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**The Impact of Foreign Direct  
Investment on Economic Growth:  
A Case Study of Ireland**

INTERNATIONAL  
ECONOMIC POLICY

**Kyuntae Kim and Hokyung Bang**

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**Wook Chae, *President***

KIEP Working Paper 08-04

# **The Impact of Foreign Direct Investment on Economic Growth: A Case Study of Ireland**

**Kyuntae Kim and Hokyung Bang**



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## Executive Summary

This study examines the long-run and the short-run relationships between foreign direct investment and economic growth in Ireland. Using an augmented aggregate production function growth model, we applied the bounds testing approach to cointegration, which is more appropriate for estimating small sample studies. The data span for the study is from 1975 to 2006.

The results indicate that foreign capital (FDI), domestic capital, and trade are statistically significant in both the long-run and the short-run, having positive effects on economic growth in Ireland. The causality analysis also suggests that there is a bi-directional Granger causality between GDP and FDI, and thus, we conclude that the FDI-led growth hypothesis is valid for the Irish economy.

Keywords: FDI, Ireland, Cointegration, Unit Roots, Bounds Test, Error Correction Models, Granger Causality

## 국문요약

금년 한국의 신정부 출범 이후 적극적인 외국인직접투자 유치가 주요 이슈로 부각되면서 외국인직접투자 유치를 통해 고성장을 이룩한 국가로 알려진 아일랜드의 성공사례가 자주 언급되고 있다. 그러나 이러한 아일랜드 사례에 대한 많은 논의에도 불구하고 이에 대한 구체적인 실증분석은 국내외 모두 미흡한 상황이다. 따라서 본 논문은 1975~2006년간 시계열 자료를 활용, 공적분 검정과 오차수정모형을 이용하여 외국인직접투자에 따른 아일랜드의 경제성장 효과에 대한 실증 분석을 시도하였다. 공적분 검정에는 시계열 소표본 분석에 적합한 것으로 알려져 최근 활발히 활용되고 있는 한계검정법(bounds test)을 도입하여 분석의 정확성을 높였다. 모형 추정 결과, 외국인직접투자는 장·단기 모두 아일랜드 경제성장에 긍정적이고 유의한 영향을 미친 것으로 분석되었다. 또한 인과관계 검정에서도 외국인직접투자와 경제성장 간 양방향의 인과관계가 존재하는 것으로 나타나 아일랜드의 적극적인 외국인직접투자 유치가 경제성장에 기여한 것으로 분석되었다.

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*From East Asian FTAs to an EAFTA: Typology of East Asian FTAs and Implications for an EAFTA* (공저, 2006) 외

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# **The Impact of Foreign Direct Investment on Economic Growth: A Case Study of Ireland**

Kyuntae Kim\* and Hokyung Bang\*\*

## **I. Introduction: Ireland's Economic Performance**

For hundreds of years, Ireland ranked with some of the poorest regions of Europe. As the Irish economy having been predominantly agricultural, Ireland virtually had a “peasant economy.” Approximately 46% of the working population in 1949 was engaged in agriculture, which led millions of people migrated from the island in pursuit of a decent living. Over the past decade, however, the Republic of Ireland has transformed itself from a struggling agricultural nation into a country with the greatest level of economic growth in the world.

As in Figure 1, Ireland showed a lower GDP per capita between late 1970s and early 1990s compared to other European countries. Starting from late 1990s, surprisingly, its GDP per capita rapidly increased to surpass those of Germany and France. Furthermore, in 1999, it even exceeded the GDP per capita of England. In sum, Ireland's GDP per

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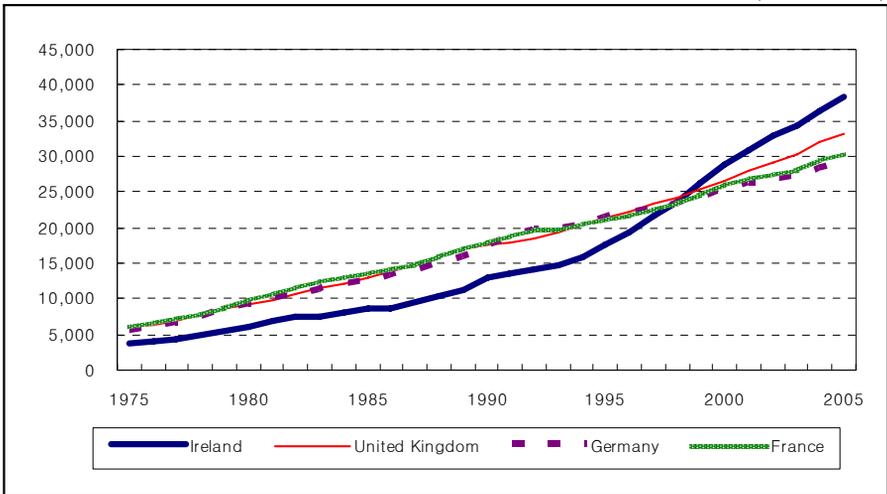
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capita in 1975 was only US\$3,699, but it quickly jumped to \$26,213 in 1999, surpassing the GDP per capita of other European countries. In 2005, Ireland’s GDP per capita was reported to be \$38,505, which is significantly higher than any of England, Germany, and France.

**Figure 1. Main European Countries’ GDP per capita in PPP**

(Unit: US \$)



Source: World Bank (2007).

Ireland’s notable economic growth can be clearly demonstrated when compared to the compound annual growth rates of the countries in the European region. The compound annual growth rates of England and France during 1991-1995 were only 1.7% and 1.2%, respectively. In the meantime, Ireland showed a growth rate of 4.6%, which is even higher than that of Germany, 4.3%. In addition, Ireland’s compound annual growth rate during the period from 1996 to 2000 was 9.8%, which is significantly higher than that of the other EU member countries.

**Table 1. Compound Annual Growth Rates  
of the Main European Countries**

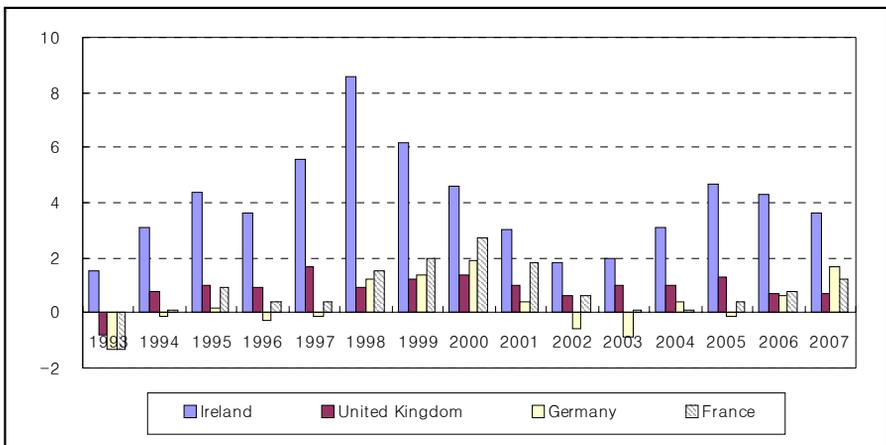
(Unit: %)

	1991-95	1996-00	2001-05
Ireland	4.6	9.8	5.4
United Kingdom	1.7	3.2	2.5
Germany	4.3	2.0	0.5
France	1.2	2.8	1.6
<b>European Union</b>	<b>1.7</b>	<b>2.9</b>	<b>1.7</b>

Source: Global Insight [online].

Ireland also recorded a notable improvement in total employment growth rate compared to other European countries. Figure 2 illustrates the rapidly increased total employment growth rate of the 1990s in Ireland in contrast to England, Germany, and France.

**Figure 2. Total Employment Growth Rates**

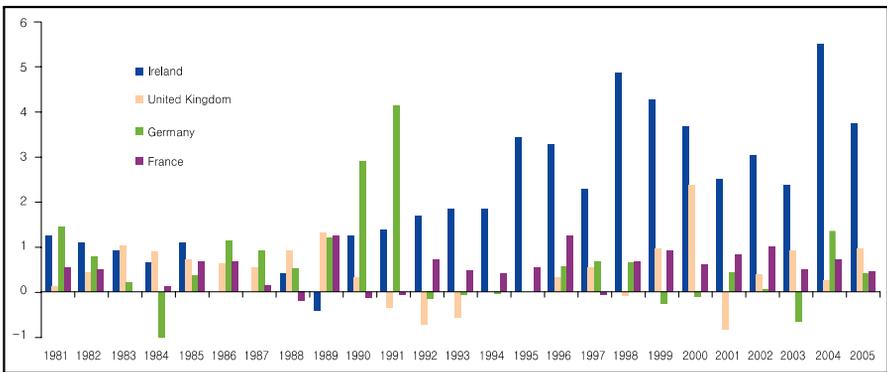


Note: Annual percentage change in total employed population.

Source: Eurostat.

Meanwhile, when Ireland showed rapid economic growth in the 1990s, Ireland’s total manpower also increased (Figure 3).<sup>1)</sup> Until the early 1990s, a great amount of the labor force was migrating overseas. Since 1995, however, Ireland’s net migration rate has shown a positive value, indicating that the inflow of labor forces immigrating to Ireland is higher than the outflow of labor force going overseas (Table 2). Therefore, the rapid economic growth in Ireland brought quick rise in employment rate, which was faster than the other EU member countries.<sup>2)</sup>

**Figure 3. Growth Rate of Total Labor Force**



Note: Annual percentage change in total labor force.

Source: Eurostat.

Many previous studies proved that Ireland’s economic growth is due to its efforts to attract inward foreign direct investment including the establishment of various kinds of FDI-friendly policies. Some of the

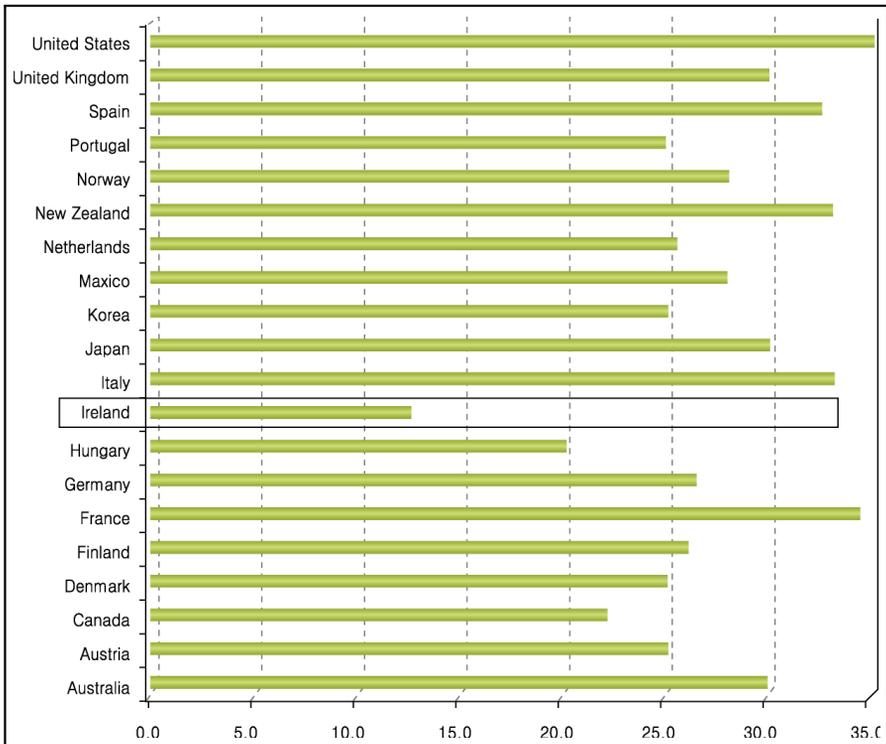
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- 1) The correlation between Ireland’s manpower and net migration rate was high, showing a positive coefficient of 0.828.
  - 2) The causal relationship between Ireland’s economic growth and manpower is closely examined in Chapter IV.

**Table 2. Trends in Net Migration Rate (per 1,000 inhabitants)**

	1960	1970	1980	1985	1990	1995	2000	2001	2002	2003	2004	2005
France	3.1	3.5	0.8	0.7	1.4	0.7	1.2	1.4	1.6	1.7	1.7	1.6
Germany	6.1	9.3	5.1	1.5	16.3	4.9	2	3.3	2.7	1.7	1.0	1.0
Ireland	-14.5	-1	-0.3	-9.3	-2.2	1.6	8.4	10	8.4	7.8	11.6	15.9
UK	2.1	-0.3	-0.6	1.6	1.2	1.0	2.5	2.5	2.5	-	-	-

Source: Eurostat.

crucial determinants of Ireland's success in attracting FDI were joining the EU and the EMU, providing low corporation tax, offering of a stable

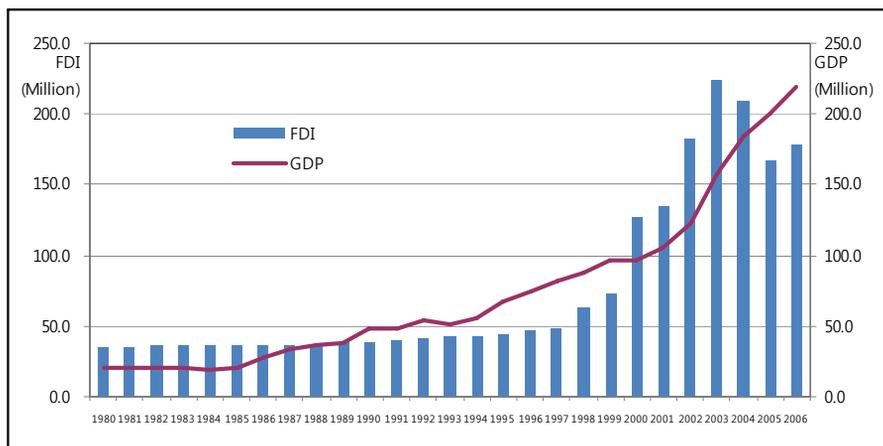
**Figure 4. Comparison of Main OECD Countries' Corporation Tax (2007)**

Source: OECD Database [online].

investment environment, and offering of the service institutions regarding FDI by the Industrial Development Agency (IDA).<sup>3</sup> In particular, Ireland's corporation tax is considerably lower than that of the other OECD countries. Specifically, IDA, the government agency responsible for supporting foreign companies' new investment and business expansion, provides a one-stop service by selecting the company, providing information on investment, selecting the location for the factory, and providing management consulting service, all in one location.

FDI in Ireland, which has played the role of a main supply power in Ireland's economic growth, expanded after the mid-1990s. Before then, the Ireland's FDI increase rate was less than 1% compared to the previous year. During the period between 1990 and 1995, however, its FDI gradually increased by 1-3% and showed a rapid increase afterward.

**Figure 5. Trend in Ireland's Foreign Direct Investment Stock and GDP**



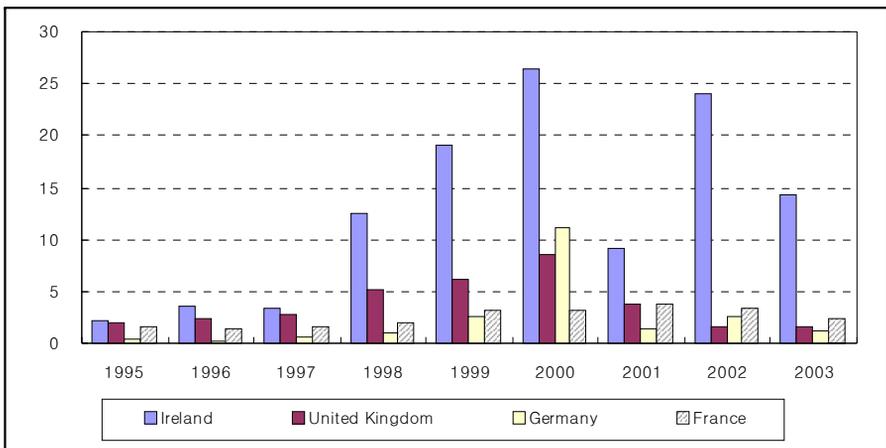
Source: OECD Database [online].

- 3) According to IMD (2003), Ireland's incentives for investment is 8.92, which is the highest among other 29 sample countries.

As a result, Ireland's FDI, which scored only \$37.99 billion in 1990, was reported as \$62.45 billion in 1998, and it rapidly increased to \$222.66 billion in 2003.

The share of FDI in GDP rapidly increased since 1998. This prominence can be confirmed when comparing the share of FDI in Ireland's GDP with that of England, Germany, and France.

**Figure 6. Foreign Direct Investment, Net Inflows (% of GDP)**



Source: World Bank (2007).

In addition, as a result of an open economy policy, the share of Ireland's imports and exports in GDP is considerably high compared with other main EU member countries (Table 3). What is noteworthy here is that the shares of foreign companies in Ireland's total imports and total exports in the year 2004 are 92.3% and 86%, respectively.

We can see that the importance of foreign companies in Ireland's economy is also reflected in other economic indicators as well. First, the share of foreign companies in Ireland accounts for 13.4% of the total

**Table 3. Exports and Imports of Goods and Services (% of GDP)**

		1975	1985	1995	2004
Exports	Ireland	39.6	56.0	76.2	83.1
	United Kingdom	25.4	28.8	28.3	25.2
	Germany	18.4	24.6	24.0	38.0
	France	18.7	23.3	22.8	25.7
Imports	Ireland	46.2	55.3	64.4	67.8
	United Kingdom	27.1	27.8	28.8	28.6
	Germany	20.2	26.9	23.5	33.1
	France	18.0	24.1	21.6	25.5

Source: World Bank (2007).

manufacturing industry, which is higher than that of England and France. Second, the number of the employees in foreign companies in Ireland takes the share of almost a half of the total employees, which is also higher than that of England, Germany, and France. Finally yet importantly in terms of the value added, the share of foreign companies in Ireland accounts for 88.4% of the total manufacturing industry. Therefore, the role of FDI in Ireland's economy is considered significant.

The main objective of this study is to examine the effect of FDI on

**Table 4. Foreign Affiliates in Manufacturing Industry  
(As a % of national total, 2004)**

	Ireland	United Kingdom	Germany	France
Number of Establishments	13.4	2.6	1.4	2.0
Number of Employees	48.0	26.6	15.4	26.2
Value added	88.4	33.4	26.7*	32.2
Total Exports	92.3	-	-	39.5
Total Imports	86.0	-	-	-

Note: \* turnover.

Source: OECD (2007).

Ireland's economic growth. As it is previously explained, Ireland's economic growth is recognized as the result of the open economy policy in general, particularly, from the active attraction of foreign direct investment (Barry 2006b). Despite such assessments, however, empirical studies on the causal relationship between FDI and economic growth are still insufficient. Hence, the current study attempts to achieve the goal of demonstrating via analysis of the relationship between FDI and economic growth that is perceived to be the driving force of Ireland's economic growth. This study is organized as follows. We start by shortly surveying the relevant literature in Chapter II and explain the analysis model between FDI and economic growth in Chapter III. In Chapter IV, we illustrate the inferred results from the analysis. Finally, Chapter V provides the main findings and implications.

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## II. Literature Review

In the neo-classical growth models, FDI only deals with factors that have an effect in the short-run, and not in the long-run. The fundamental factor, according to the growth theory from the neoclassical school, that accelerates economic growth is technological advances, but because this variable is treated as an extrinsic factor, it only has an effect in the short-term.

The endogenous growth theory, on the contrary, which treats technological advances as an endogenous factor, stimulated research on the path in which FDI accelerates a country's economic growth in the long-run. First, FDI advances new foreign technology or import of new intermediary goods in the production function and accelerates economic growth by fueling capital accumulation in capital import countries. Second, FDI enhances economic growth by contributing to the accumulation of human capital by means of labor training or absorption of technology and new management techniques.

Technological progress is enhanced or stimulated by the country inducing FDI through generating knowledge or technological spillovers that increase factor productivity. According to Hermes and Lensink (2003), Lensink and Morrissey (2001), and Gorg and Strobl (2001), the knowledge spillovers take place through four possible channels that are related to one another: imitation, competition, linkages, and/or training. Such technology or knowledge spillover arises through the channel of linkages in instances such as when domestic firms supply foreign firms with raw materials and/or intermediate goods.

Meanwhile, the ripple effect on economic growth from capital import countries by FDI is as follows: FDI is to make a contribution to economic

growth by creating employment consequent upon increased investment and improving productivity induced by technology transfer.

There are several empirical studies on FDI's spillover effect in the case of Ireland. Ruane and Ugur (2005), using data at the industry-level and covering the period 1991-1998, shows that there are no significant productivity spillovers from FDI in the Irish manufacturing sector. Moreover, it illustrates that these results are insensitive to the scale of sectoral aggregations for the foreign presence variable. Barry and Strobl (2005) provide a similar analysis based on industry-level data from the Forfás Irish Economy Expenditure Survey for the period of 1990 to 1998. They estimate equations alternatively regressing labor productivity or TFP in domestic firms on the employment share in foreign-owned firms. They also failed to detect any evidence of positive spillover effects in their estimation.

These studies analyzed the channels in which FDI affected Ireland's economic growth. However, there are no empirical studies done about the impact of FDI on Economic growth using the case of Ireland.

The results of existing studies on the effects of FDI on economic growth vary depending on the researchers' analytical approach. These results are divided into microeconomic and macroeconomic studies depending on the perspective from industry-level and from the nation as a whole. The microscopic studies from industrial perspective conclude that FDI's effect on economic growth is limited, while macroeconomic studies generally conclude that FDI contributes to economic growth under certain circumstances.

Rodrik (1999) argued that even if FDI had some kind of effect on the economic growth, the effect would be insignificant. It was also argued that it is the economic growth that causes FDI rather than FDI that

causes economic growth. Moreover, Carkovic and Levine (2002) were not able to reject the hypotheses that FDI cannot have an independent effect on economic growth with the average panel using the generalized method of moments (GMM) projected estimate.

On the other hand, Borensztein, De Gregorio, and Lee (1998), Balasubramanyan *et al.* (1996), and Alfaro, Chanda, Kalemli-Ozcan, and Sayek (2002) drew conclusions that FDI has a positive effect on economic growth. Reichert and Weinhold (2001) also drew concluding analyses that an open economy encourages FDI to promote economic growth by using mixed fixed effect and random panel estimations to consider heterogeneity of cross-sectional data.

According to De Mello's (1999) and Blonigen and Wang's (2005) research, it reported that capital import countries' absorption ability is an important factor that influences FDI's economic growth effect.

Castejon and Woerz (2006) argue that from the analysis of FDI's effect targeting OECD, Asia, and 35 Eastern European countries, the effect on economic growth from FDI varies depending on FDI's pattern by industry and the capital import country's developmental stage. In other words, FDI can be considered as a contributing factor to economic growth when the capital import country's economic condition has the ability to absorb the investment.

To summarize, there is a number of similar studies demonstrating the economic effect of FDI on certain countries' economic growth, but there are no existing studies on how FDI affects Ireland's economic growth. Rather, there are only studies analyzing the economic effect of FDI on Ireland's productivity or technology transfer.

This study empirically analyzes the effect of economic growth from FDI for the case of Ireland. With insufficient industry- and firm-level

data, however, it conducts a time-series analysis rather than a panel analysis that is frequently being used for research.<sup>4)</sup> The industry-level data from the Forfas Irish Economy Expenditures Survey used by Ruane and Barry were not applied in this analysis since data for the periods 1999-2003 were needed, but it only consisted of data for the period of 1990 to 1998. In the case of firm-level data, the number of Irish companies available in the Reuters database is only around 70. This sample even gets insignificant when considering the fact that the number of foreign manufacturing companies in Ireland is 980 as of year 2006, which only accounts for 13.4 percent in Ireland's total manufacturing industry. Accordingly, since the size of the sample is too small to use for the analysis, this study did not use the firm-level data in the Reuters database to generalize the results.

In the existing studies that analyzed the relationship between economic growth and FDI by using the time-series data, Ramirez (2006) demonstrated that Mexico's stock per capita had a significant and positive effect on labor productivity, through the cointegration test and error correction model (ECM), using the Cobb-Douglas' production function. On the contrary, Oteng-Abayie and Frimpong (2006) and Wasantha Athukorala (2003) also used the production function through the cointegration test and error correction model (ECM) and studied the effects of Ghana and Sri Lanka's FDI stock on their economic growth, but found results that were insignificant or that had negative effects. An alternative way to examine the relationship between FDI and economic growth through the cointegration and error correction model (ECM) is causality analysis, and

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4) The panel analysis is recognized to effectively control unobserved effects that are not detected in the cross section or the time-series data (Baltagi 1996).

Feridun (2006) and Tanna and Topaiboul (2005) each examined the causality relationship between Singapore's and Thailand's FDI and their economic growth.

This study examines the relationship between Ireland's FDI and its economic growth through the cointegration and error correction model (ECM) by conducting a time-series analysis. Further details on the model and methods used for the analysis are explained in Chapter III.

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## III. The Empirical Model

### 1. Theoretical Framework

The effect of FDI on economic growth is analyzed in the Cobb-Douglas type production function and standard growth accounting framework. To begin, the capital stock is assumed to consist of two components: domestic and foreign-owned capital stock. So,

$$K_t = K_{dt} + K_{ft}.$$

We adopt a production function that makes output a function of capital and labor stocks, trade, and productivity.<sup>5)</sup> We specify domestic

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5) The standard aggregate production function (APF) model has been extensively used in econometric studies to estimate the impacts of FDI inflow and trade on growth in many countries. The APF assumes that, along with ‘conventional inputs’ of capital and labor used in the neoclassical production function, ‘unconventional inputs’ like FDI and trade may be included in the model to capture their contribution to economic growth. Thus, we also included *TR* (trade) variable in the standard APF model since Ireland promoted a more active free trade policy and decreased its economic dependency on England and diversified its trade market by becoming a member of EU in 1973. Moreover, Ireland was able to openly trade in the massive European region without any risk of floating exchange rate after its joining of EMU in 1992. As a result, the share of Ireland’s exports and imports in GDP was considerably higher compared to other main EU member countries (Table 3). Ireland’s increase in imports can be explained as an increase in capital goods by expansion of inward FDI and as an

and foreign owned capital stock separately, however, in a Cobb-Douglas-type production function.

$$Y_t = A_t K_{dt}^\alpha K_{ft}^\lambda L_t^\beta TR_t^\gamma \quad (1)$$

where  $Y$  is the flow of output,  $K_d$ ,  $K_f$  represent domestic and foreign owned capital stock respectively,  $L$  is labor,  $TR$  is trade(sum of export and import).  $A$  is total factor productivity, which explains the output growth that is not accounted for by the growth in factors of production specified.

From Equation (1), an explicit estimable function is specified, after taking the natural logs of both sides, as follows:

$$\ln Y_t = c + \alpha \ln K_{dt} + \lambda \ln K_{ft} + \beta \ln L_t + \gamma \ln TR_t + \epsilon_t \quad (2)$$

where  $\alpha$ ,  $\lambda$ ,  $\beta$ , and  $\gamma$  are constant elasticity coefficient of output with respect to  $K_d$ ,  $K_f$ ,  $L$ , and  $TR$  respectively, the  $c$  is a constant parameter,

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increase in imports of intermediate-materials. In terms of exports, the multi-national enterprises in Ireland expanded its exports to EU market, thus, contributed as a major factor to Ireland's economic growth. Originally, instead of the  $TR$  variable, dummy variables related to the joining of EU (1973) and EMU (1992), the share of trade (trade amount/GDP), or amount of exports, which all represent free trade policy were to be used for the computations. However, variables excluding  $TR$  variable were either low in its significance or the models that included these variables did not pass the diagnostic test. Therefore, we added the  $TR$  variable to the existing APF model.

and  $\varepsilon$  is the white noise error term. Equation (2) represents the long-run equilibrium relationship and may form a cointegration set provided all the variables are integrated of order 1, i.e. I(1). The sign of the constant elasticity coefficients  $a$ ,  $\lambda$ ,  $\beta$ , and  $\gamma$  are all expected to be positive.

Differentiating Equation (2) with respect to time, we obtain the growth equation:

$$y_t = c_t + \alpha k_{dt} + \lambda k_{ft} + \beta l_t + \gamma tr_t + \epsilon_t \quad (3)$$

where lower case letters represent the growth rates of output, domestic capital stock, foreign capital stock, labor and trade.  $a$ ,  $\lambda$ ,  $\beta$ , and  $\gamma$  are the output elasticity coefficients of domestic capital stock, foreign capital stock, labor and trade, respectively. In a world of perfect competition and constant returns to scale, these elasticity coefficients can be interpreted as respective factor shares in total output. Equation (3) is the fundamental growth accounting equation, which decomposes the growth rate of output into growth rate of total factor productivity plus a weighted sum of the growth rates of domestic capital stock, foreign capital stock, labour and trade. Theoretically,  $a$ ,  $\beta$ , and  $\gamma$  are expected to be positive, while the sign of  $\lambda$  would depend on the relative strength of competition and linkage effects and other externalities that FDI generates in the development process.

## 2. Econometric Methodology

To empirically analyze the long-run relationships and dynamic interactions among the variables of interest, the model has been estimated by using

the bounds testing (or autoregressive distributed lag [ARDL]) cointegration procedure, developed by Pesaran, Shin, and Smith (2001). The procedure is adopted for the following three reasons.

Firstly, the bounds test procedure is simple. As opposed to other multivariate cointegration techniques such as Johansen and Juselius (1990), it allows the cointegration relationship to be estimated by OLS once the lag order of the model is identified.

Second, the bounds testing procedure does not require the pre-testing of the variables included in the model for unit roots unlike other techniques such as the Johansen approach. It is applicable irrespective of whether the regressors in the model are purely  $I(0)$ , purely  $I(1)$  or mutually cointegrated.

The other major advantage of the bounds test approach is that it can be applied to studies that have a small sample size. It is well known that the Engle and Granger (1987) and Johansen (1988, 1995) methods of cointegration are not reliable for small sample sizes, such as that of the present study.

To implement the bound test procedure, Equation (4) is modeled as a conditional ARDL-error correction model:

$$\begin{aligned} \Delta \ln Y_t = & a + \sum_{i=1}^p \theta_i \Delta \ln Y_{t-i} + \sum_{i=0}^p \alpha_i \Delta \ln K_{d,t-i} + \sum_{i=0}^p \lambda_i \Delta \ln K_{f,t-i} \\ & + \sum_{i=0}^p \beta_i \Delta \ln L_{t-i} + \sum_{i=0}^p \gamma_i \Delta \ln TR_{t-i} + \mu_1 \ln Y_{t-1} + \mu_2 \ln K_{d,t-1} \\ & + \mu_3 \ln K_{f,t-1} + \mu_4 \ln L_{t-1} + \mu_5 \ln TR_{t-1} + \varepsilon_{0,t} \end{aligned} \quad (4)$$

Here,  $\mu_i$  are the long run multipliers,  $c_0$  is the drift,  $\varepsilon_{0,t}$  are white noise errors,  $\Delta$  is first difference operator and  $p$  is the optimal

lag length.

The first step in the ARDL bounds testing approach is to estimate Equation (5) by ordinary least squares (OLS) in order to test for the existence of a long-run relationship among the variables by conducting an F-test for the joint significance of the coefficients of the lagged levels of the variables, i.e.,  $H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = 0$  against the alternative  $H_1: \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq 0$ . We denote the test which normalizes on  $Y$  by  $F_Y (Y | K_d, K_f, L, TR)$ . Two asymptotic critical values bounds provide a test for cointegration when the independent variables are  $I(d)$  with  $0 \leq d \leq 1$ . The lower bound value assumes that all the regressors are  $I(0)$ , and an upper value assumes that they are  $I(1)$ . If the F-statistic is above the upper critical value, the null hypothesis of no long-run relationship can be rejected irrespective of the orders of integration for the time series. Conversely, if the test statistic falls below the lower critical value the null hypothesis cannot be rejected. Finally, if the statistic falls between the lower and upper critical values, the result is inconclusive. The approximate critical values for the F-test were obtained from Pesaran, Shin, and Smith (2001, pp. 300-301).

If there is evidence of a long-run relationship (cointegration) between the variables, the following long-run model is estimated:

$$\begin{aligned} \ln Y_t = & b + \sum_{i=1}^p \mu_1 \ln Y_{t-i} + \sum_{i=0}^{q_1} \mu_2 \ln K_{d,t-i} + \sum_{i=0}^{q_2} \mu_3 \ln K_{f,t-i} \\ & + \sum_{i=0}^{q_3} \mu_4 \ln L_{t-i} + \sum_{i=0}^{q_4} \mu_5 \ln TR_{t-i} + \varepsilon_{1,t} \end{aligned} \quad (5)$$

The orders of lags in the ARDL model are selected by either the Akaike information criteria (AIC) or Schwarz Bayesian criterion (SBC),

before the selected model is estimated by OLS. For annual data, Pesaran and Shin (1997) recommended choosing a maximum of two lags. From this, the lag length that minimizes SBC is selected.

In addition, we obtain the short-run dynamic parameters by estimating an error correction model associated with the long-run estimates. This is specified as follows:

$$\begin{aligned} \Delta \ln Y_t = & c + \sum_{i=1}^p \theta_i \Delta \ln Y_{t-i} + \sum_{i=0}^q \alpha_i \Delta \ln K_{d,t-i} + \sum_{i=0}^q \lambda_i \Delta \ln K_{f,t-i} \\ & + \sum_{i=0}^q \beta_i \Delta \ln L_{t-i} + \sum_{i=0}^q \gamma_i \Delta \ln TR_{t-i} + \psi ECT_{t-1} + \varepsilon_{2,t} \end{aligned} \quad (6)$$

where  $ECT_{t-1}$  is the one period lagged error correction term, defined as

$$\begin{aligned} ECT_{t-1} = & \ln Y_t - b - \sum_{i=1}^p \mu_1 \ln Y_{t-i} - \sum_{i=0}^{q_1} \mu_2 \ln K_{d,t-i} \\ & - \sum_{i=0}^{q_2} \mu_3 \ln K_{f,t-i} - \sum_{i=0}^{q_3} \mu_4 \ln L_{t-i} - \sum_{i=0}^{q_4} \mu_5 \ln TR_{t-i} \end{aligned} \quad (7)$$

Here  $a$ ,  $\lambda$ ,  $\beta$ , and  $\gamma$  are the short-run dynamic coefficients of the model's convergence to long-run equilibrium, and  $\psi$  is the speed of adjustment.

### 3. Data

From equation (5)  $Y$  is defined as real GDP;  $K_d$  is the value of real domestic capital stock;  $K_f$  is the value of real foreign capital stock (i.e. FDI stock);  $L$  is measured as the volume of the total labor force;  $TR$  is the

sum of real export and import values.

The data used in this paper are annual data covering the period of 1975-2006. The data source for GDP, labor, and trade is Global Insight. The data on the foreign capital stock is taken from UNCTAD, and domestic capital stock is calculated by subtracting foreign capital stock from Ireland's total capital stock which is obtained from the Economic and Social Research Institute (ESRI).<sup>6)</sup> By the way, we were only able to obtain reports on Ireland's total capital stock up to the year 2002 from the ESRI. Therefore, we computed Ireland's total capital stock by supplementing Ireland's yearly gross fixed capital formation to the total capital stock.

In terms of the variables, we take log for GDP, labor, trade, foreign capital stock and domestic capital stock. Summary statistics of the data (in logarithm form) are presented in Table 5.

**Table 5. Summary Statistics**

Variables	Mean	Std. Dev.	Max	Min
$\ln Y$	10.954	0.433	11.864	10.280
$\ln K_d$	11.612	0.650	12.567	9.821
$\ln K_f$	11.172	0.460	11.995	10.688
$\ln L$	0.392	0.164	0.756	0.174
$\ln TR$	10.932	0.496	11.693	10.247

6) ESRI is the research centers in the social sciences, which is located in Ireland. Their Main focus is research on economic and social change in Ireland in the new global context (<http://www.esri.ie>).

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## IV. Estimation Results

### 1. Bounds Tests for Cointegration

Prior to proceeding with the bounds test, we conducted a test to find the order of integration for each variables. We use the standard tests for unit root, namely the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests proposed by Dickey and Fuller (1979) and Phillips and Perron (1988), respectively. This is to ensure that the variables are not I(2) stationary, to avoid spurious results because the bounds test is based on the assumption that the variables are I(0) or I(1).

Results of these tests are presented in Table 6. The results indicate that all our variables are either I(0) or I(1). Now that we have ascertained that the order of integration of our variables is zero or one, we can confidently apply the ARDL-bounds tests methodology to our model.

**Table 6. ADF and PP Unit Root Tests (with constant no trend)**

Variables	ADF	PP	Variables	ADF	PP
$\ln Y$	0.756	0.992	$\Delta \ln Y$	-4.112 <sup>***</sup>	-4.075 <sup>***</sup>
$\ln K_d$	-4.163 <sup>***</sup>	-2.542	$\Delta \ln K_d$	-3.071 <sup>**</sup>	-3.222 <sup>**</sup>
$\ln K_f$	-2.284	-1.764	$\Delta \ln K_f$	-3.655 <sup>**</sup>	-3.651 <sup>**</sup>
$\ln L$	3.419	3.709	$\Delta \ln L$	-4.571 <sup>***</sup>	-4.801 <sup>***</sup>
$\ln TR$	-0.960	-0.016	$\Delta \ln TR$	-3.585 <sup>**</sup>	-3.735 <sup>**</sup>

Note: The symbols <sup>\*\*\*</sup>, <sup>\*\*</sup>, and <sup>\*</sup> denote significance at 1%, 5% and 10% levels, respectively.

The next step is that in which Equation (4) is estimated to examine the long-run relationships among the variables. As suggested by Pesaran

and Shin (1997) and Narayan (2004), since the observations are annual, we choose 2 as the maximum order of the lags in the equations. In fact, we used the Schwarz-Bayesian criteria (SBC) to determine the optimal number of the lags. The F-statistics tests the joint null hypothesis that the coefficients of the lagged level variables are zero (i.e., no long-run relationship exists between them).

Table 7 reports the results of the calculated F-statistics when each variable is considered as a dependent variable (normalized) in the ARDL-OLS regressions. The calculated F-statistics  $F_Y(Y / K_d, K_f, L, TR) = 8.9043$  is higher than the upper bound critical value 5.06 at the 1% level. In the same way, F-statistics of  $F_{K_d}(K_d / Y, K_f, L, TR)$ ,  $F_{K_f}(K_f / Y, K_d, L, L)$ ,

**Table 7. Results from Bounds Tests and F-test Critical Values from Pesaran, Shin, and Smith (2001)**

Results from Bounds Tests						
Dependent Variable			F-statistic			
$F_Y (Y / K_d, K_f, L, TR)$			8.9043 <sup>***</sup>			
$F_{K_d} (K_d / Y, K_f, L, TR)$			16.0874 <sup>***</sup>			
$F_{K_f} (K_f / Y, K_d, L, TR)$			4.9811 <sup>**</sup>			
$F_L (L / Y, K_d, K_f, TR)$			3.6350 <sup>*</sup>			
$F_{TR} (TR / Y, K_d, K_f, L)$			3.6559 <sup>*</sup>			
Critical value bounds of the F-statistic: intercept and no trend						
$k$	90% level		95% level		99% level	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
4	2.45	3.52	2.86	4.01	3.74	5.06

Note:  $k$  is the number of regressors, and <sup>\*\*\*</sup> (<sup>\*\*</sup>, <sup>\*</sup>) denotes 1%(5%, 10%) significance level.

Source: The critical value bounds are from Pesaran *et al.* (2001), Table CI(iii), Case III: intercept and no trend.

$TR$ ),  $F_L(L / Y, K_d, K_f, TR)$ , and  $F_{TR}(TR / Y, K_d, K_f, L)$  are also higher than the upper-bound critical value at the 1%, 5%, and 10% level, respectively. Thus, the null hypotheses of no cointegration are rejected, implying long-run cointegration relationships among the variables when the regressions are normalized on all five variables. Based on the growth theory, however, we used  $Y_t$  as the dependent variable.

## 2. Long-Run Relationship and Short-Run Dynamics

Having found a long-run relationship, we adopted the ARDL approach to the estimation of the level relationship (i.e., Equation 5). Table 8 shows results of the long-run estimates based on the Schwartz Bayesian criteria. In the long run, domestic capital stock ( $\ln K_d$ ), foreign capital stock (i.e, FDI stock,  $\ln K_f$ ), and trade ( $\ln TR$ ) have a positive and highly significant effect on real GDP in Ireland. Above all, the estimates of the coefficient of foreign capital stock (0.3281) is positive and marginally significant at the 1% level, thus suggesting that accretions of foreign capital stock (i.e., FDI inflow) to Ireland have a stimulating effect on

**Table 8. Estimated Long Run Coefficients - ARDL(1,0,0,0)**

Dependent Variable: $\ln Y$		
Variables	Coefficient	t-Statistic
$\ln K_d$	0.2715	5.8635 <sup>***</sup>
$\ln K_f$	0.3281	5.5691 <sup>***</sup>
$\ln L$	-0.0083	-0.0380
$\ln TR$	0.6274	6.6688 <sup>***</sup>
$b$	-2.7159	-2.6205 <sup>**</sup>

Note: The symbols <sup>\*\*\*</sup>, <sup>\*\*</sup>, and <sup>\*</sup> denote significance at 1%, 5% and 10% levels, respectively.

economic growth. That is, a *ceteris paribus* 10% increase in foreign capital stock raises real GDP by an estimated 3.2% in the long-run. Labor, however, does not seem to have a significant effect on the real GDP. The estimated coefficient is negative (-0.0083) and statistically insignificant. Alarming, the (negative) constant term in the cointegrating equation suggests that GDP growth attributable to technological or residual change in Ireland was negative during the 1975-2006 period.

The results of the short-run dynamic coefficients associated with the long-run relationships obtained from ECM Equation (6) are given in Table 9. The changes in the relevant variables represent short-run elasticities, while the coefficient on the *ECT* term represents the speed of adjustment back to the long-run relationship among the variables.

The results in Table 9 suggest that the immediate impact of changes on the growth rate of foreign capital stock (the impact of changes in flow of FDI) bears positive sign (0.3054) and is significant at the 1% level. The variables, both domestic capital stock and trade, have also a positive and statistically significant effect on the Ireland's economic growth rate. On the contrary, labor appears not to have a significant impact on growth rate in the short-run. Solow residuals or constant term has a negative sign and is statistically insignificant. The equilibrium correction coefficient, estimated -0.7169, is highly significant, has the correct sign, and implies a fairly high speed of adjustment to equilibrium after a shock. Approximately 72% of disequilibria from the previous year's shock converge back to the long-run equilibrium in the current year.

Diagnostic tests for serial correlation, normality, heteroscedasticity and functional form are considered, and results are presented in Table 9. These tests show that the short-run model passes all diagnostic tests in the first stage. The results indicate that the model passes the residual

**Table 9. Estimates of the Error Correction Representation**

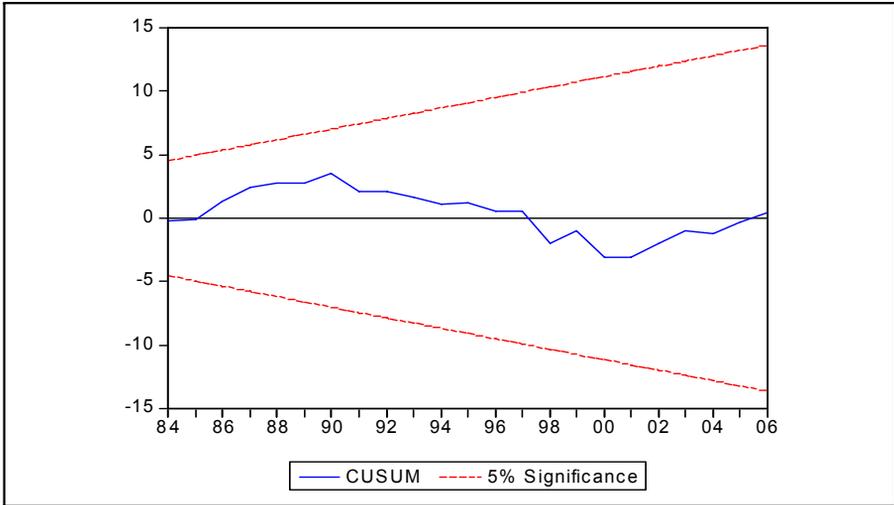
Dependent Variable: $\Delta \ln Y$				
Variable	Coefficient	Std. Error	t-Statistic	p-value
$\Delta \ln Y(-1)$	0.2290***	0.0786	2.9120	0.0078
$\Delta \ln K_d$	0.2763***	0.0435	6.3419	0.0000
$\Delta \ln K_f$	0.3054***	0.0741	4.1219	0.0004
$\Delta \ln L$	-0.4963	0.5088	-0.9754	0.3395
$\Delta \ln TR$	0.5056***	0.1105	4.5720	0.0001
$ECT(-1)$	-0.7169***	0.1953	-3.6693	0.0013
$c$	-0.0011	0.0141	-0.0812	0.9359
Diagnostics	Statistics	p-value		
$\bar{R}^2$	0.8371			
$\hat{\sigma}$	0.0434			
F-statistic	25.8463	0.0000		
$\chi^2_{Auto}(2)$	5.1441	0.0764		
$\chi^2_{RESET}(1)$	1.5239	0.2170		
$\chi^2_{Norm}(2)$	0.7109	0.7008		
$\chi^2_{White}(27)$	0.7262	0.3941		

Notes: Where  $\bar{R}^2$  is the adjusted squared multiple correlation coefficient;  $\hat{\sigma}$  is the standard error of the regression;  $\chi^2_{Auto}(2)$  is the Breusch-Godfrey LM test for autocorrelation;  $\chi^2_{RESET}(1)$  is the Ramsey test for omitted variable/functional form;  $\chi^2_{Norm}(2)$  is the Jarque-Bera normality test;  $\chi^2_{White}(1)$  is the White test for heteroscedasticity; the symbols \*\*\*, \*\*, and \* denote significance at 1%, 5% and 10% levels, respectively.

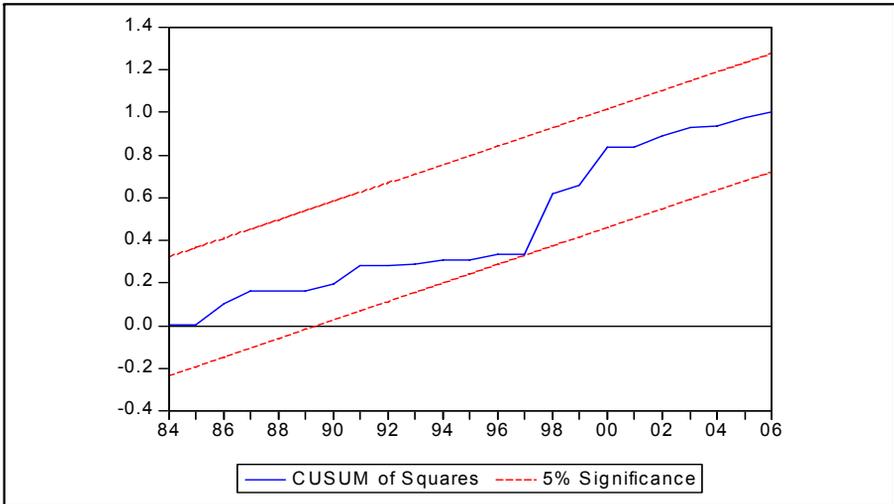
serial correlation test and the test for normality, proving that the error term is normally distributed. The functional form of the model is well specified and there is no existence of white heteroscedasticity in the model. The  $\bar{R}^2$  is 0.84, suggesting that such an error correction model fits the data reasonably well. More importantly, the error correction coefficient has the expected negative sign and is highly significant. This helps reinforce the finding of a long-run relationship among the variables in the model. Finally, the cumulative sum (CUSUM) and cumulative sum

of squares (CUSUMQ) plots from a recursive estimation of the model also indicate stability in the coefficients over the sample period (Figures 7, 8).

**Figure 7. Plot of CUSUM of Recursive Residuals**



**Figure 8. Plot of CUSUM of Squares of Recursive Residuals**



### 3. Granger Causality

In this section, we will further perform a causality analysis to supplement the long- and short-term inferred results. First, we investigate the causality relation between FDI and GDP in order to confirm that the hypothesis of FDI-led growth is supported in Ireland. All three possible cases can appear: (i) FDI-led growth is the case when the FDI improves the rate of growth of the host country; (ii) Growth-driven FDI is the case when the growth of the host country attracts FDI and; (iii) the two way are the causal link between them.

Second, we investigate the causal linkage between economic growth and labor. Since labor does not have a significant effect on Ireland's economic growth in both long-run and short-run (as can be seen in Tables 8 and 9), we should examine whether there is considerable evidence of the link between growth and labor.

To implement causality analysis among the variables, we conduct Granger causality tests. Based on the results from unit root tests (Table 6) and cointegration tests (Table 7) among the variables, error correction models (ECMs) based on Equation (6) are used for analyzing the causality relations.<sup>7)</sup>

The causality effect can be obtained by restricting the coefficient of

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7) If we do not find any evidence for cointegration among the I(1) variables, then the specification of the Granger causality test will be a vector autoregression (VAR) in the first difference form. However, if we find evidence for cointegration, then we need to augment the Granger-type causality test model with a one period lagged error correction term. So this study utilizes VECM for the causality analysis since it is verified that the 5 variables are cointegrated.

the variables with its lags equal to zero (using the Wald test). If the null hypothesis of no causality is rejected, then we conclude the relevant explanatory variable caused a dependent variable. The multivariate Granger causality tests need to be conducted by using the VECM (Vector Error Correction Model) due to the multiple variables:  $\ln Y$ ,  $\ln K_d$ ,  $\ln K_f$ ,  $\ln L$ , and  $\ln TR$ . Our sole interest is, however, in each case that the dependent variables,  $\ln Y$ ,  $\ln K_f$ , and  $\ln L$ , are regressed against past values of themselves and the other four variables, respectively.

Table 10 examines short-run and long-run Granger causality within the Error Correction Mechanism. The optimal lag lengths for the five endogenous variables are selected by the minimum Schwarz Bayesian Criterion (SBC) with maximum lag equal to 2. The F-statistics on the explanatory variables in each equation indicate the statistical significance of the short-run casual effects, while t-statistics on the coefficient of the lagged error-correction term indicate the statistical significance of the long-run casual effect. The signs of error correction term,  $ECT(-1)$ , are all negative and significant at the 1% level, which confirms the result of the bound test for cointegration.

In the short-run, the F-statistics on the explanatory variables suggest that there is bi-directional Granger causality between GDP and FDI at the 5% level, and thus, we conclude that the FDI-led growth hypothesis is valid in the Irish economy. However, at the 10% level, we found unidirectional causality from GDP to labor. This implies that an increase in labor does not lead to Ireland's economic growth, but Ireland's transformation to the nation with the greatest level of economic growth in the world drives the rise in the labor in Ireland. For example, as can be seen in Chapter I, the net immigration rate of Ireland was negative(-) by 1980s, but was changed to positive(+) in 1991, and has been increased

ever since. Furthermore, the net immigration rate of Ireland was 15.9 per 1,000 inhabitants in 2005, which is the highest level among OECD countries. Ireland's strong "Celtic Tiger" economy allowed the bright and energetic young Irish graduates to find jobs on the island. They were not forced to leave the country to find prosperity, and even for those who previously had left to find meaningful work have returned back again. Therefore, we can see that these results of causality relation between GDP and labor reflect the movement of the workforce in Ireland.

**Table 10. Results of Granger Causality**

Dependent Variable	F-Statistic [probability]						SBC Lags
	$\Delta \ln Y$	$\Delta \ln K_d$	$\Delta \ln K_f$	$\Delta \ln L$	$\Delta \ln TR$	$ECT(-1)$	
$\Delta \ln Y$	-	22.5314*** [0.0000]	4.5979** [0.0235]	0.5832 [0.5678]	13.7365*** [0.0002]	-3.7924*** [0.0012]	1
$\Delta \ln K_d$	47.3319*** [0.0000]	-	33.3820*** [0.0000]	6.5868*** [0.0067]	0.3844 [0.6860]	-6.4756*** [0.0000]	1
$\Delta \ln K_f$	5.0605** [0.0154]	5.1511** [0.0145]	-	1.3083 [0.3137]	2.7635* [0.0842]	-3.5509*** [0.0035]	2
$\Delta \ln L$	3.3277* [0.0577]	1.4731 [0.2542]	1.3235 [0.2896]	-	2.4569 [0.1125]	-4.4902*** [0.0003]	1
$\Delta \ln TR$	15.2996*** [0.0001]	2.4919 [0.1094]	1.5860 [0.2307]	0.2066 [0.8151]	-	-3.8643*** [0.0010]	1

Note: The symbols \*\*\* (\*\*, \*) denote rejection of null hypothesis at the 1% (5%, 10%, 15%) level of significance, respectively. The lag length is selected on the basis of the SBC criterion, and  $ECT(-1)$  denotes t-statistics.

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## V. Conclusions

This study examines the long-run and the short-run relationships between foreign direct investment and economic growth in Ireland. Using an augmented aggregate production function growth model, we applied the bounds testing approach to cointegration, which is more appropriate for estimating in small sample studies. The data span for the study is from 1975 to 2006.

The results indicate that foreign capital (FDI), domestic capital, and trade are statistically significant in both the long-run and the short-run, having positive effects on economic growth in Ireland. The causality analysis also suggests that there is a bi-directional Granger causality between GDP and FDI, and thus, we conclude that the FDI-led growth hypothesis is valid for the Irish economy. Yet, labor appears to have an insignificant impact on growth both in the long-run and the short-run, while there appears to be a unidirectional causality from growth to labor. This implies that an increase in labor did not lead to economic growth, but Ireland's strong "Celtic Tiger" economy drove the rise in the labor in Ireland.<sup>8)</sup>

Indeed the results imply that FDI has positive growth impact. The government's action policies are necessary to unleash economic growth by way of attracting FDI. In the case of Ireland, the actions that led to

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8) In fact, it has been recognized that a well-educated and well-trained workforce is one of the primary factors for attracting foreign investment, which led to Ireland's economic success. So, we were going to include a human capital variable in our model, but we did not because we were not able to acquire appropriate and sufficient data for the analysis period (1975-2007).

the unleashing of the “Celtic Tiger” economy include implementation of free trade policies; the impact of joining the EU; pro-growth tax policies; generating a favorable regulatory and investment climate; and creating political and economic stability in Ireland. If Korea wishes to succeed in economic growth by inducing FDI, in pursuit of the Irish model, it should take an interest in the efforts made by the Irish government, as mentioned above.

Despite Korea’s rising interest in Ireland’s FDI inducement policy, sufficient analyses are not yet performed regarding the causality relationship between Ireland’s FDI and its economic growth. Hence, this research can be distinguished from previous studies, considering the fact that this research attempts to analyze the relationship between the FDI and economic growth in Ireland.

Additionally, another valuable aspect of this research is the direct computation of the contribution degree of FDI to the total production using the production function. Accordingly, it is not an analysis of FDI’s spillover effect. Thus, it is more appropriate to thoroughly observe the trend (positive or negative) rather than putting emphasis on the absolute value of the estimates.

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# Flexible BBC Exchange Rate System and Exchange Rate Cooperation in East Asia

Yen Kyun Wang

In order to prevent competitive depreciations, excessive inflows of foreign capital and crisis contagion in the region, cooperation in exchange rate and monetary policy is very desirable, considering the fact that countries in East Asia have high trade dependence among them and similar trade patterns with each other. The BBC system proposed will be examined and the new BBC system will be suggested.

The BBC system is desirable as a new exchange rate system in Korea. Singapore has been successful with the BBC system since the early 1980s. It would be more desirable that East Asia adopt the flexible BBC (basket, band, crawl) exchange rate system jointly. Participating countries of East Asia including Japan link their exchange rates to their currency basket (ACU) with bands and the ACU is linked to the basket of the dollar and euro by a regional agency. It will stabilize real effective exchange rates of East Asian countries and reduce excessive short term capital flows into developing East Asian countries. Sound and consistent economic policies are essential for success of the BBC system. Singapore experiences with the BBC system provide good lessons. Prudential fiscal policy, flexible prices of goods and productive factors, proper interest policy and effective use of foreign reserves are needed. Joint or independent capital control could be helpful in the face of excessive capital inflows. Other measures for financial cooperation are discussed also.



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## The Impact of Foreign Direct Investment on Economic Growth: A Case Study of Ireland

Kyuntae Kim and Hokyung Bang

This study examines the long-run and the short-run relationships between foreign direct investment and economic growth in Ireland. Using an augmented aggregate production function growth model, we applied the bounds testing approach to cointegration, which is more appropriate for estimating small sample studies. The data span for the study is from 1975 to 2006.

The results indicate that foreign capital (FDI), domestic capital, and trade are statistically significant in both the long-run and the short-run, having positive effects on economic growth in Ireland. The causality analysis also suggests that there is a bi-directional Granger causality between GDP and FDI, and thus, we conclude that the FDI-led growth hypothesis is valid for the Irish economy.

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