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Financial Development and Economic Growth: A Revised Empirical Study for Ireland*

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Abstract:
This study is a revised empirical research examining the relationship between financial development and economic growth for Ireland for the period 1965-2011. The objective of this study is to examine the long-run relationship between financial development and economic growth taking into account the positive effect of industrial production index. For this purpose usual classical econometric methods are adopted. A vector error correction model is estimated based on Johansen cointegration analysis and stationarity tests. Finally, Granger causality method is applied in order to define the direction of causality between the examined variables. The empirical results indicated that there is a bilateral causal relationship between economic growth and industrial production, while there is a unidirectional causality between economic growth and credit market development. Also, stock market development causes economic growth and industrial production. Therefore, it can be inferred that stock market development has a direct causal effect on economic growth taking into account the positive effect of industrial production growth on economic growth for Ireland.

Key Words:
financial development, economic growth, Granger causality

JEL Classification : *O11, C22*

* **Note**: This study is a revised version, which corrects and completes a previous author's empirical research published in 2010, covering now a wider range data sample from 1965 to 2011 for the same examined country as Ireland. So, it is a complementary research with revised empirical results.

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1. Introduction

The issue of causal relationship between financial development and economic growth has been an intensive subject of interest for many theoretical and empirical studies (Thalassinos and Kiriazidis, 2003; Thalassinos and Pociovalisteanu, 2007). The main objective of this study is to investigate the causal relationship between economic growth and financial development taking into account the positive effect of industrial production index. Ireland consists one of the most important developed countries of European Union characterized by a high rate of economic growth, a constant monetary and fiscal economic policy and very low inflation and unemployment rates, and a healthy and competitive economy. The negative effects of financial crisis are obvious in an unstable world financial system, which is mainly characterized by an economic instability, while a possible increase of credit risk causes a highly banking uncertainty (Thalassinos *et al.,* 2010).

The remainder of the paper proceeds as follows: Initially the data and the specification of the multivariate VAR model are described. For this purpose stationarity test and Johansen cointegration analysis are examined taking into account the estimation of vector error correction model. Finally, Granger causality test is applied in order to find the direction of causality between the examined variables of the estimated model. The empirical results are presented analytically and some discussion issues resulted from this empirical study are developed shortly, while the final conclusions are summarized relatively.

2. Data and Methodology

In this study the method of vector autoregressive model (VAR) is adopted to estimate the effects of stock and credit market development on economic growth through the effect of industrial production. The use of this methodology predicts the cumulative effects taking into account the dynamic response among economic growth and the other examined variables Pereira and Hu (2000). In order to test the causal relationships, the following multivariate model is to be estimated

$$GDP_t = f(SM_t, BC_t, IND_t) \quad (1)$$

Where:
GDP_t is the gross domestic product,
SM_t is the general stock market index,
BC_t are the domestic bank credits to private sector,
IND_t is the industrial production index.

Relating to the econometric analysis this paper is based on the empirical studies of Chang (2002), Chang and Caudill (2005), Shan (2005), Vazakidis (2006), Vazakidis and Adamopoulos 2009a,b,c). Therefore, this empirical study based on the previous published version on 2010 tries to fill some possible theoretical and empirical gaps estimating a larger data sample taking into account the negative effects of financial crisis the last years.

The used data are annual covering the period 1965-2011 for Ireland, regarding 2005 as a base year. All time series data are expressed in their levels and are obtained from *International Financial Statistics,* (International Monetary Fund, 2012). The selected linear model has better statistical estimations than a logarithmic one. The tested results of the logarithmic model proved to be statistical inferior.

Unit root tests: Augmented Dickey-Fuller (ADF) test involves the estimation one of the following equations respectively, Seddighi et al (2000):

$$\Delta X_t = \delta X_{t-1} + \sum_{j=1}^{p} \delta_j \Delta X_{t-j} + \varepsilon_t \quad (2)$$

$$\Delta X_t = \alpha_0 + \delta X_{t-1} + \sum_{j=1}^{p} \delta_j \Delta X_{t-j} + \varepsilon_t \quad (3)$$

$$\Delta X_t = \alpha_0 + \alpha_1 t + \delta X_{t-1} + \sum_{j=1}^{p} \delta_j \Delta X_{t-j} + \varepsilon_t \quad (4)$$

If the calculated ADF statistic is higher than McKinnon's critical values, then the null hypothesis (H_0) is not rejected and the series is non-stationary or not integrated of order zero I(0). Alternatively, rejection of the null hypothesis implies stationarity (Dickey and Fuller, 1979, Chang, 2002). The Eviews 7.0 (2009) software package which is used to conduct the ADF tests, reports the simulated critical values based on response surfaces. The results of the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests for each variable appear in Table 1. If the time series (variables) are non-stationary in their levels, they can be integrated with integration of order 1, when their first differences are stationary.

Cointegration test: Since it has been determined that the examined variables are integrated of order one then the cointegration test is performed. The testing hypothesis is the null of non-cointegration against the alternative that is the existence of cointegration using the Johansen procedure (Johansen and Juselious, 1990)[2]. Cointegration test results are presented in Table 2.

[2] Following the empirical studies of Chang and Caudill (2005), is referred that according to Johansen and Juselius (1990) two test statistics are proposed for testing the number of cointegrated vectors (or the rank of Π): the trace (λ_{trace}) and the maximum eigenvalue (λ_{max}) statistics. The likelihood ratio statistic (LR) for the trace test (λ_{trace}) as suggested is $\lambda_{trace}(r) = -T \sum_{i=r+1}^{p} \ln(1-\dot{\lambda}_i)$ and the maximum eigenvalue (λ_{max}) is $\lambda_{max}(r, r+1) = -T \ln(1-\dot{\lambda}_{r+1})$.

Vector error correction model: Following the study of Chang and Caudill (2005), **s**ince the variables included in the VAR model found to be cointegrated, the next step is to specify and estimate a vector error correction model (VECM) including the error correction term to investigate dynamic behaviour of the model. The error-correction model with the computed t-values of the regression coefficients in parentheses is reported in Table 3. The final form of the Vector Error-Correction Model (VECM) according to the *general to specific* methodology as suggested by Hendry (Hendry and Richard, 1983; Maddala, 1992) is the following one:

$$\Delta GDP = \beta_0 + \sum_i^n \beta_1 \Delta GDP_{t-i} + \sum_i^n \beta_2 \Delta BC_{t-i} + \sum_i^n \beta_3 \Delta SM_{t-i} + \sum_i^n \beta_4 \Delta IND_{t-i} + \lambda EC_{t-i} + \varepsilon_t \qquad \textbf{(5)}$$

Where:
Δ is the first difference operator,
EC_t is the error correction term,
λ is the short-run coefficient of the error correction term (-1<λ<0),
ε_t is the white noise term.

Granger causality tests: Granger causality is used for testing the long-run relationship betw$_t$een financial development and economic growth. The Granger procedure is selected because it consists the more powerful and simpler way of testing causal relationship (Granger, 1986). The following bivariate model is estimated:

$$Y_t = a_{10} + \sum_{j=1}^k a_{1j} Y_{t-j} + \sum_{j=1}^k \beta_{1j} X_{t-j} + u_t \qquad (6)$$

$$X_t = a_{20} + \sum_{j=1}^k a_{2j} X_{t-j} + \sum_{j=1}^k \beta_{2j} Y_{t-j} + u_t \qquad (7)$$

Where (Katos, 2004, Seddighi *et al*, 2000,):
Y_t is the dependent
X_t is the explanatory variable
u_t is the white noise error term in Eq (6),
X_t is the dependent
Y_t is the explanatory variable in Eq (7).

In order to test the above hypotheses the usual Wald F-statistic test is utilised, which has the following form:

$$F = \frac{(RSS_R - RSS_U)/q}{RSS_U/(T-2q-1)}$$

where:
RSS_U= the sum of squared residuals from the complete unrestricted equation,
RSS_R= the sum of squared residuals from the restricted equation,
T = the sample size and q = is the lag length.

The validity of the test depends on the order of the VAR model and on the stationarity or not of the variables. The results of Granger causality tests appear in table 4.

3. Empirical Results

Therefore, all series that are used for the estimation of ADF equations are non-stationary in their levels, but stationary in their first differences Moreover, the Breusch-Godfrey Lang range Multiplier (LM) test shows that there is no problem autocorrelation in the disturbance terms for all variables in their first differences (Table 1). These variables can be cointegrated as well, if there are one or more linear combinations among the variables that are stationary.

According to the empirical results the best cointegration vector selected for Ireland (Table 2) and is the following one:

$$GDP_t = 0.13\ SM_t + 0.16\ BC_t + 0.69\ IND_t \quad (12)$$

The cointegrated vector of the model of Ireland has rank r equal to 2 (r=2). The process of estimating the rank r is related with the assessment of eigenvalues, which are the following for Ireland: $\dot{\lambda}_1 = 0.85$, $\dot{\lambda}_2 = 0.44$, $\dot{\lambda}_3 = 0.22$, $\dot{\lambda}_4 = 0{,}03$.

For Ireland, critical values for the trace statistic defined by equation (6) are 47.21 and 54.46 for Ho: r = 0 and 29.68 and 35.65 for Ho: $r \leq 1$, 15.41 and 20.04 for Ho: $r \leq 2$ at the significance level 5% and 1% respectively as reported by Osterwald-Lenum (1992), while critical values for the maximum eigenvalue test statistic defined by equation (7) are 27.07 and 32.24 for Ho: r = 0, 20.97 and 25.52 for Ho: $r \leq 1$, 14.07 and 18.63 for Ho: $r \leq 2$ (Table 2).

It is obvious from the estimated cointegrated vector that stock market development, credit market development and industrial production index have a positive effect on economic growth in the long-run. The results of the estimated vector error correction model suggested that a short-run increase of stock market index per 1% induces an increase of economic growth per 0.13 and also an increase of bank lending per 1% induces an increase of economic growth per 0.16, while an increase of productivity per 1% induces an increase of economic growth per 0.7 for Ireland.

The estimated coefficient of EC_{t-1} is statistically significant and its value has a negative sign, meaning that there is long-run equilibrium relationship between the examined variables (Table 3). The Granger causality tests suggested that there is a bilateral causality between economic growth and productivity, a unidirectional causal relationship between economic growth and credit market development, a unidirectional causal relationship between stock market development and economic growth, and finally a unidirectional causal relationship between stock market development and productivity (Table 4).

4. Conclusion

This paper employs with the relationship between financial development and economic growth for Ireland, using annually data for the period 1965-2011. The empirical results of this study indicated that stock market development causes economic growth directly through positive effect of industrial production on economic growth and also stock market development causes bank development indirectly through positive effect of economic growth. These empirical results fill the empirical gaps of the previous author's research in which industrial production found to have neither direct nor indirect causal relation with gross domestic product. The results of many empirical studies examining the relationship between financial development and economic growth differ relatively to the sample period, the examined countries, the measures of financial development and the estimation method and an unpredictable economic event. The direction of causal relationship between financial development and economic growth is regarded as an important issue under consideration in future empirical studies. However, more interest should be focused on the comparative analysis of empirical results for the rest of European Union members-states.

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Table 1 – DF/ADF unit root tests

Variables	*In levels*					*In first differences*				
	lag (eq_f)	*adf_test stat [prob]*	*cr_val 1% 5% 10%*	*SBC AIC*	*LM [prob]*	*lag (eq_f)*	*adf_test stat [prob]*	*cr_val 1% 5% 10%*	*SBC AIC*	*LM [prob]*
GDP	*(p=0) (4)*	*-1.57 [0.78]*	*-4.17 -3.51 -3.18*	*-3.66 -3.77*	*38.78 [0.00]*	*(p=1) (3)*	*-3.84 [0.00]*	*-3.58 -2.92 -2.60*	*-4.56 -4.68*	*3.03 [0.06]*
BC	*(p=1) (4)*	*1.84 [0.98]*	*-2.61 -1.94 -1.61*	*-3.08 -3.16*	*0.31 [0.73]*	*(p=0) (2)*	*-3.52 [0.00]*	*-2.61 -1.94 -1.61*	*-3.09 -3.13*	*0.85 [0.43]*
SM	*(p=0) (2)*	*-0.62 [0.43]*	*-2.61 -1.94 -1.61*	*-1.30 -1.33*	*8.15 [0.00]*	*(p=1) (4)*	*-5.38 [0.00]*	*-4.18 -3.51 -3.18*	*-1.31 -1.47*	*0.14 [0.70] ***
IND	*(p=1) (2)*	*1.55 [0.96]*	*-2.61 -1.94 -1.61*	*-4.29 -4.29*	*5.83 [0.06]*	*(p=0) (3)*	*-3.41 [0.01]*	*-3.58* -2.92 -2.60*	*-4.33 -4.41*	*3.26 [0.07] ***

Notes
Eq_f = equation form
Cr_val = critical values
AIC = Akaike criterion, SBC = Schwarz Bayesian criterion,
LM = (Breusch-Godfrey) Langrage Multiplier test for serial correlation
* not statistically significant, ** LM(1) selected

Table 2 –Johansen and Juselious Cointegration Tests

Sample (adjusted): 1966 2011
Included observations: 46 after adjustments
Trend assumption: Linear deterministic trend
Series: GDP SM BC IND
Lags interval (in first differences): No lags

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.851357	127.9119	47.21	54.46
At most 1 **	0.440628	40.22617	29.68	35.65
At most 2	0.225049	13.50290	15.41	20.04
At most 3	0.037850	1.774929	3.76	6.65

Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels
*(**) denotes rejection of the hypothesis at the 5%(1%) level

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.851357	87.68570	27.07	32.24
At most 1 **	0.440628	26.72327	20.97	25.52
At most 2	0.225049	11.72797	14.07	18.63
At most 3	0.037850	1.774929	3.76	6.65

Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels
*(**) denotes rejection of the hypothesis at the 5%(1%) level

Table 3 –Vector Error Correction Model

Dependent Variable: DGDP
Method: Least Squares
Sample (adjusted): 1969 2011
Included observations: 43 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.007476	0.006989	-1.069680	0.2917
DSM(-1)	0.175729	0.042072	4.176902	0.0002
DBC(-1)	0.029536	0.065198	0.453022	0.6532*
DIND(-3)	0.672237	0.160383	4.191440	0.0002
DGDP(-1)	0.081160	0.159593	0.508543	0.6141*
ECM(-1)	-0.190332	0.090366	-2.106235	0.0420

Table 4 – Granger causality tests

Null hypothesis	F-stat	[Prob]	Causal Relation
DSM does not Granger Cause DGDP	8.2139	[0.0011]	DSM→ DGDP
DGDP does not Granger Cause DSM	1.0430	[0.3620]	
DBC does not Granger Cause DGDP	0.0652	[0.9369]	DGDP→ DBC
DGDP does not Granger Cause DBC	5.2801	[0.0093]	
DIND does not Granger Cause DGDP	8.8943	[0.0007]	DGDP↔ DIND
DGDP does not Granger Cause DIND	3.8110	[0.0308]	
DBC does not Granger Cause DSM	0.7313	[0.4878]	No causality
DSM does not Granger Cause DBC	0.1992	[0.8202]	
DIND does not Granger Cause DSM	1.2743	[0.2910]	DSM→ DIND
DSM does not Granger Cause DIND	9.8168	[0.0004]	
DIND does not Granger Cause DBC	2.9803	[0.0624]	No causality
DBC does not Granger Cause DIND	0.0560	[0.9456]	