FDI and Economic Development in China 1970-2006:

A Cointegration Study

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Abstract: The relationship between high levels of FDI and of economic growth has been of enduring interest in the development literature, particularly in the context of economies like China which have enjoyed exceptional inflows of foreign capital as well as experiencing unprecedented economic growth. The specific literature on China has failed to come to a definite conclusion as to whether FDI does increase growth mainly because they focus on one or several different channels through which FDI might affect the macro-economy. A more comprehensive framework is necessary to investigate the overarching relationships between economic development and FDI, as identified by endogenous growth theory, by including the potential influences on them, and vice-versa, of domestic capital stock, human capital, the state of technology, the openness of the economy and its gradual liberalisation. Although we investigate those influences in a VAR framework, our main focus is the presence of long-run *cointegration*, between the relevant variables and aggregate output in long-run equilibrium. We find, and then identify, such long run structural relationships; one of which identifies a long-run "production function". In the long-run FDI reduces economic growth; but the latter increases the former. There are important impacts on variables such as employment, from FDI and other factors such as openness and technology transfer, which have both indirect or direct spill-over effects from FDI.

Keywords: economic growth, FDI, endogenous growth theory, spill-over effects, VAR, impulse responses, VEC, identified cointegration vectors, long-run relationships between growth and FDI.

JEL classification: O23, O24, F43.

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1: Introduction

Since the economic reforms and the opening-up policy initiated in the late 1970s, China's economic development has been remarkable. Between 1979 and 2006, real output grew in excess of 7% each year; concomitantly there has been enormous inflows of foreign direct investment (FDI) into the country. Indeed, China has now become one of the most attractive destinations for cross-border direct investment; and since the 1990s it has been the largest recipient of FDI among developing countries. In recent years, FDI to China accounted for about one third of total FDI inflow to developing countries. Since 2000 China has became the world's second largest recipient of FDI after the US. According to the *World Investment Report* (UNCTAD (2005)), China attracted $560.39 billion US dollars of FDI for the period 1980 to 2004. It would seem to be a reasonable assertion that FDI has made an increasingly important contribution to the economic growth in China. For example, in 2006 foreign funded enterprises accounted for 28 per cent of China's added value in the industrial sector, and for 21.19% of tax revenue. Those enterprises exported about 58% of the total exports of goods and services and imported 51.4% of total imports; and they accounted for 11 per cent of local employment (*China Investment Yearbook* (2006)).

China's success in both improving its economic growth and attracting foreign capital has generated several studies which have endeavoured to assess the role FDI has played in the country's economic development. However, the research has failed unambiguously to generate a consensus on the relationships between aggregate output, FDI and other possible ancillary output-inducing mechanisms. For instance, employing time series analysis, Tan et al (2004) detected a direct relationship between

FDI and GDP and found that the effect is small but significant. Su (2005) analyzed the relation between FDI, domestic investment and output via a cointegration analysis, and concluded that FDI has a positive relationship with output, but with a limited impact on domestic investment. Liu et al (2002) focused on the link between FDI and economic growth through international trade. Shan (2002) also developed a VAR model but used the technique of innovation accounting to generate the relationship between FDI with output via labour, investment, international trade and energy consumed, and found that output was not caused significantly by FDI, but has been an important determinant of it.

Hence, the conclusions of these enquiries are not consistent with each other. One of the reasons for this is that they focus on one or several different channels through which FDI might affect the macro-economy. A more comprehensive framework is still necessary to investigate the overarching relationships between economic development and FDI, by including the potential influences on them, and vice-versa, of domestic capital stock, human capital, the state of technology, the openness of the economy and its gradual liberalisation. Hence, in this study we incorporate possible influences on aggregate output that follow from endogenous growth theory: as, for example, in UNCTAD(1992,1999) and Bende-Nabende et al (2003). We investigate those influences in a VAR framework, but our main focus is the presence of long-run *cointegration*, between the variables and aggregate output. We find, and then identify, such long run relationships; one of which identifies a long-run "production function" with an important role for FDI and other factors such as openness and technology transfer, which are both having possible indirect or direct spill-over effects from FDI. Our main conclusions focus on long run or steady state relationships between FDI and output in a general equilibrium framework.

The questions that we ask are of the following type:

1) Is the impact effect of FDI on aggregate output positive or negative in long run equilibrium?

2) Does economic growth per se attract more FDI in the context of the Chinese economy?

3) Does FDI crowds out domestic investment and therefore has an indirect negative impact in an economy where capital stock is highly productive and the government has followed a capital intensive growth strategy:

4) How is aggregate emplyoment affected by FDI, given the controversy surrounding MNC destruction of traditional labour intensive sectors?

5) What role has human capital played in the complex interrelationship between output, FDI and other complementary factors?

6) Does FDI and openness affect the nature of technology transfer?

The remainder of this paper is organised as follows. Section 2 contains a little more background to the VAR system that is employed. This is followed in Section 3 by details of the measurement of the variables in the system and by an overview of them, including details of their order of integration. In Section 4, Section 4.1 summarises the econometric methodology used; Section 4.2 presents the estimates from the VAR and associated diagnostic statistics. The impulse responses and variance decompositions for output and foreign direct investment are summarised in Sections 4.3 and 4.4; and the impulse responses are graphed in Appendix III. Section 5 moves on to consider the possibility that the VAR system contains some cointegrating vectors; it then identifies the five that do emerge and interprets their long-run implications, especially in regard to the impact of the basic and spill-over variables on real GDP. This section also answers our core questions for the paper. Finally, Section 6 contains a summary of our conclusions on the role of FDI amongst other variables upon real GDP, and its growth.

2. The variables in the VAR: and a summary rationalisation

Theoretically, the neo-classical theory can only explain the potential effects of FDI on output as the increased input of physical capital, while it regards other factors affecting economic growth as exogenous. Sustainable economic growth cannot be maintained in equilibrium since capital is subject to diminishing returns: technological progress could not be encapsulated in the production function in the neo-classical Solow model (Solow (1957))). That limitation can be rectified by invoking endogenous growth theory. The latter formulated several endogenous factors in the growth process, which potentially effect quality improvements in the labour force of an economy, such as, health, education, training, technological change, international trade and government policy (see Grossman and Helpman (1991), Barro and Sala (1997), Romer (1986), Lucas (1988)). Since it is argued that FDI can lead to the creation of new technologies, increased capital formation, the development of human resources, and the expansion of international trade, it is not solely its direct impact on the stock of physical capital that has the potential to enhance output or its growth (UNCTAD 1999).

As suggested by UNCTAD (1992), the VAR model that we use here is founded on the consideration that aggregate output (GDP) depends on supply side factors: domestic capital formation (KAP), employment (EM), human capital (HK), FDI, the openness of the economy (OPEN), and technology transfers (LrTT). These are the variables in the VAR and all are taken to be endogenous, and all will be measured in logarithms, so that changes in the log of output, in the form of real GDP, will obviously be rates of economic growth.

An exogenous, dummy, variable is included in the system to capture the process of economic reform over the years since 1979. Clearly, the expectation is that that process would affect the degree of openness of the economy and thereby economic growth. Indirectly or directly it would also do so via the key variables in the VAR. The liberalization of the economy was clearly a gradual process at first. Then, as the recent history of political economy teaches us, once the reforms were seen to have positive impacts on growth and incomes, reversing the public's prior expectation of their likely value, they would be accelerated. Eventually, the reforms would tail off as the changes to industrial and financial structure were fully implemented. We take that scenario as a paradigm for the reforms in China. The implication, that reform is a process, is that it cannot be accommodated by a simple, one-off, dummy variable of the familiar shift variety: but rather by a form of sinusoidal function. We have used the reforms that have been introduced over the years to encourage FDI as the basis for such a "liberalization dummy" (which we have labelled, Libdummy). The resultant series is covered in the following section.

3. Definitions and measurement of the variables, and the actual data

3.1. Definitions and measurements

Output (GDP): Real Gross Domestic Product is used to capture the total output of economic activities in China. For multi-national enterprises (MNEs) this variable can be expected to represent a measure of the potential size of the market when they are making decisions as to the location of their FDI. Of course, in general, there is a range of factors that influence those decisions, depending upon the form that the FDI is to take: such as relative labour costs in the potential host country vis-à-vis those in other possibly host countries and in the MNE's own country, tax breaks for investment, amongst others. Here, as in other studies of this kind, we take GDP to be the predominant motivator.

Capital Formation (KAP)**:** The VAR system nominally includes the stock of domestic capital following, as noted, the supply side approach (Solow (1970), Lucas (1988) and Romer (1990)). Here that stock is measured by annual domestic capital formation, since data on the stock are not available. Research on the impact of capital stock on economic growth has often used the investment figure as a proxy for the stock (for example, see Balasubramanyam et al. (1996(a), 1966(b)), Li and Liu (2005), and Greenaway et al (2007)).

However, we made attempts to estimate the stock of domestic capital. For example, following Jorgenson (1973) and (1980), we constructed a series that captures the enhancement in the stock of capital in each year. In essence, that kind of series implies that the arbitrary capital stock can be explained by its annual inflows. Since that was the case, the results from the model based on those arbitrary data, are almost identical to those we report here.

Employment (EM)**:** Annual average employment is used to measure labour force participation in economic activities. Employment increases personal income which may lead to higher consumption and hence demand, so affecting GDP. It also generates skills through "learning by doing", and thereby it can enhance the diffusion of technology which can raise productivity.

Human Capital (HK)**:** The stock of human capital is usually quantified by the school enrolment ratio, and this is the case in this study. We estimate this as the ratio of student enrolment in secondary education normalized by the population in the appropriate age cohort. The latter variable is calculated as the product of total population and the birth rate of the relative year. The implication is that secondary school education provides individuals with the essential new skills and knowledge that will be required as they enter the workplace. Hence, an increase in the enrolment rate should lead to greater productivity and enhanced economic growth.

In general, if data were available over a long historic span, and by types of academic training and age-cohorts, a more comprehensive assessment of the role of human capital, and its potential impact on both growth and foreign direct investment, could be attempted. The conventional data used here, taken in conjunction with the short time span for which these are available, suggest that the information that we uncover will tend to relate to the long run consequences of changes in human capital. Hence the potential value of the cointegrating vectors that we explore.

International openness (OPEN): This is defined as the sum of annual imports and exports of as a percentage of GDP. International trade can promote competition and hence, innovation, more efficient investment; thereby raising economic growth. Furthermore, the openness of an economy is frequently cited as a magnet for FDI, as Multi-national Enterprises (MNEs) can be expected to favour locations into which it is easy to import original materials and from which final products can be exported without any hindrance.

***FDI* (FDI):** FDI is measured as the value of FDI inflow. The utilized value of annual FDI inflow refers to investment that actually occurred in China each year. As it takes time for transferring capital and shipping equipment, the utilized FDI may not be the same as the amount in the agreement, and should be more precise than the contracted value of FDI in determining its impact on the economy. FDI is assumed to benefit the host economy through the creation of dynamic comparative advantages that lead to new technology transfers, capital formation, human resources development and expanded international trade.

As with the stock of domestic capital, we attempted to construct a series of the stock of FDI using the methods such as those proposed by Jorgenson (1973, 1980). However, this produced a series that could be explained by the flow of FDI.

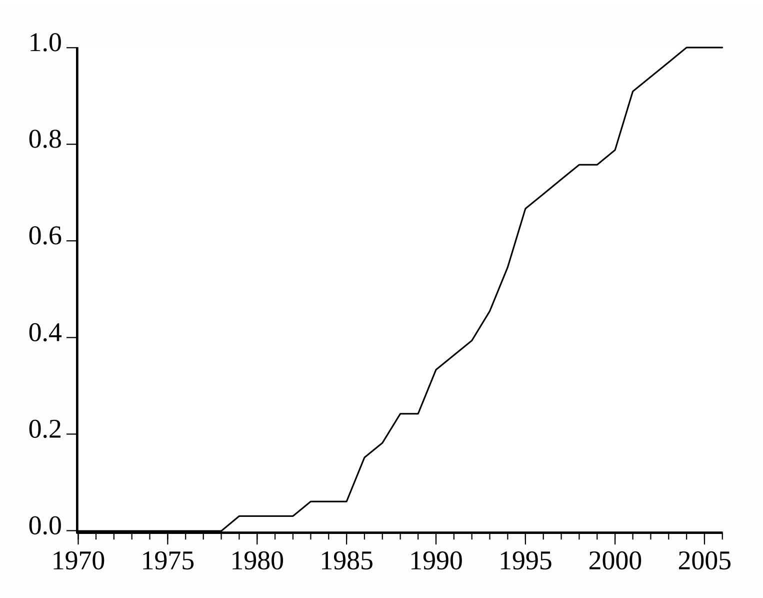
***New technology transfer* (LrTT):** The value of imports of machinery and transports as a percentage of GDP is used to capture technology innovations introduced from overseas. As China is still in the development stage, imported technology is usually considered to be more advanced than domestic technology (and technological imports from Japan and Korea have been increasing over recent years). A greater utilization of new technology in production would have obvious spin-offs in enhanced productivity and growth of real GDP.

***Liberalization (libdummy)**:* As we mentioned earlier, a dummy variable is introduced to capture the economic reform process that commenced in the late 1970s. The main objective of the reform is to remove restrictions on, and so to liberalize, private businesses in the domestic sector, international trade, and the foreign sector: this last by the incentives to encourage MNEs to invest in China. The economic reform process is a very cautious and gradual one, now lasting over last 30 years. So, for the reasons adduced earlier, it here assumes the form of a sinusoidal function of time.

To construct the dummy we used the fact that the period of reforms has included innovatory legislation, policy and strategy change. Although it is difficult to measure precisely this reference, the development of legislation related to FDI can still be considered to mirror the progress of the liberalization. Consequently, we constructed a time series dummy variable as the percentage of legislation employed by the end of each year to the sum of liberalization legislation made during 1970 to

2006 (details are provided in Appendix I). The result is, as it happens, something approaching a sinusoidal function. This is illustrated in Figure 1.

Figure 1: The economic reforms dummy:Libdummy

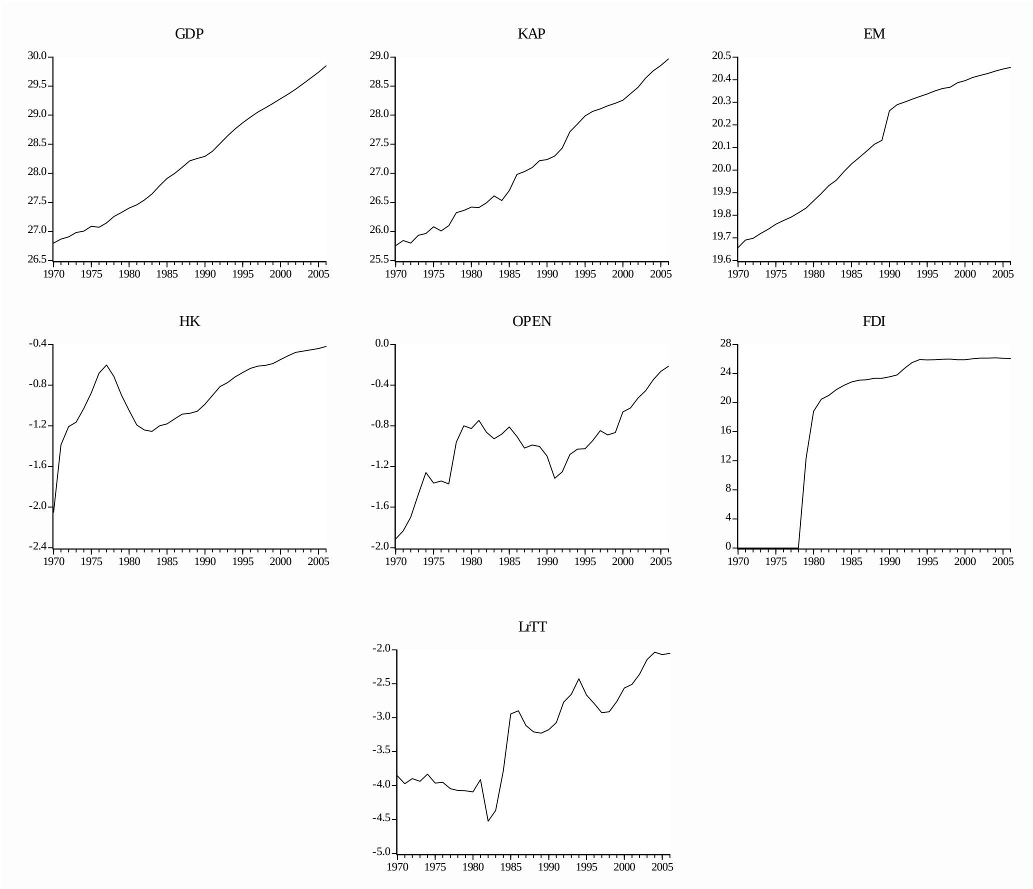


3.2 Data on the seven time series

The annual data are collected from *China Statistics Yearbook* (FDI, Human Capital, Employment, and Technology Transfer) and UNCTAD database (GDP, Capital Formation, and Openness). The time series cover the period 1970 to 2006. GDP and capital formation are measured in real RMB at 1990 prices to eliminate the influence of price changes. The FDI inflows (originally in US dollars, at 1990 prices in China) are converted into real domestic values by the (annual average series of) RMB to US dollar exchange rate. Openness is measured as the share of the sum of total exports and imports to GDP. Likewise Technology Transfer is the ratio of the import value of machinery and transport to GDP (both, of course, being either in US dollars or RMB, at 1990 prices). All variables are converted into *logarithms* in the estimation (hence, given its values are all below 1, the series for LrTT has all negative values). The graphs of the seven endogenous variables, in their logarithmic values, are given in Figure 2.

For the purposes of estimation it is necessary to consider the order of integration of the variables. On the basis of the ADF test alone all variables are I(1), save for OPEN and LrTT. The ADF test statistics are, with their probabilities in square brackets: GDP, -3.12 [0.118]; KAP, -2.44 [0.352]; EM, 6.34 [1.00]; HK, -1.837 [0.665]; FDI, -1.769 [0.389]; and, Libdummy, -2.226 [0.460]. For EM the test equation contained neither an intercept nor a trend term; for FDI there was an intercept; and for the remaining variables both the intercept and trend terms were statistically significant. OPEN is I(1) under the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, with an intercept and a trend; the LM statistic being 0.453, which is above the 5% critical level of 0.146. LrTT is I(1) under the Phillips-Perron test (-2.212 [0.469]). It follows, therefore, that we can investigate the presence of long-run, cointegrating relationships, between the variables, especially of their impacts of the other variables upon (the log of) GDP. We turn now to the VAR and thence to our estimates.

Figure 2: GDP, KAP, EM, HK, OPEN, FDI, and LrTT



4: The VAR methodology and estimates

4.1: Background

A structural VAR can be written as a simple extension of the by now popular semi-structural form, adopted by Bernanke and Blinder (1992). Thus:

$$Sy_t = Bx_t + A(L)y_t + \varepsilon_t : E(\varepsilon_t) = 0;\ y_t = n \times 1; x_t = k \times 1 \qquad (1)$$

$A(L)$ is a matrix polynomial in the lag operator L for a $\text{VAR}(p)$:

$$A(L) = A_1 L + A_2 L^2 + \ldots + A_p L^p \qquad (2)$$

S, *A* and *B*, naturally, are conformable matrices. Any structural contemporaneous parameters on the endogenous variables are, of course, contained in the matrix *S*. In our formulation the vector y_t contains the seven endogenous variables and the exogenous variables are contained in the vector x_t. The *k* elements in that vector are: the liberalisation dummy, and *deterministic terms*, intercepts and a time trend, in the estimation that follows. The time trend is included since many of the variables, as can be deduced from simple inspection of Figure 2, contain (linear) trends.

The MA representation of equation (1) is:

$$y_t = \Theta(L)\varepsilon_t : \Theta = [S - A(L)]^{-1} \tag{3}$$

Where: $E[\varepsilon_t] = 0$ and, as in Sims (1980)[1], $E[\varepsilon_t \varepsilon_t^{'}] = I_n$.

From the moving average (MA) representation of the system (equation (3)), it follows that for the system to respond in a stable manner to any given random disturbance, so that over time the responses approach 0, it must be mathematically stable, so that the roots of the matrix polynomial, $\left| I_n - (S)^{-1} A(L) \right| = 0$, must lie outside the unit circle in absolute value, or are 1 in the presence of cointegration. Alternatively, if the VAR is written in companion form, that the roots of the companion matrix should be less than one in absolute value or are equal to plus 1 in the presence of cointegration (Hamilton (1994)).

Employing the Cholesky decomposition to uncover the structural innovations means that the system is then a recursive model or Wold-causal chain; the way in

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[1] That is, the structural disturbances are orthogonal (and so independent). Therefore the Cholesky decomposition of Ω provides the zero restrictions (to complement the $\frac{1}{2}p(p+1)$ constraints) on Ω needed to identify the elements of S^{-1}.

which the variables affect each other is determined by their position in the ordering. In this sense, the contemporaneous innovations in the other variables influence all those below them in the chain and none of those variables above them in the order (footnote 1). However, we know that the ordering of the variables in the vector y_t does not matter if the correlation between any pair of the residuals in the system is smaller than about 0.20 in absolute value.

There exist, of course, alternative approaches to generating a set of orthogonal innovations, such as the generalised impulse responses formulated by Pesaran and Shin (1998). In their formulation, the impulse responses from an innovation to the *i*-th variable, are obtained from having computed a Cholesky decomposition with the *i*-th variable ordered as the first variable. Such responses will be identical to those obtained from the Cholesky decomposition on the "original" system if the correlations between the innovations in the VAR are zero. Given the structure of the correlation/covariance matrix of our system, noted below, we have employed both the Cholesky and Pesaran-Shin (1998) decompositions in deriving the impulse responses that are given in Appendix III.

In selecting the best lag structure for the VAR several criteria must be met: (1) the system must be mathematically stable; (2) standard lag selection exclusion and lag length criteria (the information criteria of Akaike, Schwarz and Hannan_Quinn and the LR test)[2] should confirm the choice of lag; and, (3) the residuals for the individual equations should be normally distributed with no AR and no Heteroskedasticity; and so that would be the case for the vector of (the system) residuals from the VAR. This last criterion is important for any tests for the presence of cointegration: since it is under those conditions that the distributional properties of the trace test for the

[2] See, for example, Lütkerpohl (1991).

presence of cointegrating vectors have been evaluated. However, Johansen (1995) points out that the normality assumption per se might not be important, but that the presence of ARCH might be; and Juselius (2006) notes that the absence of normality is of no import provided it is due to excess kurtosis.

4.2: Estimates and diagnostics

The only VARs that were mathematically stable were for 1 lag and 2 lags. However, the attributes of the residuals from employing 2 lags were superior to those arising from the use of 1 lag. The system-wide statistics and information on the residuals are given in Tables II.11 and II.2, respectively, in Appendix II: the full set of equations is available from the authors on request, since it would take up too much space here. Given that times series exhibit autocorrelation, it is not surprising that the goodness-of-fit of the seven equations is high: but so too are their adjusted values. Table II.2 indicates that there is no ARCH and the possibility of AR only in the LrTT equation. The only residuals that are not normally distributed are those for EM and FDI. However, in both instances there is excess kurtosis: for the basic (transformed: that is, standardised) residuals in the VAR the excess kurtosis for EM is 9.913 (0.827) and for FDI it is 3.283 (2.121). So the residuals possess attributes that are acceptable for evaluation of the existence of cointegrating vectors in the system.

Of interest in the VAR are the coefficients on the deterministic variables: the intercept, trend and libdummy. These (rounded up) are provided here, in Table 1: standard errors are beneath the coefficients and *t*-statistics are in [.].

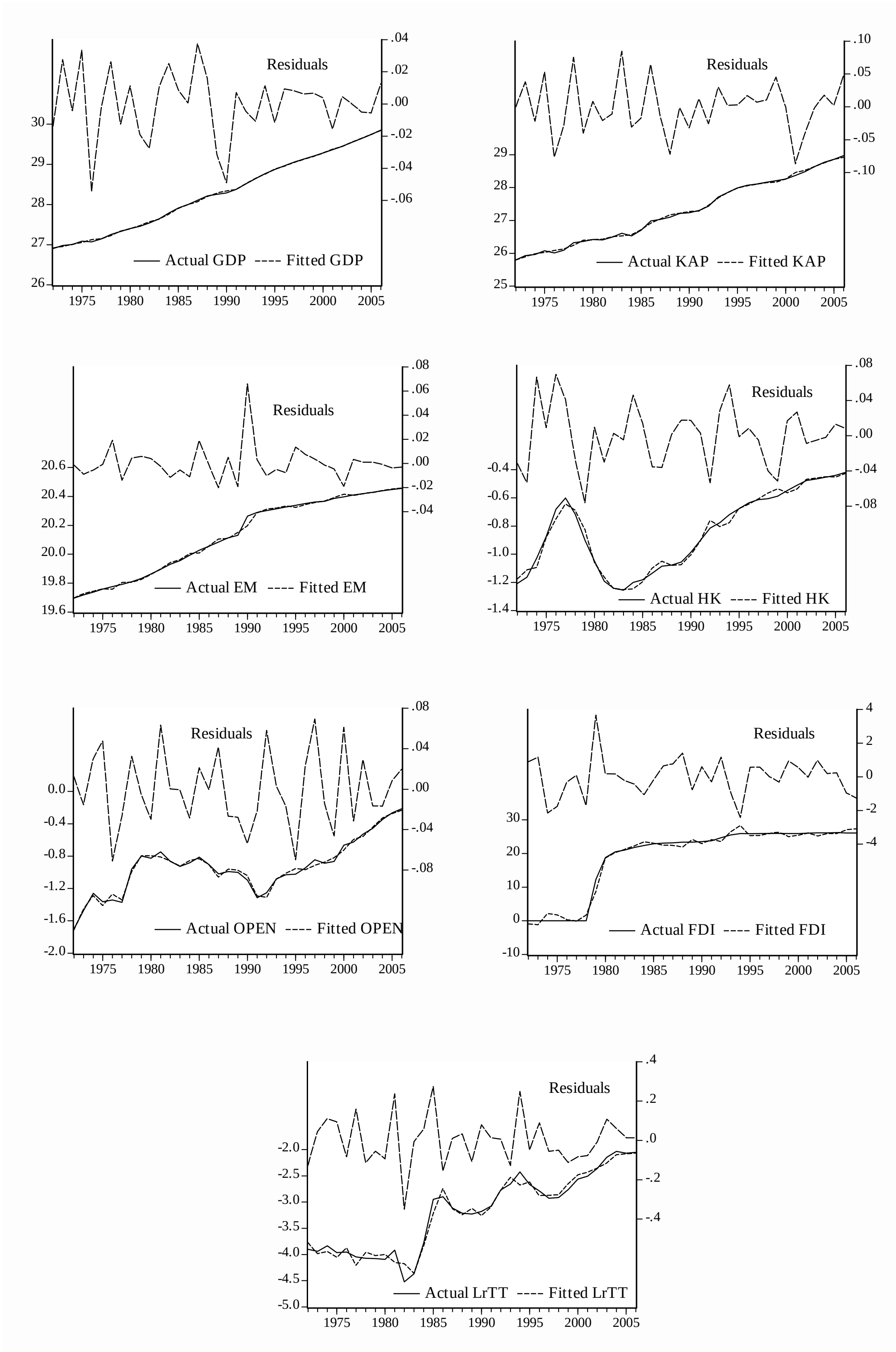
Table 1: Deterministic terms in the VAR

	Equation						
	GDP	*KAP*	*EM*	*HK*	*OPEN*	*FDI*	*LrTT*
C	17.731	35.204	5.857	-66.864	133.520	-234.895	-39.007
	11.335	22.091	8.177	-19.153	20.369	-640.264	-69.206
	[1.564]	[1.594]	[0.713]	[-3.491]	[6.556]	[-0.367]	[-0.564]
Trend	0.058	0.083	0.014	-0.115	0.236	0.861	0.021
	0.023	0.044	0.016	-0.038	0.041	1.283	0.139
	[2.541]	[1.882]	[0.875]	[-2.990]	[5.784]	[0.671]	[0.151]
Libdummy	0.057	0.533	-0.130	0.004	0.553	-11.984	-0.507
	0.145	0.282	-0.104	0.244	0.260	-8.167	-0.883
	[0.393]	[1.891]	[-1.247]	[0.018]	[2.127]	[-1.467]	[-0.575]

It is at once apparent that all three deterministic terms have some part to play in one equation or another. Indeed, all three have statistically significant impacts on OPEN, for example. If we focus on the liberalisation variable we observe that it has significant impacts on two variables, KAP and OPEN; both of which respond positively to increased liberalisation. The effect on FDI is negative, though as noted, it is not statistically significantly different from zero. The influence of the trend (positive, of course, as the time series of the variables indicate) is evident for GDP, KAP, HK and OPEN.

Figure 3 provides the graphs of the actual, fitted and residual values for the equations in the system. The virtual coincidence between the actual and fitted values is apparent for all equations. So, we observe particularly that the early heavily cyclical phase of HK and its subsequent growth phase, are almost perfectly tracked by the estimated equation. The residuals also look as though they are stationary; and this is the case, all series being I(0) under both the ADF and Phillips-Perron tests, with all test statistics carrying a probability of zero.

Figure 3: Actual and fitted values and residuals: VAR estimates



4.3 VAR: Impulses

To begin to extract information from the VAR on the role of the variables in influencing GDP and also FDI, we consider the impulse responses of those variables, rather than providing all possible responses for all the seven variables in the system. As mentioned earlier, in doing so, we present the findings from the use of the Cholesky decomposition and the Generalised impulses. The effects on GDP of one standard deviation innovation to each of the other six variables are portrayed in Figure III.1 in Appendix III; and the cumulative effects are illustrated in Figure III.2. The impacts on FDI are graphed in Figures III.3 and III.4. As is an almost universal finding in the literature, the impulse responses possess high standard errors, given by the dotted lines in the figures. Also, the ordering of the variables in the VAR is seen to matter for some of the impulses: though several are identical in their time pattern, even though not in magnitude.

These, compatible, conclusions can be extracted from the four figures: (1) GDP is generally enhanced by increases in domestic capital formation, openness and technology, both period-by-period and cumulatively; but GDP reacts negatively in the short-run and over time to higher foreign direct investment and a higher level of employment; (2) FDI itself is reduced period-by-period and cumulatively, by GDP, domestic capital formation, openness and technology; and by human capital in the long-run. It is increased only by changes in employment.

4.4 Variance decomposition

The variance decompositions from the Cholesky decomposition using the ordering in the first row of the tables are reported in Table 2 for GDP and in Table 3 for FDI. The standard errors are based on 1000 Monte Carlo replications.

Table 2: Variance decomposition for GDP, Cholesky decomposition

Period	*S.Error*	*GDP*	*KAP*	*EM*	*HK*	*OPEN*	*FDI*	*LrTT*
1.000	0.028	100.000	0.000	0.000	0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2.000	0.039	93.257	0.022	2.690	0.680	0.231	0.453	2.669
		(8.754)	(3.903)	(5.801)	(3.166)	(1.836)	(1.500)	(3.964)
3.000	0.043	90.115	0.630	2.288	0.898	0.440	0.755	4.876
		(11.514)	(5.422)	(6.178)	(5.193)	(2.279)	(2.396)	(5.543)
4.000	0.043	88.266	1.134	2.384	0.916	0.436	1.094	5.769
		(13.069)	(6.368)	(6.762)	(6.943)	(2.412)	(2.892)	(6.175)
5.000	0.044	86.055	1.283	3.632	1.568	0.462	1.113	5.888
		(13.852)	(6.519)	(7.725)	(7.809)	(2.507)	(2.986)	(6.260)
6.000	0.045	84.087	1.242	3.697	3.594	0.551	1.132	5.697
		(14.307)	(6.617)	(8.108)	(8.634)	(2.590)	(3.129)	(6.202)
7.000	0.046	81.674	1.258	3.576	5.837	0.746	1.361	5.549
		(14.690)	(6.722)	(8.556)	(9.223)	(2.750)	(3.236)	(6.090)
8.000	0.046	80.023	1.251	3.640	7.188	0.811	1.549	5.537
		(14.942)	(6.839)	(9.068)	(9.461)	(2.823)	(3.298)	(6.007)
9.000	0.046	79.066	1.236	3.732	7.919	0.858	1.669	5.519
		(15.178)	(6.949)	(9.449)	(9.614)	(2.9450	(3.330)	(5.938)
10.000	0.047	78.592	1.230	3.807	8.260	0.873	1.750	5.488
		(15.377)	(7.092)	(9.846)	(9.729)	(3.032)	(3.349)	(5.917)

As anticipated, the standard errors indicate that GDP is largely, and statistically speaking, influenced by its own fluctuations. FDI has a numerically small contribution to play in the fluctuations of GDP. The only other variable that makes some contribution to the latter is human capital.

For FDI, its own contributions to its variance are all statistically significant, contributing from 27% to 13% to its own variance. Human capital is the only other variable that contributes statistically throughout to the variance of FDI; contributing from 62% to 46% over the ten years. GDP’s contribution rises rapidly over the years, but is only statistically significant for the last three of those years, when it is tending to increase FDI, as we saw from the impulse responses.

Table 3: Variance decomposition for FDI, Cholesky decomposition

Period	*S.Error*	*GDP*	*KAP*	*EM*	*HK*	*OPEN*	*FDI*	*LrTT*
1	0.028	1.899	6.591	0.800	62.114	1.794	26.802	0.000
		(6.388)	(8.576)	(4.385)	(10.743)	(2.571)	(7.444)	(0.000)
2	0.039	0.900	3.192	1.238	68.603	1.667	22.468	1.933
		(6.192)	(6.654)	(5.864)	(11.026)	(2.988)	(7.041)	(3.270)
3	0.043	0.729	2.607	1.772	72.944	1.235	19.122	1.590
		(7.852)	(6.975)	(6.426)	(11.966)	(2.462)	(7.107)	(3.786)
4	0.043	5.311	1.998	3.894	66.983	2.558	18.008	1.248
		(11.006)	(7.081)	(7.893)	(13.044)	(2.791)	(7.261)	(3.866)
5	0.044	18.159	1.639	3.205	57.072	2.529	16.241	1.154
		(14.660)	(6.759)	(7.917)	(13.509)	(2.839)	(6.925)	(4.321)
6	0.045	26.503	1.506	4.202	50.056	2.210	14.449	1.075
		(16.154)	(6.779)	(8.425)	(13.808)	(2.724)	(6.420)	(4.775)
7	0.046	28.937	1.669	5.581	47.083	2.079	13.629	1.022
		(16.145)	(7.039)	(9.448)	(13.842)	(2.675)	(6.048)	(4.921)
8	0.046	29.395	1.875	6.161	46.105	2.060	13.338	1.067
		(15.952)	(7.139)	(10.038)	(13.782)	(2.695)	(5.787)	(5.074)
9	0.046	29.286	1.892	6.504	45.814	2.048	13.211	1.246
		(15.845)	(7.162)	(10.416)	(13.825)	(2.716)	(5.645)	(5.221)
10	0.047	29.069	1.885	6.838	45.655	2.032	13.153	1.367
		(15.834)	(7.175)	(10.763)	(13.811)	(2.790)	(5.541)	(5.313)

5. Cointegration, identified cointegrated vectors and the VECM findings

5.1: Cointegration

We have seen that the estimation of the VAR has generated conditions that permit us to investigate the presence of cointegration between the variables. This is important because it allows us to endeavour to identify (in the strict mathematical sense) long-run relationships between, say, GDP and FDI.

The vector error correction form of equation (1) required for testing for the presence of cointegration is, of course:

$$\Delta y_t = Z + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t ; S^{-1}B = Z, S^{-1}A(i) = \Pi_i \qquad (4)$$

Here: $\Pi = \sum_{i=1}^{p} \Pi_i - I;\ and,\ \Gamma_i = -\sum_{k=i+1}^{p} \Pi_k$ (4a)

The long-run matrix is:

$$\Pi = \alpha\beta' : \alpha = n \times r,\ \beta' = r \times n,\ r \le n \tag{5}$$

In equation (5), *r* denotes the rank of the matrix Π; which must be of reduced rank, $r < n$, for cointegration to exist. The matrix β' contains the coefficients in the cointegrating relationships between the *n* variables; which provide the error correction, disequilibrium, terms, to which the coefficients in the matrix α determine how, if at all, any disequilibrium changes the endogenous variables. The Trace statistic developed by Johansen is used to determine *r*, the number of cointegrating relationships in the VARs that follow.

When cointegration is found, of course, the cointegrating vectors are not necessarily identified (unique).[3] Normalisations are employed to obtain the vectors, and that suggested by Johansen (1995) is frequently adopted.[4] Attempts to identify the vectors might use relevant formal economic theory; or in our enquiry, economic intuition concerning the possible linkages between the variables that have been formulated in literature.

To assess the number of cointegrating vectors, Models 3 and 4 proposed by Johansen (1995) were used. Model 3 excludes a trend from the cointegrating vectors, whilst Model 4 does not: and that model has to be evaluated since the vector of endogenous variables is a linear function of time (these are linear trends; so that Model 5 of Johansen (1995) is not relevant). Model 4 produces 5 cointegrating vectors on the basis of the Trace test, and Model 3 indicates that there are 4 vectors.

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[3] As Johansen ((1995), pp.71-72) noted:
The parameters in α and β are not uniquely identified in the sense that given any choice of α and β and any non-singular matrix $\xi(r \times r)$ the choice of $\alpha\xi$ and $\beta(\xi')^{-1}$ will give the same matrix Π and hence determine the same probability distribution for the variables. One way of expressing this is to say that what the data can determine is the space spanned by the columns of β …., and the space spanned by α ….

[4] Standard software packages use alternative normalisations, including that of Johansen: however, they do not identify the vectors.

Accordingly, the LR test that Johansen (1995, pp.97-98) advocates for determining which is the dominant specification, is not necessarily an accurate test of the superior model: since that test is based on the assumption that both models generate the same number of cointegrating vectors (the same rank of the long-run matrix). Consequently, we took account of the statistical significance of the trend in the potential cointegrating vectors and conducted an LR test to assess if the trends could be set at zero. Consequently, that test, with a $\chi^2(4) = 16.7454$ indicated that restricting the trend to lie outside the cointegrating space would be incorrect (and taking the rank as 5 only enhanced that conclusion). The eigenvalues (which for the four years over which recursive estimation could be conducted were almost identical and indicated rank four) and the trace statistics are given in Table IV.1, Appendix IV. The critical values for the trace test are derived on the assumption (as is noted in the various software packages) that there are no exogenous variables in the potential cointegrating relationships. Therefore, using 100,000 replications we used Monte Carlo methods to calculate critical values for Model 4 allowing for the libdummy exogenous variable; and we also allowed for our smallish sample size of 37 (using the algorithm written for us by Bagus Santoso (2002)). The resultant critical values revealed that we could still accept the presence of 4 cointegrating vectors in Model 3 and 5 in Model 4 (as reported in Appendix Table IV.1 for Model 4).

The ideal is to be able to impose constraints on the coefficients in the cointegration vectors and/or the adjustment coefficients, so that both the restrictions hold statistically by the Chi-squared test and they do *identify* the vectors. Occasionally, attempts at identification are made easier by the nature of the variables in the potential relationships and the form of those relationships suggested by economic theory: as in the classic example of links between money, an interest rate and national income.

Here, in our endeavours to identify the vectors we focused on exploring these kind of issues: (1) the long-run links between GDP and FDI and vice-versa; (2) the possibility that spill-over effects and externalities from FDI might affect GDP, domestic investment and employment, such effects arising from the use of more advanced technology in production, either directly or indirectly through imports of technological inputs; and, (3) the possibility of identifying a long-run aggregate production function which shows the major factors (domestic and foreign capital, employment and human capital) which could influence GDP and its growth in the steady state equilibrium. . With five cointegrating vectors the identification process is made that more difficult and arduous. However, the vectors have been identified. These are reported in Table 5, where the restrictions have been given for individual parameters since it is easier to see what they are rather than when they are given in terms of a matrix of restrictions on the betas and alphas (β_{ij} denotes the coefficient on the j^{th} variable in equation *i*; and α_{ij} denotes the coefficient on the j^{th} error correction term in the first difference equation of variable *i*).

Table 4: The identified cointegration vectors

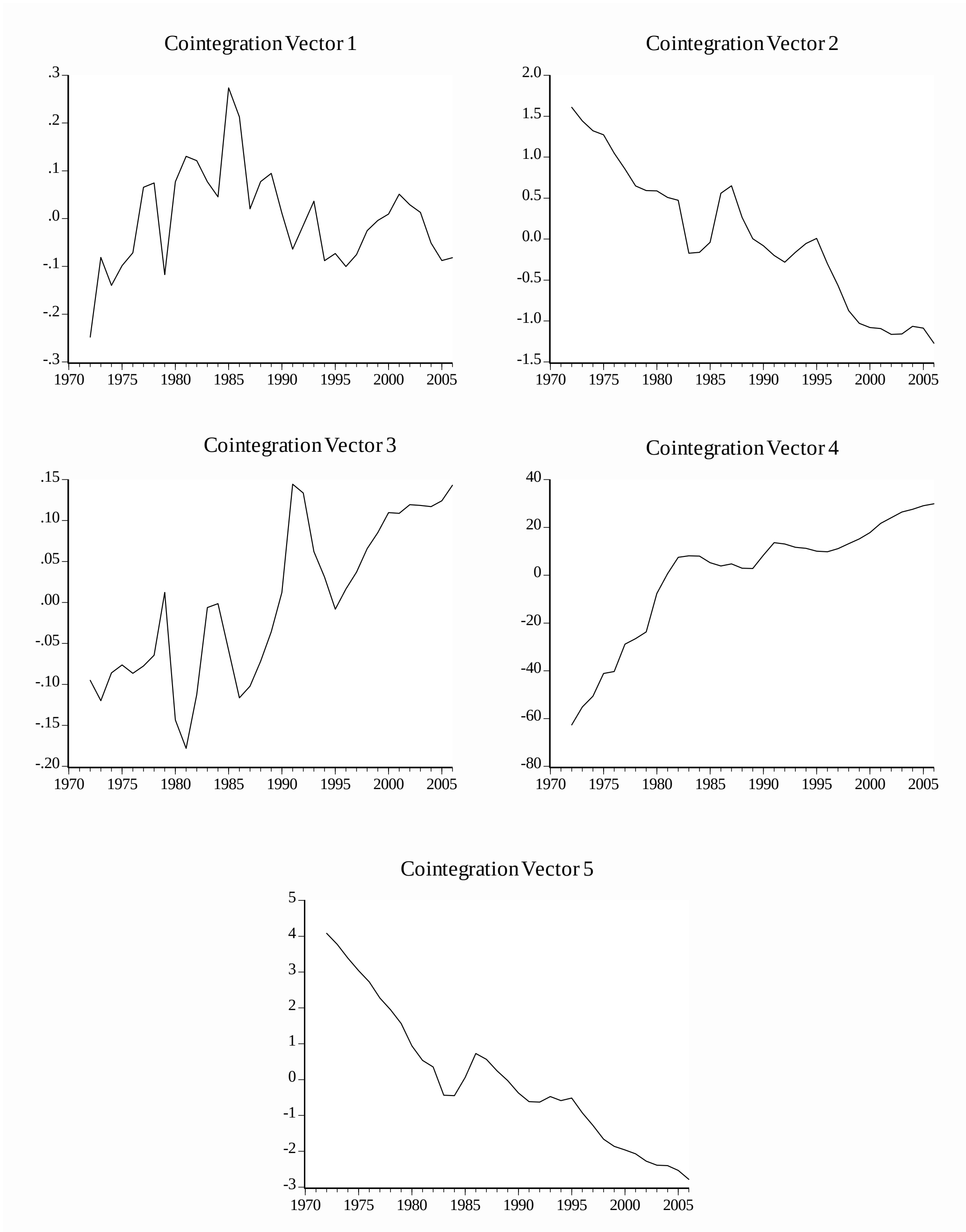
Cointegration Restrictions:
β(1,1)=1, β(1,2)=1, β(1,3)=1, β(1,5)=0, β(1,7)=0, β(2,1)=1, β(2,2)=1, β(2,3)=0, β(2,4)=0, β(2,5)=0, β(3,3)=1, β(3,2)=0, β(4,2)=0, β(4,3)=0, β(4,6)=1, β(4,7)=0, β(5,3)=0, β(5,4)=0, β(5,7)=1,
α(2,1)=0, α(2,3)=0, α(3,1)=0, α(3,2)=0, α(3,3)=0, α(3,4)=0, α(6,1)=0, α(6,2)=0, α(6,4)=0, α(6,5)=0, α(7,1)=0, α(7,3)=0, α(7,5)=0

Convergence achieved after 2482 iterations.
Restrictions identify all cointegrating vectors
LR test for binding restrictions (rank = 5):

χ^2(7)	2.404213				
Probability	0.934136				
Cointegrating Eq:	CointEq1	CointEq2	CointEq3	CointEq4	CointEq5
GDP(-1)	1.000000	-1.000000	-0.466180	-94.10783	2.559329
			(0.10125)	(21.0802)	(0.76346)
			[-4.60447]	[-4.46428]	[3.35228]
KAP(-1)	-1.000000	1.000000	0.000000	0.000000	-0.158321
					(0.01786)
					[-8.86580]
EM(-1)	-1.000000	0.000000	1.000000	0.000000	0.000000
HK(-1)	0.512763	0.000000	-0.365955	1.558056	0.000000
	(0.10411)		(0.05770)	(3.10442)	
	[4.92516]		[-6.34278]	[0.50188]	
OPEN(-1)	0.000000	0.000000	0.022789	9.541357	-0.435986
			(0.01797)	(4.52260)	(0.16196)
			[1.26810]	[2.10971]	[-2.69188]
FDI(-1)	0.022288	0.014723	-0.021840	1.000000	-0.025605
	(0.00423)	(0.00840)	(0.00261)		(0.01134)
	[5.26849]	[1.75220]	[-8.35699]		[-2.25847]
LrTT(-1)	0.000000	0.828260	-0.087335	0.000000	1.000000
		(0.02580)	(0.01658)		
		[32.1015]	[-5.26654]		
TREND	-0.000143	-0.146551	0.054961	9.418907	-0.420107
	(0.01024)	(0.03506)	(0.01008)	(1.84910)	(0.08982)
	[-0.01399]	[-4.18000]	[5.45072]	[5.09379]	[-4.67695]
Constant	19.12930	6.217832	-8.183219	2466.676	-56.58195

The graphs of the cointegrating vectors are given in Figure 4.

Figure 4: The cointegration vectors



All vectors are I(0); though at first appearance that looks not to be so. Thus: the relevant statistics are as follows: for CV1, with statistically significant intercept and trend, the ADF t-statistic is -3.558 [0.0008]; for CV2, with an intercept and a trend, the KPSS test produces an LM statistic of 0.0905, which is not only under the 5% critical value (of 0.146) but is lower than that at the 10% level (0.119); for CV3, with a statistically significant intercept and trend, the ADF t-statistic is -4.3607 [0.0078]; for CV4, with neither intercept nor trend, the PP adjusted t-statistic is -2.412 [0.0174]; and, for CV5, with both intercept and trend the KPSS LM statistic is 0.12298, which is below the 5% critical value as required.

Omitting the trend and drift terms, and rounding up the coefficients in Table 4, we have the following relationships:

$$GDP = 1*KAP + 1*EM - 0.518*HK - 0.022*FDI \quad (6)$$

$$KAP = 1*GDP - 0.015*FDI - 0.828*LrTT \quad (7)$$

$$EM = 0.0466*GDP + 0.366*HK - 0.023*OPEN + 0.022*FDI + 0.087*LrTT \quad (8)$$

$$FDI = 0.94.108*GDP - 1.558*HK - 9.541*OPEN \quad (9)$$

$$LrTT = -2.559*GDP + 0.158*KAP + 0.436*OPEN + 0.026*FDI \quad (10)$$

The conclusions that we can extract from these long-run relationships give some possible indications of the answers to the issues posed in our introduction especially those related to the links between economic development and FDI. Recalling the measurement of our variables in Section 3.2, equation (1) suggests that in the long-run FDI inhibits GDP per se, or growth in FDI is inimical to the growth in GDP; and statistically significantly so (Table 5). If think of equation (6) as the logarithmic transformation of a multiplicative aggregate production function, then the elasticities of aggregate output with respect to the domestic capital stock and to the surrogate for the labour supply are one. We also observe that domestic capital is ‘super-productive’ in the sense that it does not suffer from diminishing returns which is unlike that of standard neo-classical growth theory but consistent with the predictions of endogenous growth models. Output responds negatively in the long-run to changes in human capital and not just to FDI. The state of technology, for which a surrogate might be the imports of technology, has no impact in the long run on economic growth: that finding being accepted statistically under our restrictions on the coefficients. Growth in China seems to follow the strategy of *domestic* capital intensive development

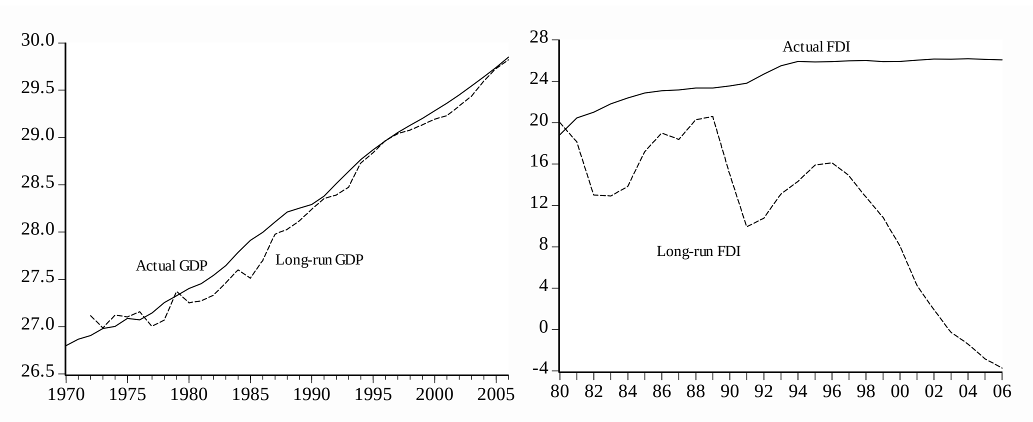
Equation (7) provides a feasible explanation for the negative response of long-run output to FDI. The latter tends to reduce domestic capital formation in the long-run and so works against the tendency of that productive capital formation to enhance long-run growth. The impact of the technology variable on the long-run stock of domestic capital is also negative: perhaps reflecting the inappropriate or inadequate application of imported technology by foreign firms. As a consequence domestic capital formation is being crowded out by multi-national enterprises and continuing FDI may not be growth enhancing.

We turn now to equation (9) for FDI before extracting some implications of the long-run equations for employment and imports of technology. Over the long-run no other variables could be found to produce an identified long-run relationship for FDI, besides GDP, openness and human capital. The latter's impact was not statistically significant, but like openness in the long-run equation for employment, it could not be omitted without rendering most other coefficients in the system statistically insignificant and preventing identification of the vectors. However, whilst the degree of openness seems to hamper long-run FDI, we observe that GDP is a positive and substantial attractor of FDI (with an elasticity of 0.94). So, FDI might not impact on long-term economic growth, but economic growth is its main attractor in the long-run. FDI flows into China seems to be driven by the inexorable growth of the macro economy over the last three decades.

Finally, we consider equations (8) and (10). Long-run employment increases with GDP, human capital and FDI, which would probably be generally consistent with a priori expectations. The positive impact from FDI implies that whilst FDI might not be a direct influence on long run economic growth it has a positive indirect influence via its employment generating activities. Improvements in technology could be beneficial to employment via its indirect impetus to labour productivity. That technological development is itself increased in the long run by increased FDI and openness; as well as by higher domestic capital formation.

The long-run time paths of GDP and of FDI are portrayed in Figure 5.

Figure 5: Long-run time paths of GDP and FDI



These time series are, of course, dependent upon the cointegration vectors 1 and 4 graphed earlier. The first graph suggests that GDP is now nearer to its long-run (sustainable?) level. For FDI, its current path is running ahead of its long-run under current links between the (indeed, conventional) variables in our framework (recall that FDI also is measured in logs: hence the negative values; and the graph is drawn from 1979/1980 when FDI commenced).

We now supply some of the key features of the *VEC* model itself. In Table 5 we report the impact of the error correction terms on the changes in the variables. The unrestricted, non-zero, values of the adjustment coefficients, with one exception, are statistically significantly different from zero. We see that only one variable comes close to being a “weakly exogenous” variable, namely, employment. All variables react to changes to the equilibrium between them caused by any one of them.

Table 5: VEC model: Adjustment matrix

	ΔGDP	ΔKAP	ΔEM	ΔHK	$\Delta OPEN$	ΔFDI	$\Delta LrTT$
CEq1	-1.803737	0.000000	0.000000	6.834144	-17.12682	0.000000	0.000000
	(0.81690)			(1.01561)	(1.78141)		
	[-2.20803]			[6.72911]	[-9.61420]		
CEq2	-1.456663	-0.724592	0.000000	6.128162	-15.19331	0.000000	-0.849224
	(0.70050)	(0.14178)		(0.87220)	(1.52601)		(0.14931)
	[-2.07946]	[-5.11057]		[7.02611]	[-9.95622]		[-5.68761]
CEq3	-2.045544	0.000000	0.000000	9.330099	-22.61393	19.60258	0.000000
	(1.08363)			(1.35598)	(2.36291)	(6.09680)	
	[-1.88768]			[6.88069]	[-9.57036]	[3.21522]	
CEq4	0.043173	0.032299	0.000000	-0.164383	0.396037	0.000000	-0.014975
	(0.01876)	(0.00497)		(0.02338)	(0.04084)		(0.00444)
	[2.30143]	[6.50002]		[-7.02985]	[9.69768]		[-3.37056]
CEq5	1.065976	0.793605	-0.011459	-4.315349	10.65575	0.000000	0.000000
	(0.49354)	(0.12889)	(0.00772)	(0.61517)	(1.07449)		
	[2.15984]	[6.15713]	[-1.48518]	[-7.01485]	[9.91707]		

In Table 6 we provide the coefficients on the Libdummy variable, since this is a potentially important component of our study. The table also includes some overall statistics for the VEC model.

Table 6: VEC model: Libdummy’s coefficients and overall statistics

	ΔGDP	ΔKAP	ΔEM	ΔHK	$\Delta OPEN$	ΔFDI	$\Delta LrTT$
Libdummy	-0.041070	0.450157	-0.064393	-0.098142	0.452999	-5.850617	-0.994961
	(0.05828)	(0.11045)	(0.04651)	(0.10519)	(0.10253)	(3.46756)	(0.35953)
	[-0.70465]	[4.07555]	[-1.38443]	[-0.93295]	[4.41816]	[-1.68725]	[-2.76738]
R^2	0.588737	0.753330	0.361296	0.782946	0.904289	0.702850	0.692853
$\bar{R}^2$	0.334146	0.600629	-0.034093	0.648579	0.845040	0.518901	0.502715
S.E. eq.	0.026870	0.050922	0.021443	0.048498	0.047269	1.598632	0.165753
F-stat.	2.312482	4.933370	0.913774	5.826921	15.26237	3.820883	3.643941

It is at once apparent that the goodness-of-fit for these equations is particularly high for such modelling. True the adjusted value is very low for the change in EM: however, that could be rationalised by noting that this variable is almost a “weakly exogenous” variable so that its first-difference equation is likely to be “weak”, with only a set of one-period first differences of the variables to influence the change in EM. Of particular note is the fact that the Libdummy is statistically significant in the majority of the equations; and, obviously, by an F-test should be a retained regressor.

6. Summary and conclusions

In this paper we have explored the fundamental question of the role of foreign direct investment in the economic growth of China over the past near-40 years. Conflicting opinions exist in the now rather voluminous theoretical, descriptive and formal econometric as to that role for many other countries: but the existing empirical, certainly econometric, studies for China, to which we have made reference in our introduction, have been rather limited so far in number and scope, and have produced incomplete, but also competing answers on the role of FDI. Our objective has been to encompass the various narrow studies in one comprehensive framework into which the several feasible determinants of aggregate output and of FDI could be incorporated and be allowed potentially to interact with one another. The simple unifying feature driving the resultant VAR framework that we have utilised was a (surrogate for) the aggregate production function: itself drawing on the “modern” endogenous growth theory, which seeks to reduce the adverse impact of diminishing returns and thereby create long run sustainable growth through capital accumulation.

We can summarise our findings as follows. In the *long-run*, relationships can be discerned between GDP and FDI. These inform us that GDP (or its rate of growth if we work in terms of changes, since it and FDI are, we recall, measured in logarithms) declines as FDI increases; however, FDI itself responds positively to economic growth in China. Economic growth is a major influence on FDI, with an elasticity of almost 1. FDI will decline over the long-run according to our findings as the economy becomes more open. A possible rationale for this outcome could be that since FDI raises the level of technology in the economy, foreign firms begin to lose their competitive comparative advantage in Chinese markets as productivity rises in domestic industry consequent upon the utilisation of the latest technology.

The question as to whether FDI crowds out domestic capital formation has been one of the concerns of the literature and of policy makers. Our findings indicate that it does so. Thereby, it further reduces aggregate output in the long run, since output responds strongly to enhanced domestic capital formation.

An important element in the VARs from which the long-run relationships were derived is the liberalisation dummy. The results show that it was an important determinant of the variables in the VAR. The VEC equations (Table 6) reveal that it had a statistically significant impact on the changes to domestic capital stock and to the degree of openness in the economy. However, it had significant negative effects on the changes to FDI and imported technology. As far as FDI is concerned, there might be a longer time-delay effect than can be captured (statistically reliably) with our set of observations, because of the gestation period for FDI. Or it could be that, for example, the announced encouragement of FDI, for which the actual changes in legislation would take time, had already impacted on FDI.

Considering the VEC model further, in the short-run FDI also declines with an increase in the liberalization variable, but it increases as openness increases. No other changes in the variables impact statistically significantly on FDI. In regard to short-run changes in GDP, the only significant impact arises from a change in employment: so that changes in FDI have no impact.

We conclude that FDI has had limited (even negative) impact on the spectacular phenomenon of Chinese economic growth. Growth of GDP has been driven by domestic capital accumulation and concomitant employment of labour, presumably fuelled by government infrastructural capital accumulation. This rapid growth within an open economy, with increasing liberalisation, has attracted increasing amounts of FDI (the elasticity of FDI with respect to GDP being almost unity). However, this FDI has also displaced domestic capital accumulation, which has traditionally been the core engine of growth. Our policy prescription would therefore be to target FDI at the most technologically sophisticated sectors of the economy but not to allow a fee for all entry of foreign capital, which may have become a substitute, rather than a complement, for domestic capital. These results are statistically robust and emanate from a more broad-base general equilibrium framework, which looks at the inter-relationship of FDI and growth but in the context of employment, human capital, liberalisation and openness.

References

Balasubramanyam, V. N., Salisu.M., and Sapsford D., 1996a. Foreign Direct Investment and Growth in EP and IS Countries. Economic Journal 106, 92–105.

Balasubramanyam, V. N., Salisu. M., and Sapsford D.,1996b. Foreign Direct Investment and Growth: New Hypotheses and Evidence. Journal of International Trade and Economic Development 8, 27–40.

Barro, R. J. and Sala-I-Martin, X., 1997. Technological Diffusion, Convergence and Growth. Journal of Economic Growth 2, 1-26.

Bende-Nabende, A., Ford, J.L., Santoso, B., and Sen, S., 2003. The Interaction between FDI, Output and the Spillover variables: Co-integration and VAR Analyses for APEC 1965-1999. Applied Economics Letters 10, 165-172.

Bernanke, B., and Blinder, A.S., 1992, The federal funds rate and the channel of monetary transmission. The American Economic Review 82, 901-21.

China Investment Yearbook 2006. China Statistics Press, Beijing.

Greenaway, D., Sapsford, D., and Pfaffenzeller, S., 2007. Foreign Direct Investment, Economic Performance and Trade Liberalization. The World Economy, 10, 197-210.

Grossman, G.M., and Helpman, E., 1991. Trade, Knowledge Spillovers, and Growth. European Economic Review 35, 517-26.

Hamilton, J. D., 1994. Time Series Analysis. Princeton University Press, Princeton.

Johansen,S., 1995. Likelihood-based inference in Cointegrated Vector Autoregressive models. Oxford University Press, Oxford.

Jorgenson, D.W., l973. The Economic Theory of Replacement and Depreciation, in: W. Sellekaerts, W.(Ed.), Econometrics and Economic Theory. Macmillan, New York, pp. l89-22l.

Jorgenson, S., 1980. Accounting for Capital, in: G. von Furstenberg, G. (Ed.), Capital Efficiency and Growth. Ballinger,Cambridge, pp. 25l-3l9.

Juselius, K., 2006. The Cointegration VAR Model: Methodology and Applications, Oxford University Press, Oxford.

Li, X., and Liu, X., 2005. Foreign Direct Investment and Economic Growth: An Increasingly Endogenous Relationship. World Development 33, 393-407.

Liu X., Burridge P., and Sinclair P. J. N., 2002. Relationships between economic growth, foreign direct investment and trade: evidence from China. Applied Economics 34, 1433-1440.

Lucas R.E., 1988. On the mechanics of Economic Development. Journal of Monetary Economics 22, 3-42.

Lükterpohl, H., 1991. Introduction to Multiple Time Series Analysis. Springer-Verlag, New York.

Pesaran M. H., and Shin Y., 1998. Impulse Response Analysis in Linear Multivariate Models. Economics Letters 58, 17-29.

Romer P., 1986. Increasing Returns and Long run growth. Journal of Political Economy 99, 500-521.

Romer P., 1990. Endogenous Technological Change. Journal of Political Economy 98, Part II: S71-S102.

Santoso, B., 2002, Algorithm for Monte Carlo critical values for Johansen's models. University of Birmingham: now Department of Economics, Gadjah Mada University, Yogyakarta, Indonesia.

Shan J., 2002. A VAR approach to the economics of FDI in China. Applied Economics 34, 885-893.

Sims C.A., 1980. Macroeconomics and Reality. Econometrica, 48, 1-48.

Solow R., 1957. Technical Change and the Aggregate Production Function. Review of Economics and Statistics 39, 312-320.

Su Meitang (2005): Does Foreign Direct Investment Crowd out Domestic Investment in China?, *Conference Paper for Austrian Conference of Economist,* 2005.

Tan Jingrong, Dong Mei and Zhou Yinghao (2004). The Analyses of FDI and Economic Growth in China, USA-China Business Reviews, 2004 7 (33).

UNCTAD (1992): *World* Investment Report 1992: Transnational Corporations as Engines of Growth. UN, New York.

UNCTAD (1999): World Investment Report, Foreign Direct Investment and the Challenge of Development. UN, New York.

UNCTAD (2005): World Investment Report, Foreign Direct Investment and the Challenge of Development. UN, New York.

Appendix I

Table I.1: Summary of progress in legislation related to FDI

Time	Implementation of Laws and Regulations
July 1979	the Law of People's Republic of China on Joint Ventures Using Chinese and Foreign Investment
1983	Regulation for the Implementation of the Law of the People's Republic of china on Chinese –foreign Equity Joint Ventures
1986	Wholly Owned Subsidiaries Law (WOS Law)
1986	Provision for the FDI Encouragement
1986	Constitutional Status of Foreign invested Enterprises in Chinese Civil Law
1987	Adoption of Interim provision on guiding FDI
1988	Delegation on approval of selected FDI projects to more local governments
1988	Laws of cooperative joint ventures
1990	Revision of equity joint venture law
1990	Rules for implementation of WOS law
December 1990	Detailed Rules and Regulations for the Implementation of the People's Republic of China Concerning Joint Ventures with Chinese and Foreign Investment
1991	Income tax law and its rules for implementation
1992	Adoption of Trade Union Law
1993	Company Law
1993	Provision regulations of value-added tax, consumption tax, business tax and enterprise income tax
1994	Law on Certified Public Accountants
1994	Issues relating to Strengthening the Examination and Approval of Foreign-funded Enterprises.
1994	Provisions for Foreign Exchange Controls (1995)
1995	Provisional Guidelines for Foreign Investment Projects (1995)
1995	Insurance Law
1995	Law of Commercial Bank
1995	Detailed rules for implementation of Cooperative Joint Venture Law (1995)
1996	Further delegation For Approving FDI to Local Government
1997	Provisions for Foreign Exchange Controls (1997)
1998	Provisions on Guiding Foreign Investment Direction (1998)
2000	Industrial Catalogue for Foreign Investment in the Central and Western Region
2001	Administrational Rules for Foreign Financial Institutions
2001	Revision of Equity Joint Venture Law
2001	Revision of regulation for the implementation of the law of the People's Republic of China on Chinese-foreign Equity Joint Ventures
2001	Rules for Implementation of WOS Law
2002	Provisions on Guiding Foreign Investment Direction (2002)
2003	Provision Rules for Foreign-funded Enterprises in International Trade
2004	International Trade Law
2005 and 2006	No significant changes

Source: *China Investment Yearbook*: various issues.

Appendix II

Table II.1: VAR estimates, overall statistics (rounded up)

R^2	1.000	0.998	0.997	0.984	0.988	0.987	0.971
$\overline{R}^2$	0.999	0.997	0.994	0.971	0.977	0.975	0.945
S.E. eq.	0.028	0.055	0.020	0.048	0.051	1.588	0.172
F-stat.	2310.6	676.23	354.026	71.130	92.397	84.110	37.678

Table II.2: VAR diagnostic statistics: residuals[¶]

	Portmanteau(5)	*AR*: 1-2: F(2,16)	*Normality test* $\chi^2(2)$	*ARCH* F(1,16)
GDP	1.833	2.1292 [0.1514]	3.4417 [0.1789]	0.17595 [0.6805]
KAP	5.292	1.6620 [0.2209]	0.63175 [0.7291]	0.29298 [0.5958]
EM	10.622	1.5762 [0.2372]	25.746 [0.0000]**	0.0024748 [0.9609]
HK	8.707	0.90584 [0.4240]	0.15996 [0.9231]	0.046106 [0.8327]
OPEN	7.101	3.6099 [0.0508]	0.22668 [0.8928]	0.32354 [0.5774]
FDI	4.996	0.27467 [0.7633]	8.4540 [0.0146]*	0.10801 [0.7467]
LrTT	19.213	4.7416 [0.0242]*	4.2489 [0.1195]	0.44430 [0.5146]
	Vector tests			
	314.624	0.038003 [1.0000]	27.937 [0.0145]*	

[¶] Insufficient observations to test for Heteroskedasticity.

Appendix III

Figure III.1 Impulses on GDP

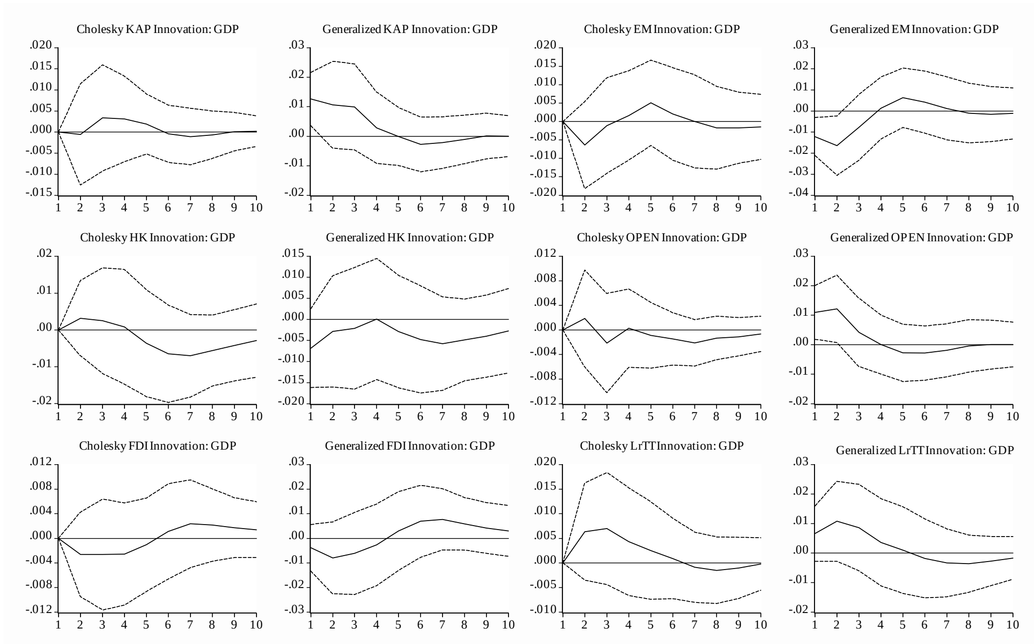


Figure III.2 Cumulative Impulses on GDP

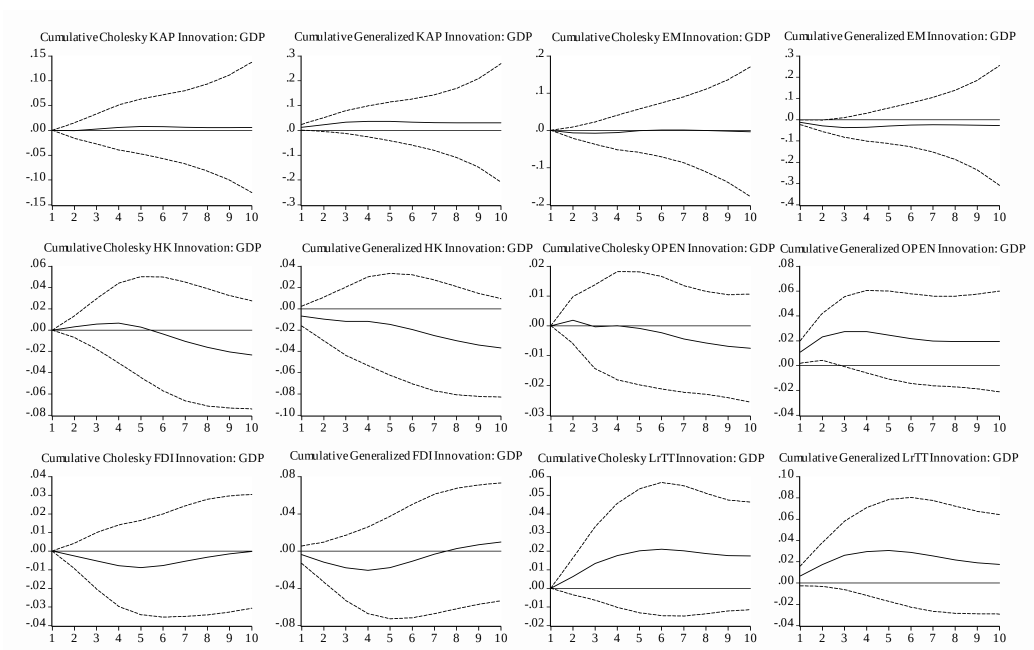


Figure III.3 Impulses on FDI

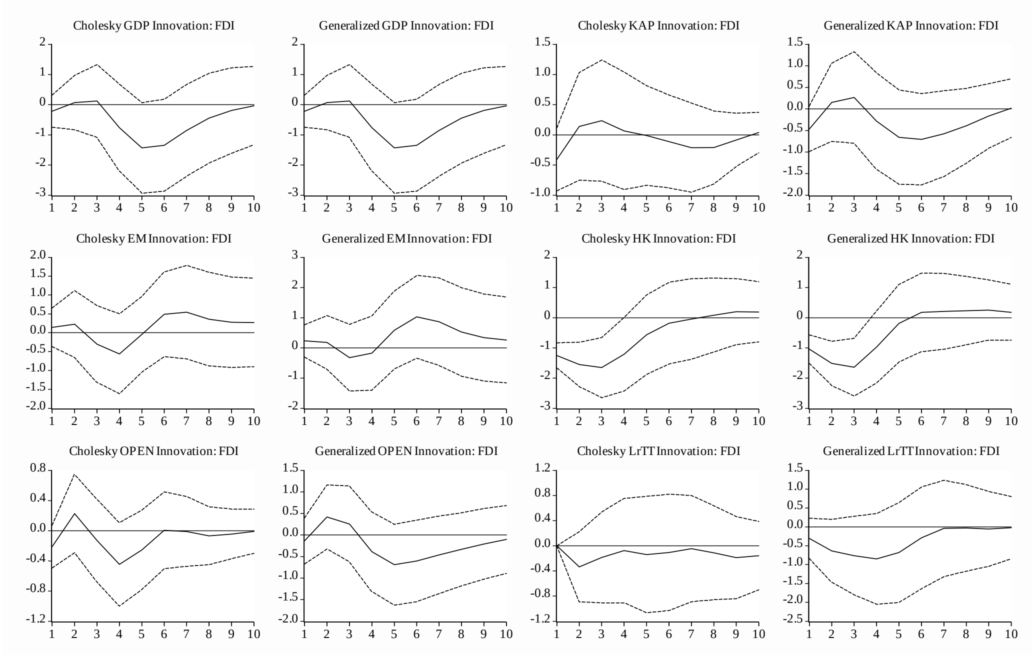
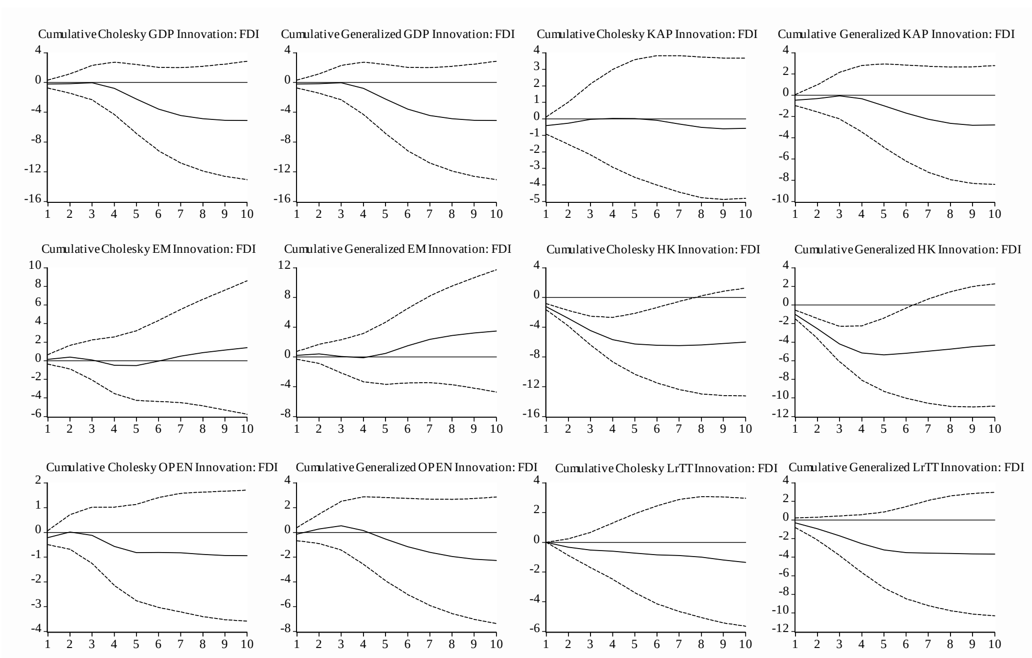


Figure III.4Cumulative impulses on FDI



Appendix IV

Table IV.1: Unrestricted cointegration rank test: Trace test, Model 4

No. of CE(s)	Eigenvalue	Trace Stat.	0.05 Critical Value	Prob.
None *	0.886509	259.6934	150.5585 [239.1686]	0.0000
At most 1 *	0.851734	183.5324	117.7082 [163.6259]	0.0000
At most 2 *	0.669006	116.7263	88.80380 [110.9092]	0.0001
At most 3 *	0.615965	78.02837	63.87610 [72.3184]	0.0021
At most 4 *	0.539418	44.53262	42.91525 [43.7792]	0.0341
At most 5	0.339743	17.39837	25.87211 [23.4182]	0.3858
At most 6	0.078700	2.868951	12.51798 [9.4202]	0.8917

Figures in [.] are Critical Values for our sample size and 1 exogenous variable via Santoso's (2002) algorithm.