the cointegrating vector β and the first lags of the variables included in the model (Y_{t-1}), described the cointegrating relations and – for two cointegrating relationships – could also be written in the following form:[18]

$$\alpha\beta' Y_{t-1} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \\ \alpha_{41} & \alpha_{42} \\ \alpha_{51} & \alpha_{52} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{21} & \beta_{31} & \beta_{41} & \beta_{51} \\ \beta_{12} & \beta_{22} & \beta_{32} & \beta_{42} & \beta_{52} \end{bmatrix} \begin{bmatrix} ausrfdi_{t-1} \\ ausrdi_{t-1} \\ ausrimpo_{t-1} \\ ausrexpo_{t-1} \\ ausrgdp_{t-1} \end{bmatrix} = \begin{bmatrix} \alpha_{11} ec_{1,t-1} + \alpha_{12} ec_{2,t-1} \\ \alpha_{21} ec_{1,t-1} + \alpha_{22} ec_{2,t-1} \\ \alpha_{31} ec_{1,t-1} + \alpha_{32} ec_{2,t-1} \\ \alpha_{41} ec_{1,t-1} + \alpha_{42} ec_{2,t-1} \\ \alpha_{51} ec_{1,t-1} + \alpha_{52} ec_{2,t-1} \end{bmatrix}$$

where the error correction (*ec*) terms are:

$$ec_{1,t-1} = \beta_{11} ausrfdi_{t-1} + \beta_{21} ausrdi_{t-1} + \beta_{31} ausrimpo_{t-1} + \beta_{41} ausrexpo_{t-1} + \beta_{51} ausrgdp_{t-1}$$

and

$$ec_{2,t-1} = \beta_{12} ausrfdi_{t-1} + \beta_{22} ausrdi_{t-1} + \beta_{32} ausrimpo_{t-1} + \beta_{42} ausrexpo_{t-1} + \beta_{52} ausrgdp_{t-1} .$$

Identifying restrictions can be imposed on the adjustment matrix α and the cointegrating vector β, though the latter is more relevant for defining the long-term relationship between variables.

A cointegration test was performed to see whether this group of nonstationary variables had any long-run equilibrium relationship, i.e. whether a stationary linear combination (called a cointegrating equation) of two or more nonstationary time series existed. The methodology developed in Johansen (1991, 1995) was used to test for cointegration.

If a VAR of order p is written as:

$$Y_t = \sum_{i=1}^{p} \Phi_i Y_{t-i} + \varepsilon_t$$

(where Y_t is a k-vector of nonstationary I(1) variables (in this case k = 5), which have a cointegrating relationship),

then the VEC model could be written as:[19]

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \ ^{20} \qquad \text{with} \quad \Pi = \sum_{i=1}^{p} \Phi_i - I \ \text{ and } \ \Gamma_i = -\sum_{i=1}^{p-1} \Phi_i .$$

If the coefficient matrix $\prod$ has reduced rank $r < k$ (here: $r < 5$), then there exist (k x r) matrices α and β (here: (5 x r) matrices) each with rank r such that $\prod = \alpha\beta'$ and $\beta' Y_t$ is I(0). r is the number of cointegrating relations (the cointegrating rank) and each column of β is the

[17] The adjustment or loading matrix "contains weights attached to the cointegrating relations in the individual equations of the model". Lütkepohl (2004), p.90.

[18] Lütkepohl (2004), p.90.

[19] EViews (2001), pp.527-528.

[20] This specification is just an alternative way of writing: $\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{i=1}^{p-1} A_i \Delta Y_{t-i} + c + \varepsilon_t$.

cointegrating vector. The elements of α are known as the adjustment parameters in the VEC model. Johansen's method is to estimate the $\prod$ matrix from an unrestricted VAR and to test whether the restrictions implied by the reduced rank of $\prod$ can be rejected.

In order to carry out the cointegration test, an assumption needs to be made regarding the trend underlying the data. In this case, the level data Y_t are assumed to have linear trends ($\alpha_\perp\gamma_0$), but the cointegrating equations have only intercepts[21]:

$$H(r): \Pi Y_{t-1} = \alpha(\beta' Y_{t-1} + \rho_0) + \alpha_\perp \gamma_0$$

Two tests are commonly used to determine the number of cointegrating vectors: the trace test and the maximum-eigenvalue test. To determine the number of cointegrating relations r (conditional on the assumptions made about the trend), one can proceed sequentially from r = 0 to r = k-1 (here: r = 4) until failing to reject, when using the trace test. The trace and maximum eigenvalue tests are sequences of LR-tests of the null hypothesis H_0: r = i against H_1: r > i for i = 0, 1, …, k-1.[22] The cointegration test results are stated in Table 3. Since the Johansen test rejected rank 0 and 1 at a 5% critical value for the trace and the maximum-eigenvalue test, there were two cointegrating relations.

Table 3: Consequences of Quarterly Aggregate FDI in Australia, Johansen Cointegration Test

Variables: *ausrfdi, ausrdi, ausrimpo, ausrexpo, ausrgdp*, Lags interval (in first differences): 1 to 3
Observations (adjusted): 67 (Q3/1986 to Q1/2003)

Unrestricted Cointegration Rank Test (Trend assumption: Linear deterministic trend)

Hypothesized No. of CEs	Eigenvalue	Trace Statistics	5% CV
None *	0.514	102.032*	68.520
At most 1 *	0.364	53.705*	47.210
At most 2	0.225	23.360	29.680
At most 3	0.078	6.241	15.410
At most 4	0.012	0.793	3.760

* denotes rejection of the hypothesis at the 5% level. Trace test indicates 2 cointegrating equations at the 5% level

Hypothesized No. of CEs	Eigenvalue	Max Eigenvalue Statistics	5% CV
None *	0.514	48.327*	33.460
At most 1 *	0.364	30.346*	27.070
At most 2	0.225	17.119	20.970
At most 3	0.078	5.447	14.070
At most 4	0.012	0.793	3.760

* denotes rejection of the hypothesis at the 5% level. Max-eigenvalue test indicates 2 cointegrating equations at the 5% level

The two cointegrating relations were described by two sets of restrictions. To ensure that FDI was described and estimated as a stationary variable in levels form, the first restriction was $\beta_{11}=1$, $\beta_{21}=0$, $\beta_{31}=0$, $\beta_{41}=0$ and $\beta_{51}=0$. The second restriction had to exclude FDI and describe a

[21] The term $\alpha_\perp$ describes the null space of α such that $\alpha'\alpha_\perp=0$. The term $\alpha_\perp\gamma_0$ includes what was the constant c in the VAR. Using the alternative (more restricted) specification of intercepts in the cointegrating equations and no deterministic trend in Y_t ($H'(r): \Pi Y_{t-1} = \alpha(\beta' Y_{t-1} + \rho_0)$) does not affect the test result. Other specifications did not seem to be appropriate. The assumption of no intercept in the cointegrating equation, for example, should only be used if all series have zero mean, which is not the case in this model. And since the series were not trend-stationary, a linear trend in the cointegrating equation or quadratic trends in the level data was no plausible specification. Eviews (2001), pp.529-530.

[22] Chakraborty and Basu (2002) recommended that one should rely on the evidence based on the maximum eigenvalue test if the results from the trace and the maximum eigenvalue test differ, since the results of the latter test are more reliable in small samples. They based this suggestion on Banerjee et al. (1986 and 1993).

long-term relationship between domestic investment, imports, exports and GDP that is based on a theoretical hypothesis about the possible linkage between the four variables. One possibility is the normalisation of GDP, for which GDP was specified as a function of domestic investment, imports and exports (β_{12}=0 and β_{52}=1). This specification was based on GDP being defined as a function of consumer expenditure, gross private investment, government consumption and investment and net exports (i.e. exports minus imports).

Using these restrictions, the VEC model could be estimated. The parameters are stated in Table 4. The five equations explained between 32.5% and 68.2% of the variation of the relevant variable. The equations of *ausrfdi,* and *ausrdi* appeared to be the best representations of the data generating process, while the equation for *ausrexpo* had little explanatory power.[23]

Table 4: Consequences of Quarterly Aggregate FDI in Australia, VEC Model Estimation

Dependent Variables: ***ausrfdi, ausrdi, ausrimpo, ausrexpo, ausrgdp***
Least Squares. Observations (adjusted): 67 (Q3/1986 to Q1/2003)

Cointegration Restrictions: β_{11}=1, β_{12}=0, β_{13}=0, β_{14}=0 and β_{15}=0 and β_{21}=0 and β_{25}=1.

	Cointegrating Equation 1		**Cointegrating Equation 2**	
	Coeff.	**t-stat**	**Coeff.**	**t-stat**
ausrfdi(-1)	1.000	na (restriction imposed)	0.000	na (restriction imposed)
ausrdi(-1)	0.000	na (restriction imposed)	0.156	0.579
ausrimpo(-1)	0.000	na (restriction imposed)	-2.237	-5.831
ausrexpo(-1)	0.000	na (restriction imposed)	-0.424	-1.547
ausrgdp(-1)	0.000	na (restriction imposed)	1.000	na (restriction imposed)
C	-2,558.852	---	69,996.020	---

		***Δausrfdi* Equation**		***Δausrdi* Equation**		***Δausrimpo* Equation**		***Δausrexpo* Equation**		***Δausrgdp* Equation**	
Variable	**Lags**	**Coeff**	**t-stat**	**Coeff**	**t-stat**	**Coeff**	**t-stat**	**Coeff**	**t-stat**	**Coeff**	**t-stat**
CE 1	---	-0.976**	-4.141	1.011**	4.042	0.069	0.831	-0.151**	-2.066	-0.088	-1.291
CE 2	---	0.382**	2.282	-0.294**	-1.659	-0.142**	-2.399	-0.006	-0.120	0.171**	3.522
ausrfdi	**1**	-0.067	-0.109	0.129	0.199	0.488**	2.246	0.490**	2.572	0.289*	1.624
	2	1.334**	2.124	-1.547**	-2.320	-0.274	-1.228	0.093	0.477	0.263*	1.443
	3	0.910*	1.433	-0.753	-1.118	-0.329*	-1.462	-0.048	-0.243	0.107	0.580
Δausrdi	**1**	0.075	0.140	0.002	0.003	0.546**	2.848	0.301**	1.792	0.173	1.101
	2	1.256**	2.243	-1.414**	-2.380	-0.140	-0.705	-0.122	-0.701	0.179	1.104
	3	0.681	1.119	-0.507	-0.786	-0.232	-1.073	-0.150	-0.795	0.064	0.361
Δausrimpo	**1**	-0.141	-0.245	0.501	0.819	-0.155	-0.756	-0.307**	-1.717	0.068	0.404
	2	-0.709	-1.182	1.052**	1.654	-0.127	-0.598	0.134	0.720	0.349**	2.004
	3	0.799	1.319	-1.151**	-1.792	-0.124	-0.576	0.046	0.244	-0.114	-0.646
Δausrexpo	**1**	0.122	0.263	-0.354	-0.719	-0.301**	-1.826	0.014	0.094	0.098	0.725
	2	0.845**	1.824	-0.897**	-1.823	0.080	0.485	-0.042	-0.291	-0.061	-0.457
	3	-0.285	-0.648	0.297	0.636	-0.239*	-1.529	-0.210*	-1.538	0.158	1.239
Δausrgdp	**1**	-0.581	-1.398	0.756**	1.715	0.194	1.318	-0.178	-1.375	-0.085	-0.702
	2	-0.680**	-1.548	0.546	1.172	0.037	0.235	-0.021	-0.157	-0.104	-0.814
	3	-0.032	-0.083	0.103	0.247	0.419**	3.016	0.193*	1.585	0.128	1.120
C	---	616.541	0.791	-451.226	-0.545	722.007**	2.612	461.332**	1.905	165.979	0.733

** significant at 10% critical value, * significant at 15% critical value

	Δausrfdi	*Δausrdi*	*Δausrimpo*	*Δausrexpo*	*Δausrgdp*
R-squared	0.676	0.682	0.460	0.325	0.539
Adjusted R-squared	0.564	0.572	0.273	0.091	0.379
S.E. of regression	2,197.292	2,331.412	778.835	682.466	637.798
Sum squared resid	237,000,000.000	266,000,000.000	29,722,635.000	22,822,260.000	19,932,509.000
F-statistic	6.014	6.191	2.457	1.389	3.369
Log likelihood	-600.151	-604.121	-530.660	-521.810	-517.275
Akaike AIC	18.452	18.571	16.378	16.114	15.978
Schwarz SC	19.045	19.163	16.970	16.706	16.571
Mean dependent	-1.541	373.390	1,167.209	365.179	454.134
S.D. dependent	3,326.257	3,564.141	913.367	715.848	809.304

[23] Tests for lag exclusion showed that the lag length was correctly specified. All lags were significant at a 10% critical value and should be included when testing for joint exclusion of all five variables in all five equations.

III.III Model Evaluation

In order to evaluate the adequacy of the VEC model, a series of diagnostic tests was performed, including the test of hypothesis of correct specification with regard to non-autocorrelation and homoscedasticity. The hypotheses of non-autocorrelation and homoscedasticity were not rejected at a 5% critical value.[24] The model seemed to be correctly specified.

The next step was the analysis of the dynamic relationship between the five variables. In order to analyse whether there was a causal link between two variables (for instance *ausrfdi* and *Δausrdi*) and whether an endogenous variable can be treated as exogenous, Granger-causality tests were performed. The tests are generally (i.e. in a standard VAR model) performed as F-tests of the joint hypothesis that the coefficients of the lagged causal variables are significantly different from zero. The dynamic relationship between variables can be tested for any pair of variables: *ausrfdi* and *Δausrdi*, *ausrfdi* and *Δausrimpo, Δausrdi* and *Δausrimpo*, etc. The tests are operationalisations of the Granger-causality concept[25]:

H_0: *Δausrdi → ausrfdi:* $\Phi_{12,i} = 0$, i =1,…L

H_0: *ausrfdi → Δausrdi:* $\Phi_{21,i} = 0$, i =1,…L

(where $\Phi_{12,i}$ and $\Phi_{21,i}$ are lag polynomials, as described in Chapter 8.3, and L is the lag order, which, in this case, is three).

Since this model was set up as a VEC model and not as a VAR model, not only the lag variables, but also the variables in the cointegrating equations were taken into account. Since the VEC model with the restrictions could be written as:

$$\Delta Y_t = \alpha(\beta' Y_{t-1} + \rho_0) + \alpha_\perp \gamma_0 + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t$$

with

$$\alpha\beta' Y_{t-1} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \\ \alpha_{41} & \alpha_{42} \\ \alpha_{51} & \alpha_{52} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & \beta_{22} & \beta_{32} & \beta_{42} & 1 \end{bmatrix} \begin{bmatrix} ausrfdi_{t-1} \\ ausrdi_{t-1} \\ ausrimpo_{t-1} \\ ausrexpo_{t-1} \\ ausrgdp_{t-1} \end{bmatrix},$$

a joint F-test of $\Phi_{12}(L) = 0$ and $\alpha_{12}\beta_{22}=0$ had to be conducted to test for the causal link from *Δausrdi* to *ausrfdi*, and not just for $\Phi_{12}(L) = 0$ alone.[26] Toda and Phillips (1994) referred to the first half of the hypothesis ($\Phi_{12}(L) = 0$) as "short-run noncausality" and the second half of the

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[24] Heteroscedasticity (White, ARCH(1)): $\chi^2(510) = 534.566$, Prob = 0.218, Autocorrelation (LM-Test): Lag 1: $\chi^2(25) = 27.158$, Prob = 0.348, Lag 1-2: $\chi^2(25) = 27.432$, Prob = 0.335, Lag 1-3: $\chi^2(25) = 23.469$, Prob = 0.550, Lag 1-4: $\chi^2(25) = 24.885$, Prob = 0.469. The test of correct functional form (RESET-test) or the test of parameter stability could not be performed for the overall model in Eviews due to the way the model was set up.

[25] Pfaffermayr, 1994, p.339 and Johnston and DiNardo (1997), pp.296-297.

[26] One did not have to test $\alpha_{11}*\beta_{12}=0$ since one of the restrictions was that β_{12} is equal to 0.

hypothesis ($\alpha_{12}\beta_{22}$=0) as “long-run noncausality”. Similarly, to test for the causal link from *ausrfdi* to *Δausrdi*, a joint F-test of $\Phi_{21}(L) = \alpha_{21} = 0$ was conducted.[27] Tests for causal links between the remaining variables followed the same concept. The test results are stated in Table 6.[28]

Table 6: Granger-Causality Test, VEC Model Estimation

Equation	H_0: exclude	*ausrfdi & Δausrfdi*	*ausrdi & Δausrdi*	*ausrimpo & Δausrimpo*	*ausrexpo & Δausrexpo*	*ausrgdp & Δausrgdp*
ausrfdi	CE & lags	$\chi^2(4) = 28.052$**	$\chi^2(4) = 8.703$**	$\chi^2(4) = 13.126$**	$\chi^2(4) = 5.873$	$\chi^2(4) = 10.228$**
Δausrdi	CE & lags	$\chi^2(4) = 29.933$**	$\chi^2(4) = 9.086$**	$\chi^2(4) = 14.612$**	$\chi^2(4) = 6.418$	$\chi^2(4) = 7.489$*
Δausrimpo	CE & lags	$\chi^2(4) = 4.547$	$\chi^2(4) = 3.699$	$\chi^2(4) = 21.619$**	$\chi^2(4) = 3.834$	$\chi^2(4) = 20.276$**
Δausrexpo	CE & lags	$\chi^2(4) = 12.216$**	$\chi^2(4) = 7.563$*	$\chi^2(4) = 6.224$	$\chi^2(4) = 3.515$	$\chi^2(4) = 6.365$
Δausrgdp	CE & lags	$\chi^2(4) = 18.909$**	$\chi^2(4) = 17.650$**	$\chi^2(4) = 7.146$*	$\chi^2(4) = 7.351$*	$\chi^2(4) = 17.650$**

CE: Cointegrating Equation (CE 1 in case of FDI, CE2 in the case of Δ*ausrgdp,* Δ*ausrdi,* Δ*ausrexpo* and Δ*ausrimpo*)
10% Critical Value for $\chi^2(4) = 7.779$
** significant at 10% critical value, * significant at 15% critical value

The pairwise Granger causality tests showed that at a 10% critical level, causal links were found in thirteen of the 25 possible cases (from *ausrfdi* to *ausrfdi*, *Δausrdi*, *Δausrexpo* and *Δausrgdp*, from *Δausrdi* to *ausrfdi, Δausrdi* and *Δausrgdp*, from *Δausrimpo* to *ausrfdi, Δausrdi* and *Δausrimpo* and from *Δausrgdp* to *ausrfdi*, *Δausrimpo* and *Δausrgdp*). A further four causal links were found at a 15% critical level (from *Δausrdi* to *Δausrexpo,* from *Δausrimpo* to *Δausrgdp,* from *Δausrexpo* to *Δausrgdp* and from *Δausrgdp* to *Δausrdi*). No causal link was found in the remaining eight cases. Most importantly, *ausrfdi* had significant direct effects on *Δausrdi*, *Δausrexpo*, *Δausrgdp* and itself (*ausrfdi*), but not on *Δausrimpo*. However, *ausrfdi* also had various indirect effects on all variables including *Δausrimpo*.

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[27] One did not have to test $\alpha_{22}*\beta_{21}=0$ since one of the restrictions was that β_{21} is equal to 0. Furthermore, β_{11} was set to be 1, so only one only had to test $\alpha_{21}=0$ instead of $\alpha_{21}*\beta_{11}=0$.

[28] If H_0 is not rejected, the failure to reject may be caused by both α and β being equal to 0, in which case the correct critical value should be lower than previously assumed (the different critical value is not an issue when the hypothesis is already rejected at a higher critical value). This could be the case for *ausrdi* & *Δausrdi* in the *Δausrexpo* equation and for *ausrexpo* & *Δausrexpo* in the *Δausrexpo* equation, since neither the hypothesis $\alpha_{42}=\beta_{22}=0$ nor the hypothesis of $\alpha_{42}=\beta_{42}= 0$ was rejected at a 10% critical value (the test statistics were: $\chi^2(2) = 0.308$, P = 0.857 and $\chi^2(2) = 2.272$, P = 0.321 respectively).

Toda and Phillips (1993 and 1994) suggested a sequential procedure in this case. For the first case (*ausrdi* & *Δausrdi* in the *Δausrexpo* equation), let: H_0: $\phi_{42}(L) = 0$ and $\alpha_{42}\beta_{22}=0$, H_1: $\phi_{42}(L) = 0$, H_2: $\alpha_{42}=0$, H_3: $\beta_{22}=0$ and H_4: $\alpha_{42}\beta_{22}=0$. Now the sequential testing procedures to be considered are the following:

(1) Test H_2. If H_2 is rejected, test H_0, otherwise test H_1.

(2) Test H_3. If H_3 is rejected, test H_0, otherwise test H_1.

(3) Test H_1. If H_1 is rejected, reject the hypothesis of noncausality, otherwise test H_2 and H_3. If both are rejected, test H_4, otherwise accept the hypothesis of noncausality.

In this case, H_2 and H_3 was not rejected ($\chi^2(1) = 0.020$, P = 0.889 and $\chi^2(1) = 0.289$, P = 0.591 respectively), while H_1 was rejected at a 10% critical value ($\chi^2(3) = 7.497$, P = 0.058), so that the hypothesis of noncausality was rejected.

In the second case (*ausrexpo* & *Δausrexpo* in the *Δausrexpo* equation), the same procedure can be followed with H_0: $\phi_{44}(L) = 0$ and $\alpha_{42}\beta_{42}=0$, H_1: $\phi_{44}(L) = 0$, H_2: $\alpha_{42}=0$, H_3: $\beta_{42}=0$ and H_4: $\alpha_{42}\beta_{42}=0$. Here, H_2, H_3 and H_1 were not rejected ($\chi^2(1) = 0.020$, P = 0.889, $\chi^2(1) = 2.255$, P = 0.133 and $\chi^2(3) = 3.515$, P = 0.319 respectively), so that the hypothesis of noncausality was accepted.

Hence, *ausrdi* & *Δausrdi* could be viewed as having an effect on *Δausrexpo*, while *ausrexpo* & *Δausrexpo* could not. Since *ausrdi* & *Δausrdi* were already significant at a 15% critical value, the result did not change the overall conclusions.

III.IV Results

In order to investigate in more detail the quantitative impact of an exogenous increase in *ausrfdi* on *Δausrdi, Δausrimpo, Δausrexpo, Δausrgdp* and itself and the impact of an exogenous increase in the other variables and the dynamic adjustment of the system to these exogenous shocks and impulse response analysis were used. The results of the impulse response analysis, illustrating one variable's response to an innovation in the other, are shown in Table 7 and Figure 4.

Using the impulse response analysis to calculate the effect in the short-run (e.g. after one or two periods) and the long-run (e.g. after twelve, sixteen or twenty periods), it was possible to put signs to the significant links established in the Granger-causality analysis. For results see Table 7. In the short-run (after two periods), the significant variables had the following signs: *ausrfdi* had a positive effect on itself, but reduced domestic investment growth, export growth and GDP growth. *Δausrdi* increased domestic investment growth and GDP growth, but reduced FDI and export growth. *Δausrimpo* increased domestic investment growth, import growth and GDP growth, but reduced FDI. *Δausrexpo* reduced GDP growth. Finally, *Δausrgdp* increased FDI, domestic investment growth and GDP growth, reduced import growth. In the short run, FDI had positive direct effects on domestic investment growth and positive indirect effects on all variables. FDI also had negative direct effects export growth, GDP growth and itself and negative indirect effects on all variables. In the short-run, the overall effects of a change in FDI were unclear.

The long-run effects (after twelve periods) were the same, apart from *ausrfdi*, which now has a positive effect on *Δausrdi* and *Δausrgdp*. Both *Δausrdi and Δausrimpo* now have a positive effect on *ausrfdi* and *Δausrgdp* has a positive effect on *Δausrimpo*. In the long run, FDI had positive direct effects on itself, domestic investment growth and GDP growth and positive indirect effects on all variables except for export growth. In contrast, FDI had negative direct and indirect effects export growth.

Table 7: Observed (Accumulated Impulse Response) and Predicted Effects, Cholesky Ordering: *ausrfdi, ausrdi, ausrimpo, ausrexpo, ausrgdp*

Variable	Effect on	1 period	2 periods	4 periods	8 periods	12 periods	16 periods	20 periods	Long-run effect
ausrfdi	*ausrfdi*	2,197.292	1,945.963	2,907.033	3,274.661	4,035.350	4,114.198	4,315.295	+
	Δausrdi	0.000	-287.024	431.685	225.579	2.204	162.209	15.035	+
	Δausrimpo	0.000	-508.281	-950.782	-1,873.997	-2,129.543	-2,321.216	-2,486.322	(n.s.: -)
	Δausrexpo	0.000	-59.906	-66.238	-401.986	-377.779	-467.301	-504.176	-
	Δausrgdp	0.000	-126.323	-117.815	213.116	50.913	65.564	146.711	+
Δausrdi	*ausrfdi*	-2,197.128	-1,895.595	-2,839.629	-1,614.494	643.551	3,692.906	7,145.564	+
	Δausrdi	779.813	2,056.333	3,492.429	8,288.752	13,125.720	17,926.470	22,757.480	+
	Δausrimpo	0.000	512.448	827.671	225.852	-1,286.509	-3,378.030	-5,775.245	(n.s. -)
	Δausrexpo	0.000	-69.302	-497.733	-1,230.149	-2,326.889	-3,526.947	-4,820.739	- (*)
	Δausrgdp	0.000	292.667	806.764	2,489.014	4,335.525	6,182.350	8,067.493	+
Δaus-rimpo	*ausrfdi*	-166.072	-266.958	-548.345	-498.884	969.411	2,189.745	3,850.327	+
	Δausrdi	317.606	724.153	2,025.854	4,704.929	7,210.517	10,315.750	13,056.930	+
	Δausrimpo	527.572	883.471	1,390.642	1,266.903	1,306.271	1,032.918	450.761	+
	Δausrexpo	0.000	31.131	-62.968	-643.505	-1,037.419	-1,629.051	-2,275.098	(n.s.: -)
	Δausrgdp	0.000	54.611	516.704	2,696.859	4,486.179	6,384.552	8,527.840	+ (*)
Δaus-rexpo	*ausrfdi*	-93.322	-81.043	-219.821	-1,796.402	-3,667.029	-6,042.028	-8,504.826	(n.s.: -)
	Δausrdi	42.700	157.897	30.015	-67.639	-289.842	-332.188	-461.171	(n.s.: -)
	Δausrimpo	189.170	248.730	483.215	1,345.617	2,800.030	4,476.592	6,243.645	(n.s.: +)
	Δausrexpo	647.644	1,274.238	2,359.248	4,398.910	6,714.990	9,027.095	11,381.500	(n.s.: +)
	Δausrgdp	0.000	-116.400	-260.535	-385.669	-673.930	-940.675	-1,157.445	- (*)
Δaus-rgdp	*ausrfdi*	145.718	369.354	455.519	1,806.530	3,401.375	5,342.537	7,589.465	+
	Δausrdi	374.314	1,217.878	2,978.725	7,636.918	13,107.780	18,646.130	24,217.080	+ (*)
	Δausrimpo	-120.690	-206.848	-89.080	398.531	772.685	830.456	872.994	+
	Δausrexpo	171.581	196.363	183.881	198.306	134.907	-47.715	-208.019	(n.s.: +)
	Δausrgdp	633.431	1299.741	2912.595	6,564.988	10,387.360	14,499.060	18,490.300	+

Figure 4 illustrates the dynamic effects that *ausrfdi* had on the remaining variables and itself.

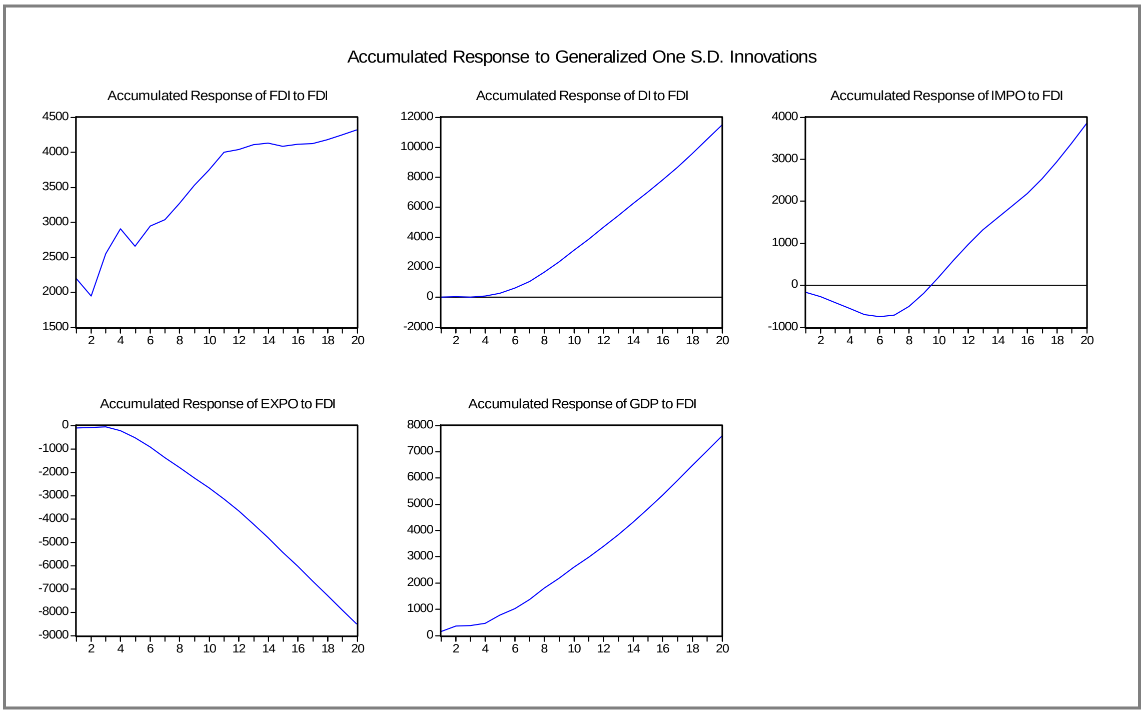

Figure 4: Impulse Response, Accumulated Response to an Innovation in FDI

IV Summary and Conclusions

Previous surveys and econometric studies suggested that FDI in Australia has a positive effect on output and domestic investment, but may have a negative effect on Australia's trade performance, increasing imports by more than exports. Analysing the dynamic relationship of quarterly FDI inflows with a set of endogenous variables including the change of GDP, domestic investment, imports and exports between 1985 and 2003 in a VEC model suggested that the long-term effects of an increase in FDI were an increase in domestic investment growth, GDP growth and FDI itself, but also a reduction in export growth. Through its effect on GDP growth, FDI also led to an increase in import growth. Taking indirect effects into account, FDI led to GDP growth, leading to an increase in domestic investment growth, GDP growth, import growth and FDI, but to a reduction of export growth.

FDI had the expected positive effect on economic growth. The link was strong in the long-run, since both direct and indirect effects were positive, but FDI directly and indirectly (over reduced export growth and reduced FDI) affected GDP growth in the short-run. The crowding-out effect of domestic investment through FDI was not substantiated for Australia, as FDI and domestic investment were complement, but the direct and indirect positive effects on domestic investment growth in the long-run were qualified by taking into account the indirect negative effect in the short-run (through decreased GDP and FDI).

The effect of FDI on the Australian trade performance was more difficult to summarise. No evidence was found of FDI directly increasing export or import growth. In contrast, an increase in FDI directly reduced export growth in the short- and long-run. While only negative indirect effects were found in the long-run, FDI had both positive and negative indirect effects on export growth in the short-run. The negative link could suggest that MNEs were less export-oriented than domestic firms. The claim that "FDI promotes export growth"[29], established by some case studies, was not supported when looking at aggregate data, as FDI reduced export growth. Import growth was not directly affected by FDI, but GDP growth appeared to increase import growth in the long-run (but not the short-run). In the short-run, both positive and negative indirect effects of FDI on import growth were found. Hence, the question of whether FDI increases intermediate good imports by more than it reduces final good imports could not be tested, as no direct effects were found. Looking at the overall trade performance, FDI did not seem to be beneficial to the Australian economy. Since there was evidence that FDI indirectly increased import growth and directly and indirectly reduced export growth, it was concluded that FDI had negative effects on Australia's trade balance.

Comparing the findings of this econometric analysis with the results of the econometric studies on which it was based, the evidence is mixed. While some of the previous results were supported (e.g. the positive effect of FDI on economic growth found by Shan (2002)), others

[29] DFAT (1999), p.xi

were not substantiated (e.g. the positive effect of FDI on exports found by Liu et al. (2001)). Most links were more evident for Australia than in previous studies (Chakraborty and Basu (2002) did not find a significant link between FDI and economic growth, Kim and Seo (2003) did not find a significant link between FDI and domestic investment and Liu et al. (2001) did not find a significant link between FDI and imports).

Overall, the positive effects of FDI on economic growth and, to some degree, domestic investment supported the Australian government's view that FDI is a favourable source of capital for the Australian economy. The claim that FDI is favourable for Australia's balance-of-payments position was not supported by this econometric analysis. FDI did not have a positive effect on Australian exports and did not reduce imports. The contrary was observed, a claim that went well with the results from the ABS (2004) report, in which foreign-owned firms were found to increase the Australian trade deficit. Hence, such an important issue deserves further analysis and should not be judged by case studies alone. Even with some data limitations, this study provides a better understanding of the effects that FDI inflows into Australia may have.

Appendix: Data Sources

Australian Bureau of Statistics (ABS) Data:

- *National Accounts*: Australian quarterly GDP (*ausgdp*, A$ million 2000/01 prices), Nominal investment in Australia (*dominv*, A$ million)
- *Balance of Payments and International Investment Position:* Australian nominal quarterly FDI inflows (*nfdi*, A$ million), Australian real quarterly exports (*expo*, A$ million, 2000/01 prices) and Australian real quarterly imports (*impo*, A$ million, 2000/01 prices),
- *Treasury Model Database*: Investment deflator (*invdef*, Index, 2000/01 = 1)

References

A.T. Kearney and Global Business Policy Council (2002), *FDI Confidence Index* **5**, A.T. Kearney, Alexandria, VA.

Agosín, M. and Mayer, R. (2000), 'Foreign Investment in Developing Countries: Does it Crowd In Domestic Investment?', *UNCTAD Discussion Paper 146*, United Nations Publication, Geneva.

Aharoni, Y. (1966), *The Foreign Investment Decision Process,* Harvard University Press, Boston.

Aitken, B., Hanson, G.H. and Harrison, A.E. (1997), 'Spillovers, Foreign Investment and Export Behaviour', *Journal of International Economics* **43**, 103-132.

Australian Bureau of Statistics (ABS) (1998), 'Small and Medium Enterprises: Business Growth and Performance', *ABS Cat. No 8141.0, 1996-1997.*

Australian Bureau of Statistics (ABS) (2004), 'Foreign Ownership of Australian Exporters and Importers', *ABS Cat. No 5496.0.55.001, 2002-2003.*

Barros, P.P. and Cabral, L.M.B. (2001), 'Government Subsidies to Foreign Direct Investment', *CEPR Working Paper*.

Barry, F. and Bradley, J. (1997), 'FDI and Trade: the Irish Host-Country Experience', *Economic Journal* **107**, 1798-1811.

Blomström, M., Lipsey, R. and Zejan, M. (1994), 'What Explains Developing Country Growth?' *NBER Working Paper 4132*. National Bureau of Economic Research, Cambridge, MA.

Bond, E. and Samuelson, L. (1986), 'Tax Holidays as Signals', *American Economic Review* **76**, 820-826.

Bora, B. (1998), *Characteristics and Behaviour of Multinationals in Australia,* Flinders University, Adelaide.

Borensztein, E., de Gregorio, J. and L.-W. Lee, L.-W. (1998), 'How does Foreign Investment affect Economic Growth?', *Journal of International Economics* **45**, 115-135.

Bosworth, P., Collins, S.M. and Reinhart, C.M. (1999), 'Capital Flows to Developing Economies: Implications for Saving and Investment', *Brookings Papers on Economic Activity* **1999**, 143-169.

Brash, D.T. (1966), *American Investment in Australian Industry*, Australian University Press, Canberra.

Buckley, P.J. and Casson, M. (1976), *The Future of the Multinational Enterprise,* Macmillan, London.

Carkovic, M. and Levine, R. (2000), 'Does Foreign Direct Investment Accelerate Economic Growth', *University of Minnesota Working Paper*.

Casson, M.C. (1987), *The Firm and the Market: Studies in Multinational Enterprise and the Scope of the Firm,* Blackwell, Oxford and MIT Press, Cambridge, MA.

Caves, R.E. (1971), 'International Corporations: the Industrial Economics of Foreign Investment', *Economica* **38**, 1-27.

Chakraborty, C. and Basu, P. (2002), 'Foreign Direct Investment and Growth in India: a Cointegration Approach', *Applied Economics* **34**, 1061-1073.

De Mello, L.R. (1999), 'Foreign Direct Investment-led Growth: Evidence from Time Series and Panel Data', *Oxford Economic Papers* **51**, 133-151.

Department of Foreign Affairs and Trade (DFAT) (1999), *Foreign Direct Investment: The Benefits for Australia*, Commonwealth of Australia, Canberra.

Donovan, D. and Mai, Y. (1996), 'APEC Trade Liberalisation: the Effects of Increased Capital Mobility', *Australian Commodities Forecasts and Issues* **3**, 520-526.

Dunning, J.H. (1993), 'MNEs, the Balance of Payments and the Structure of Trade', in: Dunning, J.H. (ed), *Multinational enterprises and the global economy,* Addison-Wesley, Wokingham, UK and Reading, MA.

Eviews (2001), *EViews 4.0 User Guide,* Quantitative Micro Software, LLC, Irvine, CA.

Feenstra, R.C. and Hanson, G.H. (1996), 'Foreign Investment, Outsourcing, and Relative Wages', in: Feenstra, R.C., Grossman, G.M. and Irwin, D.A. (eds), *Political Economy of Trade Policy: Essays in Honour of Jagdish Bhagwati,* MIT Press, Cambridge, MA.

Fisher, S., Stoeckel, A. and Borrell, B. (1998), *Trojan Horse or more Horsepower? Foreign Investment and the Australian Rural Economy,* Centre of International Research Economics, Canberra.

Graham, E.M. and Krugman, P.R. (1993), *Foreign Direct Investment in the United States,* Institute for International Economics, Washington, DC.

Haaland, J.I. and Wooton, I. (1999), 'International Competition for Multinational Investment', *Scandinavian Journal of Economics* **101**, 631-649.

Haaland, J.I. and Wooton, I. (2001a), 'Multinational Firms: Easy Come, Easy Go?' *CEPR Discussion Paper 2600.*

Haaland, J.I. and Wooton, I. (2001b), 'Multinational Investment, Industry Risk, and Policy Competition' *Discussion Paper No. 35/2001,* Department of Economics, Norwegian School of Economics and Business Administration.

Haaparanta, P. (1996), 'Competition for Foreign Direct Investment', *Journal of Public Economics* **63**, 141-153.

Hejazi, W. (2002), 'Foreign Direct Investment and Domestic Capital Formation', *Industry Canada Working Paper No.36,* Industry Canada, Ottawa.

Helpman, E. (1984), 'A Simple Theory of Trade with Multinational Corporations', *Journal of Political Economy* **92**, 451-471.

Helpman, E. (1985), 'Multinational Corporations and Trade Structure', *Review of Economic Studies* **52**, 443-458.

Horstmann, I.J. and Markusen, J.R. (1987a), 'Strategic Investment and the Development of Multinationals', *International Economic Review* **28**, 109-121.

Horstmann, I.J. and Markusen, J.R. (1987b), 'Licensing Versus Direct Investment: A Model of Internalisation by the Multinational Enterprise', *Canadian Journal of Economics* 2**0**, 464-481.

Horstmann, I.J. and Markusen, J.R. (1992), 'Endogenous Market Structures in International Trade (natura facit saltum)', *Journal of International Economics* **32**, 109–129.

Hymer, S.H. (1976), *The International Operations of National Firms: A Study of Direct Investment*, MIT Press, Cambridge, MA.

Johnston, J. and DiNardo, J. (1997), *Econometric Methods,* McGraw-Hill, Singapore.

Kim, D.D.-K. and Seo, J.-S. (2003), 'Does FDI Inflow Crowd out Domestic Investment in Korea?', *Journal of Economic Studies* **30**, 605-622.

Kindleberger, C.P. (1969), *American Business Abroad: Six Lectures on Foreign Direct Investment*, Yale University Press, New Haven.

Krugman, P.R. (1983), 'The "New Theories" of International Trade and the Multinational Enterprise', in: Kindleberger, C.P. and Audretsch, D.B. (eds), *The multinational corporation in the 1980s*, MIT Press, Cambridge, MA.

Lall, S. and Streeten, P. (1977), *Foreign Investment, Transnational and Developing Countries,* Macmillan, London.

Layton, A.P. and Makin, T. (1993), 'Estimates of the Macroeconomic Impact of Foreign Investment in Australia', *International Economic Journal* **7**, 35-42.

Lipsey, R.E. (2000), 'Interpreting Developed Countries' Foreign Direct Investment', *NBER Working Paper 7810,* National Bureau of Economic Research, Cambridge, MA.

Liu, X., Wang, C. and Wei, Y. (2001), 'Causal Links between Foreign Direct Investment and Trade in China', *China Economic Review* **12**, 190-202.

Lütkepohl, H. (2004), 'Vector Autoregressive and Vector Error Correction Models', in: Lütkepohl, H. and Krätzig, M. (eds), *Applied Time Series Econometrics,* Cambridge University Press.

MacDougall, G.D.A. (1960), 'The Benefits and Costs of Private Investment from Abroad: A Theoretical Approach', *Economic Record* **36**, 13-35.

Makin, T. (1998), The National Income Gains from Foreign Investment, in: Paul, P.S. (ed), *Trade and Growth: New Theory and the Australian Experience,* Allen and Unwin, St Leonards, NSW.

Markusen, J.R. (1984), 'Multinationals, Multi-Plant Economies, and the Gains from Trade', *Journal of International Economics* **16**, 205-266.

Markusen, J.R. (1997), 'Trade versus Investment Liberalisation', *NBER Working Paper 6231*, National Bureau of Economic Research, Cambridge, MA.

Markusen, J.R. (2002), *Multinational Firms and the Theory of International Trade,* MIT Press, Cambridge, MA.

Markusen, J.R., Venables, A.J., Konan, D.E. and Zhang, K.H. (1996), 'A Unified Treatment of Horizontal Direct Investment, Vertical Direct Investment, and the Pattern of Trade in Goods and Services', *NBER Working Paper 5696*, National Bureau of Economic Research, Cambridge, MA.

Mundell, R.A. (1957), 'International Trade and Factor Mobility', *American Economic Review* **47**, 321-335.

OECD (2005), *Trends and Recent Developments in Foreign Direct Investments*, OECD, Paris. www.oecd.org/dataoecd/13/62/35032229.pdf

Pain, N. and Wakelin, K. (1998), 'Export Performance and the Role of Foreign Direct Investment', *Manchester School of Economic and Social Studies* **66**, 62–88.

Pfaffermayr, M. (1994), 'Foreign Direct Investment and Exports: a Time Series Approach', *Applied Economics* **26**, 337-351.

Raff, H. and Srinivasan, K. (1998), 'Tax Incentives for Import-Substituting Foreign Investment: Does Signaling Play a Role?', *Journal of Public Economics* **67**, 167–193.

Shan, J. (2002), 'A VAR Approach to the Economics of FDI in China', *Applied Economics* **34**, 885-893.

Sousa, N., Greenaway, D. and Wakelin, K. (2000), 'Multinationals and Export Spillovers', *GLM Research Paper 2000/14,* Centre for Research on Globalisation and Labour Markets, University of Nottingham, UK.

Streeten, P. (1969), 'New Approaches to Private Investment in Less Developed Countries' (first published as: Nouvelles manieres d'aborder le probleme de l'investissement prive dans les pays en boie de developpement), Revue de la Societe d'Etudes et d'Expansion 238, 909-924, reprinted in: Dunning, J.H. (ed) (1972), *International Investment,* Penguin Books, Harmondsworth.

Teece, D.J. (1981), 'The Multinational Enterprise: Market Failure and Market Power Consideration', *Sloan Management Review* **22**, 3-17.

Toda, H.Y. and Phillips, P.C.B. (1993), 'Vector Autoregressions and Causality', *Econometrica* **61**, 1367-1393.

Toda, H.Y. and Phillips, P.C.B. (1994), 'Vector Autoregression and Causality: A Theoretical Overview and Simulation Study', *Econometric Reviews* **13**, 259-285.

United Nations Conference on Trade and Development (UNCTAD) (2002), *World Investment Report 2002: Transnational Corporations and Export Competitiveness*, United Nations, New York and Geneva.

Van Loo, F. (1977), 'The Effect of Foreign Direct Investment on Investment in Canada', *Review of Economics and Statistics* **59**, 474-481.

Vernon, R. (1966), 'International Investment and International Trade in the Product Cycle', *Quarterly Journal of Economics* **80**, 190-207.

Wong, K.-Y. (1988), 'International Factor Mobility and the Volume of Trade: An Empirical Study', in: Feenstra, R.C. (ed), *Empirical Methods for International Trade,* MIT Press, Cambridge, MA.

Zhang, K.H. (2001), 'Does Foreign Direct Investment Promote Economic Growth? Evidence from East Asia and Latin America', *Contemporary Economic Policy* **19**, 175-185.