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Title	International influences on Irish stock returns
Authors(s)	Bredin, Donal, Hyde, Stuart
Publication date	2004-03
Publication information	Bredin, Donal, and Stuart Hyde. "International Influences on Irish Stock Returns" (March, 2004).
Series	Centre for Financial Markets working paper series, WP-04-16
Publisher	University College Dublin. School of Business. Centre for Financial Markets
Item record/more information	http://hdl.handle.net/10197/1164

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International Influences on Irish Stock Returns

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March 2004

Abstract

We examine the influence of US and UK macroeconomic and financial variables on Irish stock returns in a nonlinear framework. We allow for time variation via regime switching using a smooth transition regression (STR) model. Importantly we find that both US and UK stock returns are significant determinants of Irish returns. Further, US returns are an important transition variable. Additionally, we show that both the US industrial production growth and changes in short term interest rates play an important role in explaining Irish stock returns. A two transition variable model finds that US short term interest rate changes exert a secondary nonlinear influence on Irish returns. The significance of US variables is reflective of the influence of US investment in the Irish economy.

Keywords: Smooth transition, Regime switching

JEL Classification: G14, G15

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1 Introduction

Understanding the relationship between international stock markets and the relationship between stock markets and the macroeconomy is of importance and of relevance to market participants irrespective of their role. Consequently a large amount of research has been employed trying to analyse these relationships from different perspectives.

In this paper, we are interested in investigating these relationships in the context of the Irish stock market. The Irish market is of interest because of its small size. It is highly integrated with the important international stock markets and its membership of the EMU means that the cyclical movements are linked to Euro area developments. Further, there is a long tradition of links with the UK economy and the UK stock market. Indeed many Irish firms are listed on the London stock exchange in addition to the Irish market.

Recent research has investigated the influence of both domestic and foreign economic news on domestic stock market activity, e.g. Connolly and Wang (2003) and Flannery and Protopapakis (2002). Given, Ireland is a small open economy, factors outside the country are likely to play a large role in determining economic conditions within the economy. Research, for example, by Gallagher (1995) and Gallagher and Twomey (1998) have investigated linkages between Irish and international stock markets. With greater global and European financial integration, it is likely that global monetary conditions will play an ever increasing role on the Irish stock market. Hence, our interest in examining the effect of international as well as domestic macroeconomic and financial variables on the domestic stock market. Given the country's competing interests, it is likely that there could be a number of influences on the Irish market.

Therefore we seek to investigate the influence of both the UK and the US on movement in the market. Importantly previous studies do not account for the time variation in the relationship between these variables. We allow for such variation by considering regime switching in the form of smooth transition models. We adopt a conventional set of macroeconomic variables along the lines of Aslanidis et al. (2003) to investigate international influences from the UK and the US on Irish stock returns. We find that US stock returns, US Industrial production growth, and changes in US short term interest rates are important factors in determining Irish stock returns. UK stock returns are also significant. Further, US stock returns provide a nonlinear influence which captures the time varying nature of Irish stock returns. A two transition variable model finds that US short term interest rate changes exert a secondary nonlinear influence over Irish returns. Again, US stock returns and industrial production growth are significant explanatory variables. The importance of US macroeconomic and financial factors

over domestic variables is representative of the strength and dominance of US multinationals in the Irish economy.

The remainder of the paper is set out as follows. Section 2 discusses previous research which has investigated the relationship between Ireland and other stock markets and documents the importance of possible nonlinearities. Section 3 provides the details of the empirical methodology adopted in the study while section 4 provides a discussion of the data and presents the empirical results. Section 5 concludes.

2 Literature Review

Given the small open nature of the Irish stock market, Gallagher (1995) studies the interdependencies between the Irish and the UK and German stock markets.¹ The author uses data from January 1983 to February 1993 at both weekly and daily frequencies. He finds no long-run relationship between the Irish stock market and either the UK or the German market. However, greater stock market integration is found for the post 1987 period and there is evidence of unidirectional Granger-causality running from Germany and the UK to Ireland. Indeed, the finding of Granger-causality is relatively stronger in the case of the UK. This is in line with expectations given that the post 1987 period (up to 1992) represented a more stable period in financial markets and there was greater co-ordination of European economic policy.

Kearney (1998) models stock returns (and volatility) for the Irish market for the period July 1975 to May 1994 using end month returns focusing on domestic as well as international determinants. Important indicators are industrial production, price level, and the spot exchange rate. Given the importance of international influences, the ratio of domestic to foreign industrial production, prices and interest rates are also included. Kearney (1998) focuses primarily on the UK as the source of international influence and finds a cointegrating relationship between the Irish and UK market and a number of business cycle variables.² Further, contemporaneous FTSE volatility was found to be highly significant in determining ISEQ volatility, along with exchange rate volatility, inflation volatility and volatility of industrial production.

¹The Irish market is small by international standards, approximately 5% of the Financial Times All Share index (FTSE). It is also highly influenced by both the London and the Frankfurt market, see Gallagher (1995).

²The following variables were included, Irish stock price, UK stock price, industrial production, prices, exchange rate, interest rate, ratio of domestic to foreign industrial production, and the ratio of domestic to foreign interest rates.

Although the focus of this study is not volatility these findings indicate spillovers and relationships between the markets. Indeed, Kearney (1998) comments that the Irish market is highly integrated with the London stock market. However, Irish membership of the EMS and now EMU means that its financial and the business cycle are determined by Euro area events. This is supported by the results in Gallagher (1995). Neither study looks at the influence of the US market. Over the recent past, Irish economic growth has been more akin to that of the US than any of its European neighbours, with growth prospects in the US acting as a good barometer for economic activity in Ireland. This has been due in part to the large influx of US multinationals and the concomitant decline in traditional firms who mainly exported to European neighbours. Gottheil (2003) shows this increase in the influence of the US. In 1973, only 7.3% of the Irish workforce were employed in US owned firms however this had increased to 23.2% by 1994. Further, Ireland has been seen as the choice location for foreign direct investment by US multinationals. There has been an influx of firms from the computer, pharmaceutical and chemical industries and by 1999 foreign direct investment accounted for 88% of the capital formation in Ireland. In addition, there has been an increased expansion of the major players in the Irish stock market in the US market.^{3 4}

It is well established that returns across international stock markets are time varying. In order to take account of the time variation, GARCH type models became very popular, see Kearney (1998) for evidence on the Irish market. However, recent empirical evidence has shown that correlations are higher during bear markets than bull markets, see Longin and Solnik (2001). Ang and Bekaert (2002) show that the asymmetric GARCH is unable to take account of this type of correlation pattern. Hence it is the regime or the nonlinearity that is important rather than the changing volatility. However, recent evidence has shown that regime switching models that account for different phases in the business cycle are quite successful in this regard, see Ang and Bekaert (2002), Perez-Quiros and Timmermann (2000), Guidolin and Timmermann (2003). A special class of regime switching models, where the state variable is observed, and also allows intermediate positions between the regimes is the smooth transition models, see van Dijk et al. (2002). This is seen as an appropriate regime switching approach if we want to examine the nature of the underlying regime and have proven to work well with specifications of two or more explanatory variables. A number of studies have applied these type of approaches to modelling stock returns, see Aslanidis et al. (2003), McMillan (2001) and Sarantis (2001). Aslanidis et al. (2003)

³CRH, Kerry Group, IAWS, Elan and the two major banks expanded in the US during this period.

⁴Further, Bredin et al. (2003) report evidence that monetary policy conditions in the UK, Germany and Euroland appear to have had little influence on Irish stock market returns. US monetary policy on the other hand has a strongly influential relationship.

show that UK stock returns behave in a non-linear fashion and this non-linearity is being driven firstly by the dividend yield and secondly by US stock returns.

In this paper we look at the determinants of Irish stock returns, given the time varying international stock market correlations and domestic conditions. Based on recent empirical evidence which shows that correlations vary with market conditions, Longin and Solnik (2001), we adopt the approach of Aslanidis et al. (2003) and use smooth transition models to ascertain the influence of international markets on the Irish economy. In particular, we aim to capture how the very important influence of both UK and US returns and any non-linearities driving these markets will affect the Irish market.

3 Methodology

Given the recent finding that correlations among stock markets are influenced by the position on business cycle, we will adopt a regime switching model. Specifically a smooth transition regression (STR) model is adopted, given that we assume the transition from one regime to another is smooth, see Aslanidis et al. (2003).

$$y_t = \alpha_0' w_t + F(s_t) \alpha_1' w_t + u_t \quad (1)$$

$$F(s_t) = \{1 + \exp[-\gamma(s_t - c)]\}^{-1} \quad \text{where } \gamma > 0 \quad (2)$$

where α_0 and α_1 are the coefficient vectors, w_t is a $(k + 1) \times 1$ vector of explanatory variables, u_t is the error term, which is $iid(0, \sigma^2)$ and finally $F(s_t)$ is the transition function defining the regime. The role of the explanatory variables in w_t can differ between the two regimes through the coefficients α_1 . Equation (2) shows the transition function, which is defined as a logistic function. A number of studies that have applied these type of approaches to modelling stock returns, see Aslanidis et al. (2003), McMillan (2001) and Sarantis (2001) have advocated the use of the logistic as opposed to the exponential function. The *S*-shaped logistic function is more intuitive to bull and bear stock market regimes or recessions versus expansions, as opposed to the *U*-shaped exponential function. The transition function determines the regime and is itself governed by the transition variable, s_t , and by the speed of transition, γ . As $\gamma \rightarrow \infty$ the transition becomes more and more abrupt, $F(s_t)$ becomes a step function and the model approaches the standard threshold regression model. The transition function is bounded by zero and unity, which is determined by s_t . Under this set-up the different

transition variables can be tested to ascertain which is driving the nonlinearity in Irish stock returns. The parameter c is the threshold variable and the transition function is dependent on the position of the transition variable relative to the threshold variable, with $F(s_t) = 0.5$ when $s_t = c$.

The two regime model assumes that all the nonlinearity in stock returns is captured through a single transition variable. However, this specification may not be sufficiently complex to model the nonlinearity. Thus, we could consider the existence of two transition functions, giving:

$$y_t = \alpha'_0 w_t + F_1(s_{1t})\alpha'_1 w_t + F_2(s_{2t})\alpha'_2 w_t + u_t \quad (3)$$

where each transition function $F_i(s_{it})$, $i = 1, 2$, is a logistic function as defined in equation (2). We could also consider the existence of only one transition variable, i.e. s_{1t} and s_{2t} are the same variable, but with two distinct thresholds, i.e. different values for c_1 and c_2 .

The modelling procedure adopted is detailed in Sensier et al. (2002) and Aslanidis et al. (2003). We employ a grid search in order to identify the appropriate transition variable, i.e. the variable which minimises the residual sum of squares, and use ordinary least squares to generate initial values of the model conditional on the choice of transition variable. We allow the transition variable s_t to be any candidate variable from the set of explanatory variables w_t (excluding the constant). A more parsimonious model is obtained via a general to specific modelling procedure and this model is then estimated by non-linear least squares. A further reduction in the model may occur at this stage to remove any highly insignificant variables. Additionally, we consider the possibility of more than two regimes. We consider the existence of two transition variables to examine whether there is an additionally secondary influence causing any nonlinearity in the model.

We apply a battery of diagnostic tests to check the validity of the estimated models. Specifically we employ the tests of Eitrheim and Teräsvirta (1996) to check the validity of the STR models with respect to autocorrelation, additional nonlinearity and parameter constancy. Further, the residuals are also checked using the standard test for ARCH effects and the Lomnicki-Jarque-Bera test for normality.

4 Data and Empirical Results

The data employed in the study is monthly observations from 1980:1 to 2001:12. Specifically we model the influence of UK and US stock returns

on Irish stock returns accounting for a number of macroeconomic factors. The stock returns are calculated from end of month prices on the ISEQ Index, FT All Share Index, and the S&P 500 Index for Ireland, the UK and the US respectively. The macroeconomic and financial variables included in the model are, for Ireland, industrial production growth, changes in the long term interest rate, changes in the short term interest rate, and inflation measured by the wholesale price index, and for both the UK and the US, industrial production growth and changes in the short term interest rate. Additionally, we include changes in the US\$/Punt exchange rate and changes in oil prices. We also include a January dummy and for the EMS crisis.⁵ It is anticipated that these variables will capture both the domestic economic and financial conditions in Ireland and the major international influences on the Irish economy and the stock market. The lag structures for the candidate variables are important in relation to the information set available at any point in time. Financial variables are allowed to enter the model contemporaneously since data and information on such variables are available continuously. Price level (inflation) information releases are made in the subsequent month so the variable enters with a one month lag, however industrial production releases are not and so it enters the model with a two month lag.

Table 1 presents the results of the linear model using all the explanatory variables. It can clearly be seen that contemporaneous stock returns in both the UK and the US have a significant impact on Irish stock returns while lagged Irish returns are only significant at a 10% level. Positive returns in the UK and the US increase the Irish market, while there is also some persistence in Irish returns suggesting a degree of weak form inefficiency. There is little evidence that domestic variables play a substantial role in the determination of stock returns. Only the coefficient on changes in the long term interest rate is significant. The variable enters the model with the expected negative sign implying that increases in long term interest rates are detrimental to the performance of the stock market. However, US industrial production growth provides significant explanation of Irish stock returns, increases in US industrial production have a positive effect on the Irish stock market. This is as expected given the dominance of US multinationals in the Irish economy, such that a strong US economy will provide a solid platform for future overseas expansion. Finally, changes in oil prices are negatively significant at the 10% level. While the linear model explains 38% of the variation in Irish stock returns, the performance of the model with respect to the diagnostic tests is weak. Although there is no problem of serial correlation, there is clear evidence of both the presence of ARCH and non normality.

⁵The dummy for the EMS crisis proved to be insignificant in the linear model and was subsequently dropped.

To analyse the model for nonlinearity, the linear model is adopted as the null hypothesis for testing linearity against the smooth transition type nonlinearity. The test results are reported in Table 2. There is evidence of nonlinearity in relation to changes in long term interest rates, ΔLR_t^{IRL} , US stock returns, R_t^{US} and the change in oil prices, Δoil_t . The grid search procedure identified US stock returns as the primary transition variable.

Figure 1 shows the estimated transition function, $F(R_t^{US})$ over time and in relation to R_t^{US} . The function clearly implies one regime for large falls in US stock prices and another, the “normal” regime, applying for small negative and all positive stock returns. Switches between these regimes are not frequent but do occur at regular intervals throughout the sample. The transition between the two regimes is relatively smooth supporting the adoption of a STR model over the traditional threshold model implied by abrupt changes. The normal regime applies with $F(R_t^{US}) = 1$ and implies the following model:

$$\widehat{R_t^{IRL}} = -0.56 + 0.12R_{t-1}^{IRL} + 0.52R_t^{UK} + 0.34R_t^{US} - 0.07\Delta oil_t - 3.02\Delta ER_t + 1.04\Delta IP_{t-2}^{US} + 0.64\Delta SR_t^{US} \quad (4)$$

With the exception of changes in the US short term interest rate, ΔSR_t^{US} , the coefficients on the variables all have the expected signs. The importance of the US and UK stock returns remains and the overall coefficients are of similar magnitude of those reported for the linear model. Table 3 reports the estimated single transition model. The broad findings are not dissimilar to those reported for the linear model. Again the importance of the US economic indicators is striking.

The diagnostics suggest that the single transition model is an appropriate specification, there is no serial correlation and it removes the presence of ARCH, and that it captures the nonlinearity present within the data. Clearly the non-linear approach offers a major advancement on our linear model. We now test the possibility of a second transition variable. Again we adopt the grid search approach and find that the US short-rate is identified as a second transition variable. This is not surprising given the findings by Bredin et al. (2003), that unexpected changes in US short term interest rates have a significant influence on Irish stock returns.

Figure 2 shows the estimated transition function, $F(R_t^{US})$ over time and in relation to R_t^{US} for the two transition model. There is only a slight change in the transition function from when estimated in the single transition function. The function has moved slightly to the left and the slope is a little shallower. The second transition function, $F(SR_t^{US})$ over time and in relation to SR_t^{US} is shown in Figure 3. It can be seen that the regime for

downward revisions in US short term interest rates occurs predominantly in the early part of the sample, 1980-83. For the majority of the sample period, the transition function equals or is very close to unity. The transition function for SR_t^{US} is estimated to have a slightly steeper slope than the functions for US stock returns.

Table 4 presents the results of two transitions model where the contemporaneous US stock return is used as the first transition variable and the US short term interest rate is used as the second transition variable. The normal regime applies with $F(R_t^{US}) = 1$ and $F(SR_t^{US}) = 1$ implying the following model:

$$\widehat{R_t^{IRL}} = -0.39 + 0.13R_{t-1}^{IRL} + 0.57R_t^{UK} + 0.30R_t^{US} - 0.07\Delta oil_t - 2.87\Delta LR_t^{IRL} + 0.69\Delta IP_{t-2}^{US} \quad (5)$$

The results show that the impact of the UK and US stock returns and previous Irish returns is not significantly different, and that the influence of oil price changes is unchanged. US industrial production growth still has a significant influence on Irish stock returns. Exchange rate changes are no longer significant while changes in Irish long term interest rates re-enter the model and changes in US short term rates only influence the model as the second transition variable and do not enter directly. There is no improvement in the overall capability of the model to describe Irish stock returns. The two transition model describes 56% of the variability in Irish stock returns, the same as the single transition model. Further, there is no improvement in the performance of the model with respect to the diagnostic tests.

The importance of US macroeconomic and financial variables in describing Irish stock returns is robust. This finding is reflective of the influence of US multinationals and US foreign direct investment in the Irish economy.

5 Conclusion

In this paper we investigate the influence of US, UK and Irish macroeconomic and financial variables on Irish stock returns. Previous research has provided evidence of a role for both the US and the UK in determining movements in the Irish stock market. The novel aspect of this study is that we allow for time variation through regime switching. The approach used is the smooth transition regression (STR) model. We find that UK and US stock returns are important influences on Irish stock returns. However, importantly, we find evidence of much stronger influences from the US

economy. Additionally, both US industrial production growth and changes in short term interest rates have significant impacts on Irish stock returns.

We find that Irish stock returns respond in a nonlinear fashion to both domestic and international macroeconomic and financial information. In particular, we find that US stock returns capture the nonlinearity, with falls of greater than around 5% leading to a different regime to that of smaller negative or positive returns. There is a marked difference in the response of Irish returns to the macroeconomic and financial variables between the regimes, especially for US variables. Further, we find evidence that changes in US short term interest rates provide a secondary nonlinear influence. US stock returns and US industrial production growth remain strongly influential.

In both STR models we find that having accounted for the nonlinearity, the ARCH effects present in the linear model are removed. This suggests, in support of Longin and Solnik (2001) that it is the nonlinearities or regimes which are important rather than volatility.

The importance of US macroeconomic and financial factors on Irish stock returns is reflective of the dominance and influence of US multinationals in the Irish economy and the increase in US foreign direct investment in Ireland over the sample period.

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Table 1: Linear Model

Variable	Coeff	T-Stat
constant	-0.266	-0.909
January	2.660*	2.608
EMS	0.240	0.323
R_{t-1}^{IRL}	0.091	1.680
R_t^{UK}	0.354*	5.176
R_t^{US}	0.221*	2.615
Δoil_t	-0.127*	-3.486
ΔER_t	-0.092	-0.918
ΔIP_{t-2}^{IRL}	0.046	0.583
ΔWPI_{t-1}^{IRL}	0.009	0.073
ΔLR_t^{IRL}	-1.621*	-3.360
ΔSR_t^{IRL}	-0.037	-0.354
ΔIP_{t-2}^{US}	1.180*	2.602
ΔSR_t^{US}	0.082	1.530
Diagnostics		
$\bar{R}^2 = 0.38$	$S.E. = 3.9145$	
$AIC = 2.7853$		
$SC = 0.8907$	$ARCH = 0.0342$	
$NORM = 0.0030$		
Parameter Constancy		
All Coeffs	0.1076	
Intercept	0.1637	

Notes: Diagnostic test results are p-values. Tests for autocorrelation (SC) and ARCH are LM tests up to lag 6. NORM is the Lomnicki-Jarque-Bera test. The * indicates significance at 5 percent.

Table 2: Linearity Tests

Choice of Transition Variable	Linear Model	Single Transition Model	Two Transition Model
Time	0.84	0.61	0.57
R_{t-1}^{IRL}	0.29	0.46	0.53
R_t^{UK}	0.18	0.98	0.93
R_t^{US}	0.02*	0.88	0.96
Δoil_t	0.03*	0.52	0.26
ΔER_t	0.59	0.49	0.35
ΔIP_{t-2}^{IRL}	0.83	0.62	0.59
ΔWPI_{t-1}^{IRL}	0.97	0.37	0.50
ΔLR_t^{IRL}	0.002*	0.59	0.62
ΔSR_t^{IRL}	0.59	0.37	0.30
ΔIP_{t-2}^{US}	0.84	0.56	0.73
ΔSR_t^{US}	0.81	0.22	0.14

Notes: All results are p-values. The * indicates significance at 5 percent.

Figure 1: R_t^{US} transition function for single transition function model.

Table 3: Single Transition Model

Variable	Coeff	T-Stat
constant	15.42*	2.57
January	2.22*	2.66
R_{t-1}^{IRL}	0.12*	2.74
R_t^{UK}	1.16*	3.10
R_t^{US}	1.70*	3.43
Δoil_t	-0.067*	-2.07
ΔER_t	7.13*	2.63
ΔIP_{t-2}^{US}	-6.10	-1.61
ΔSR_t^{US}	-6.82	-1.86
$F(R_t^{US})$	-15.98*	-2.66
$F(R_t^{US}) \times R_t^{UK}$	-0.64	-1.58
$F(R_t^{US}) \times R_t^{US}$	-1.36*	-2.71
$F(R_t^{US}) \times \Delta ER_t$	-10.15*	-3.66
$F(R_t^{US}) \times \Delta IP_{t-2}^{US}$	7.14	1.84
$F(R_t^{US}) \times \Delta SR_t^{US}$	7.46*	2.02
γ	6.48*	2.00
c	-5.18*	-6.97
Diagnostics		
$\bar{R}^2 = 0.56$	$S.E. = 3.8554$	
$AIC = 2.7663$		
$SC = 0.8461$	$ARCH = 0.2397$	
$NORM = 0.0365$		
Parameter Constancy		
All Coeffs	0.8385	
Intercept	0.7012	

Notes: Diagnostic test results are p-values. Tests for autocorrelation (SC) and ARCH are LM tests up to lag 6. NORM is the Lomnicki-Jarque-Bera test. The * indicates significance at 5 percent.

Figure 2: R_t^{US} transition function for the two transition function model.

Table 4: Two Transition Model

Variable	Coeff	T-Stat
constant	11.55*	2.08
January	1.83*	2.09
R_{t-1}^{IRL}	0.13*	2.87
R_t^{UK}	0.57*	7.15
R_t^{US}	1.74*	3.21
Δoil_t	-0.066*	-2.04
ΔLR_t^{IRL}	8.19*	2.65
$F_1(R_t^{US})$	-11.94*	-2.14
$F_1(R_t^{US}) \times R_t^{US}$	-1.44*	-2.68
$F_1(R_t^{US}) \times \Delta LR_t^{IRL}$	-11.06*	-3.48
$F_1(R_t^{US}) \times \Delta IP_{t-2}^{US}$	4.09*	2.86
$F_2(\Delta SR_t^{US}) \times \Delta IP_{t-2}^{US}$	-3.40*	-2.32
γ_1	6.14	1.36
c_1	-5.62*	-5.94
γ_2	6.69	0.84
c_2	-0.61*	-2.64
Diagnostics		
$\bar{R}^2 = 0.56$	$S.E. = 3.8493$	
$AIC = 2.7594$		
$SC = 0.7895$	$ARCH = 0.2450$	
$NORM = 0.0192$		
Parameter Constancy		
All Coeffs	0.6532	
Intercept	0.6183	

Notes: Diagnostic test results are p-values. Tests for autocorrelation (SC) and ARCH are LM tests up to lag 6. NORM is the Lomnicki-Jarque-Bera test. The * indicates significance at 5 percent.

Figure 3: ΔSR_t^{US} transition function for the two transition function model.