What drove Irish Government bond yields during the crisis?

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1. Introduction

The Irish Government bond market has been exceptionally volatile in the seven years since the financial crisis began[1]. The ten-year yield averaged 4-5 per cent for an extended period in the mid-2000s, but the yield jumped in the crisis years reaching close to 14 per cent at its peak before the price rally saw it drop to new all-time lows in 2014. Although it is likely that most of this variation is driven by market reaction to changing fundamentals, the question remains: what exactly drove market movements and by how much? This paper uses monthly economic and financial data to model Irish ten-year sovereign yields through the crisis.

The paper aims to answer three questions:

- What were the driving factors for Irish ten-year Government bond yields in the period January 2003 - March 2014?
- Can economic and financial variables explain the large spike in Irish yields in 2011, i.e. was the spike caused by fundamentals or transitory market sentiment?
- Did the ECB's Outright Monetary Transactions programme (OMT) make a difference? And, if so, by how much?

Central to the idea that economic and financial fundamentals can explain the movements in sovereign yields is the theory of efficient markets. The Efficient Market Hypothesis suggests that any pricing of assets divergent from that suggested by underlying theory will be quickly eliminated. Running counter to the theory of fully efficient markets, behavioural finance recognises that, while fundamentals matter, collective movements of fear and uncertainty can have temporary but dramatic effects on financial markets. This field has grown considerably in the decades since the seminal Shiller (1981) paper showed market pricing moves too much to be simply explained by changes in fundamentals. De Grauwe (2011) shows for the post-crisis euro area these collective movements of fear and euphoria can

[1] With thanks to Karl Whelan, Professor at University College Dublin, for helpful comments.

drive sovereign yields and yield spreads away from underlying fundamentals (see also Corsetti & Dedola (2011), and Gros (2011)).

With regards to the OMT programme, De Grauwe (2014) finds that its effectiveness in reducing sovereign yields for several euro area periphery countries was significant. Altavilla, Giannone and Lenza (2014) propose that the OMT announcements suppressed yields in Italy and Spain by approximately 200 bps.

The rest of this paper proceeds as follows: section two describes the data used in the analysis followed by a discussion on the methodology used in section three. The results from the analysis follow. A final section concludes and detailed econometric results are in the Annex.

2. Data

The data used for this paper span the period January 2003 to March 2014. However, given the need for both high and low frequency data to be incorporated in the model, the question was which frequency would best showcase the data. Quarterly observations may have been best for macro variables but much of the variation and timeliness of the daily data would be lost. As a compromise, all variables were converted to monthly observations. Daily data was averaged across the month while quarterly data (GDP, debt etc.) were interpolated using a cubic mean function.

There are three groups of variables in the model. Standard macro-economic variables were included such as the stock of government debt-to-GDP ratio (denoted below as debt_gdp), the current account on an accumulated basis over time (denoted by acc_ca) and the government primary balance[2] (PB). To capture the effects of the banking sector collapse on sovereign yields, two variables were included. First, given the large degree of uncertainty surrounding the solvency of the Irish banking system during the crisis, a measure to capture the contingent liabilities to the State arising from the distressed banking system was needed. These contingent liabilities had the potential to be crystallised onto the State's balance sheet. Although not directly observable, a reasonable proxy for this series is monthly data on the usage by the "Covered" (Irish-owned) banks of the Central Bank of

[2] The results stemming from a second model including the primary balance can be found in the annex. It produces very similar results to the main model.

Ireland's Emergency Liquidity Assistance (ELA) facility[3]. The Irish Government was liable in the event that losses materialised as a result of the use of this uncollateralised facility. Second, to approximate the liquidity pressures felt across the euro area during the crisis, a series on recourse to the ECB's long term refinancing operations (LTRO) facility was used. Finally, dummy variables for both the introduction of the ECB's Outright Monetary Transactions (OMT) programme and Moody's decision to rate Ireland's sovereign bonds as below investment grade in 2011 were also added (denoted as loss_of_inv_grade).

3. Methodology

Preliminary work on the variables mentioned above showed, unsurprisingly, that all were non-stationary (see Annex for more details). However using Engel and Granger's single equation cointegration test, a cointegrating vector was found meaning the standard OLS method is appropriate to determine the long run relationship between the selected variables (see Annex). We used a simple OLS model with first-order autoregressive conditional heteroskedastic (ARCH) errors. The following equation outlines the specification:

$$ie_{yield_t} = \beta_0 + \beta_1 * acc\_ca_{t-3} + \beta_2 * debt\_gdp_{t-6} + \beta_3 * ela_t + \beta_4 * ltro_t + \beta_5 * omt + \beta_6 * loss\ of\ investment\ grade + \varepsilon_t$$

$$\varepsilon_t = \alpha_0 + \alpha_1 * \varepsilon_{t-1}^2 + \epsilon_t$$

The first equation relates the monthly average yield on Irish ten-year sovereign bonds to the vector of macroeconomic variables, the banking variables, and the OMT and Moody's downgrade dummy variables. The macroeconomic variables are lagged at either three or six months (i.e. one or two quarters) to better model the information on hand to market participants at the time of yield movements. The second equation describes the relationship of the error term with past iterations of itself. Initial analysis showed that using standard OLS resulted in significant autoregressive heteroskedasticity in the error term (alongside non-normality): this was accounted for by the introduction of a first-order ARCH modelling structure (see Annex for more details).

[3] The series used is taken from Central Bank of Ireland data - namely the "remaining liabilities" category which ELA falls under. Some small amount of other liabilities is recorded here, but the majority of variance in this series is ELA-related.

4. Results

Table 1 shows the results of the regression analysis. All of the variables are significant (at the 99 per cent confidence interval) and have the correct signs. The model explains approximately 87 per cent of the variation in Irish yields with the standardised residuals passing the necessary serial correlation, heteroskedasticity and normality tests.

Table 1: Results of regression analysis

Dependent Variable: IE_10Y
Method: ML – ARCH
Sample (adjusted): 2003M01 2014M03
Included observations: 135 after adjustments

Variable	Coefficient	Std. Error	z-Statistic	Prob.
β_0	2.409	0.078	30.842	0.000
ACC_CA(-3)[4]	-0.007	0.002	-4.526	0.000
DEBT_GDP(-6)	0.015	0.002	6.351	0.000
ELA[4]	0.043	0.003	12.218	0.000
LTRO[4]	-0.002	0.000	-6.515	0.000
OMT	-1.653	0.178	-9.310	0.000
LOSS_OF_INV_GRADE	0.734	0.175	4.186	0.000
Variance Equation				
α_0	0.034	0.012	2.965	0.003
RESID(-1)^2	0.977	0.298	3.275	0.001

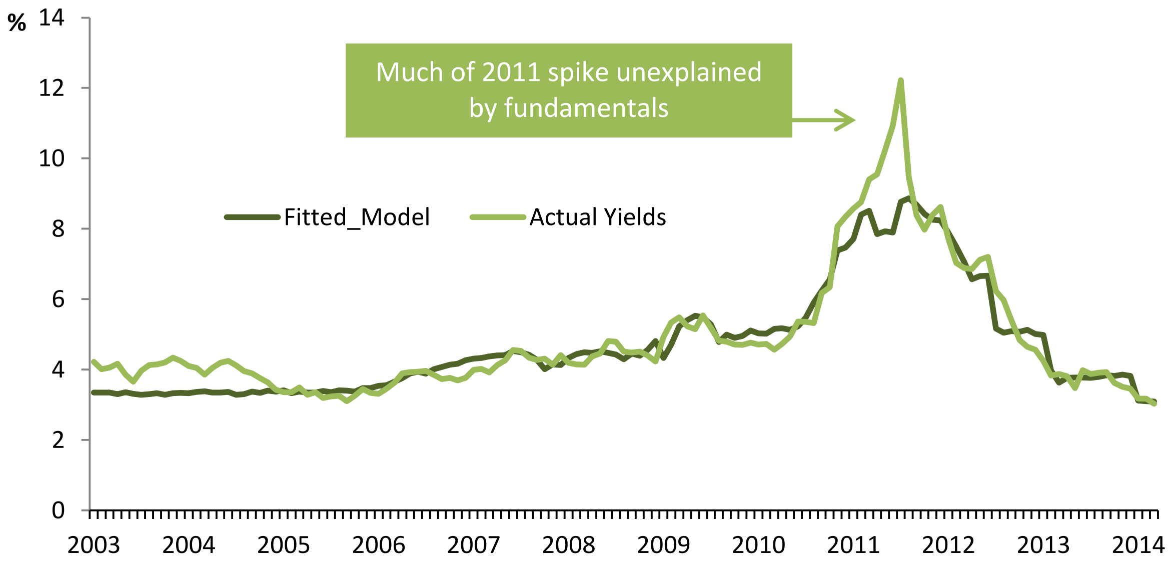
R-squared	0.869	Mean dependent var	4.859
Adjusted R-squared	0.863	S.D. dependent var	1.769
S.E. of regression	0.655	Akaike info criterion	1.049
Sum squared resid	54.923	Schwarz criterion	1.243
Log likelihood	-61.859	Hannan-Quinn criter.	1.128
Durbin-Watson stat	0.377		

Unsurprisingly, the model fails to fully explain the large spike in Irish yields in during 2011 (Figure 1). That is, fundamental variables cannot explain the entirety of the spike in yields. Crucially, although the loss of investment grade is significant and relatively large, it fails to account for all of the variation in the yields at this time despite Moody's announcement

[4] Results should be read as that for every €1 billion of the variable, yields change by the figure in the coefficient column. For example, for every €1 billion increase in ELA, yields increased by 4 basis points.

coming around this period[5]. The large spike is most likely explained by a temporary collective movement due to fear and uncertainty (about Government bond default and/or euro exit) which is divorced from the fundamentals. In time, yields declined to levels estimated by the model on the foot of various factors both domestic and external. The general improvement in Irish economic fundamentals coupled with improved market sentiment towards the viability of the covered banks (in this regard the credibility of the PCAR 2011 exercise as well as the rapid reduction in recourse to the Central Bank liquidity facilities were key drivers) helped drive bond prices up quickly. The agreement by Europe to reduce interest rates and to extend the maturity of Ireland's EFSF/EFSM loans under the Programme and, soon afterwards, the arrival of a significant investor at the margin marked the turning point in July 2011.

<u>Figure 1: Actual yields versus fitted values from model</u>



On the question of OMT effectiveness, it had a clear suppressing impact on Irish ten-year yields. The OMT coefficient is significant and of the expected sign. The impact is close to a 165 bps drop in yields following the announcements in 2012. This result corroborates with a recent ECB working paper using different methodology by Altavilla, Giannone and Lenza (2014), which suggested yields in Italy and Spain fell by close to 200 bps due to the OMT announcements. Furthermore, an alternative model using primary balance data (described

[5] It is worth noting that changing the month in which the investment grade dummy is activated does little to change the coefficient or significance of the dummy variable. For example, starting the dummy variable in April 2011 to coincide with Moody's downgrade of Irish debt to Baa3 (that is one notch above investment grade with a negative outlook) adds little explanatory power.

in the Annex) shows the effect of OMT is similar to the 200 bps suggested by Altavilla, Giannone and Lenza. These findings would suggest that the drop in yields caused by the announcements of the OMT programme across peripheral countries was significant but the effect was possibly less for Ireland.

5. Conclusion

The Irish sovereign bond market has seen extreme movements in recent years. This paper sought to answer whether these movements could be explained fully by a set of macroeconomic and financial variables. Fundamental variables can explain the majority of the variance present, but the spike in yields seen in the first seven months of 2011 was driven in large part by non-fundamental or behavioural factors, characterised by investor panic about multiple equilibria including outcomes such as disorderly default. Furthermore, the paper finds that the ECB's OMT programme had a significant downward effect on Irish yields, in line with what other studies have found.

References:

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Eaton, J. and M. Gersovitz (1981), "Debt with Potential Repudiation: Theoretical and Empirical Analysis", *Review of Economic Studies* 48, 289-309.

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Annex

Unit root testing

Variable	(AIC) Lag length	Test Statistic	p-value
ie_yields	1	-1.683	.438
acc_ca	10	-1.918	.323
debt_gdp	12	-2.890	.169
ela	1	-1.545	.509
ltro	1	-1.425	.569

Cointegrating vector testing

Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C @TREND

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
IE_10Y	-6.159	0.003	-77.122	0.000
ACC_CA	-2.123	0.986	-9.178	0.990
DEBT_GDP	-3.554	0.615	-23.720	0.590
ELA	-5.370	0.028	-58.539	0.003
LTRO	-4.118	0.333	-37.060	0.135
OMT	-3.771	0.504	-25.861	0.495
LOSS_OF_INV_GRADE	-2.801	0.904	-15.009	0.912

*MacKinnon (1996) p-values.

Heteroskedasticity tests

Breusch-Pagan-Godfrey
Null: no heteroskedasticity

F-statistic	5.255	Prob. F(7,127)	0.000
Obs*R-squared	26.682	Prob. Chi-Square(7)	0.000

ARCH (one lag) - Null: no autoregressive conditional heteroskedasticity

F-statistic	34.015	Prob. F(1,132)	0.000
Obs*R-squared	27.456	Prob. Chi-Square(1)	0.000

Model B

This is an alternative model using a primary balance explanatory variable rather than the current account from the Balance of Payments. The primary balance series is constructed using monthly Exchequer balances (closely interchangeable with Central Government) where both the interest cost and the cost of the banking recapitalisation to the Irish State have been stripped out. The (Exchequer) primary balance is lagged by one month. Looking at the econometric results, all of the variables are significant and have the correct signs. The model has a strong R-squared while the standardised residuals are normal and serially uncorrelated.

Table 2: Results of regression analysis - Model B

Dependent Variable: IE_10Y
Sample: 2003M01 2014M03

Variable	Coefficient	Std. Error	z-Statistic	Prob.
β_0	2.924	0.105	27.759	0.000
PB(-1)	-0.118	0.017	-7.010	0.000
DEBT_GDP(-6)	0.022	0.002	9.110	0.000
ELA	0.035	0.002	18.076	0.000
LTRO	-0.002	0.000	-12.235	0.000
OMT	-2.009	0.132	-15.217	0.000
LOSS_OF_INV_GRADE	0.887	0.145	6.134	0.000
Variance Equation				
α_0	0.029	0.016	1.864	0.062
RESID(-1)^2	1.085	0.311	3.487	0.000

R-squared	0.878	Mean dependent var	4.859
Adjusted R-squared	0.873	S.D. dependent var	1.770
S.E. of regression	0.632	Akaike info criterion	1.013
Sum squared resid	51.063	Schwarz criterion	1.207
Log likelihood	-59.374	Hannan-Quinn criter.	1.092
Durbin-Watson stat	0.410		

Figure 2: Actual yields versus fitted values from Model B