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ON THE DEBT-EQUITY LINK: EVIDENCE FROM EUROPEAN MARKETS

JOÃO FILIPE DIAS DE CARVALHO

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“On the Debt-Equity link: evidence from European markets”

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Abstract

With this thesis, we tried to answer the following question: “Is there any relationship between equity and debt markets?”. Since most of the literature uses samples of U.S. firms, we enhanced our contribute to this subject by introducing a 100% european sample, thus providing insight for a different market than untill now. The sample to be used compreends the constituent firms of the EURO STOXX 50 Index, both its shares and bonds and also the index itself and short and long term riskless bonds. We performed also formal Granger causality tests in order to assess if there is an inquestionable lead-lag relationship between both markets in study.

Key Words: Financial Markets, Granger Causality, Corporate Bond Yields, Share Returns

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1 Introduction

Financial markets are composed by investors, who demand securities, and issuers, who supply these securities. Despite the side they are, both sets of market players have a common objective when entering the market: maximizing profits. In order to achieve this objective, they can buy or sell securities. Elton et al. (2011) distinguish between two types of investors: "information traders" and "liquidity traders". As the first ones enter the market to trade upon their beliefs and expectations on a given securities' pricing, the latter ones trade to allocate a surplus or a shortage of cash. Before starting to trade, both types of investors face a choice of whether to invest in equity instruments (shares of stock), fixed income instruments (treasury bills/bonds, corporate bonds) or derivatives (stock/bond options, CDS, warrants), being the first two the most traditional and most important in financial markets. Merton (1974) presents both shares and bonds as "claims" over a firm's assets, suggesting that both securities' value will be dependent on this variable. However, they are also subject to demand and supply, as they are being traded in widely open markets. This means that the quotation of any security (equity, fixed income or derivative) will reflect the preferences of market players, which are very subjective as each investor has its own opinions on how the market will evolve.

Regarding the way investors' value securities, there are several methodologies available being the most used the Discounted Cash-Flow Model, where we see both equities and fixed income assets valued independently and using only each security's characteristics. It states that the value of a security is the present value of its expected future cash flows, where the discount rate reveals the return earned by the investor and increasing with risk. However, Fama and French (1992) suggest that both shares and bonds' returns are related through "five common risk factors". These authors divide the factors between "bond-market factors" and "stock- market factors". The firsts respect to the overall market behavior and to some firm-specific aspects (book-to-market equity value and firm size), as the latter respect to the bonds' maturities and risk profile. As to their conclusions, Fama and French (1992) find that is the "market factor" that explains the differences in returns of both types of securities. The "stock-market factors" are only capable of explaining differences in returns of different shares, as the "bond-market factors" only explain differences between different bonds' returns. On a different mindset, Merton (1974) proposes a valuation of a firm's debt in which he splits the value of a firm in "two classes of claims": debt, which will be paid ti investors according ti the value of the firm's assets, and equity, which will be the residual difference between the value of assets and the value of debt. This is the same as to say that the value of a firm's assets is equal to the value of its debt plus an option striking when the assets cover entirely the firm's debt.

By Merton's definition of shares and bonds, it becomes easy to understand that whenever new information reaches the market, both types of securities will react. What is not immediate is to know how will they react, otherwise all investors would profit from the market by responding with the same trading orders. This would not be feasible, as it would involve unrealistic market conditions. For example, if a firm releases any information that would lead all investors to sell the firm's shares and all investors reacted that way, the firm would reach a moment where its shares would reach a price of 0. In fact, this usually does not happen, as each investor has its own preferences and somewhere along the way the share would reach a price that would make some investors interested in that security. However, if investors could predict somehow the securities' reaction to new information in the market, they could adjust their strategies and portfolios in order to increase profits, at least in an early stage of the prediction. As the market continues to trade, this increased transparency would lead this predictable lag between securities to diminish, as more investors would adapt their strategies. Ultimately, both securities will adapt simultaneously to new information, becoming impossible to profit from a security based on the others movement.

With this study, we intend to answer the following question: "Is there any relationship between equity and debt markets?" If new information is released into the market, how will debt and equity markets react to it? Will they react simultaneously? Or will one lead the other incorporating it into its prices? Can we say that the performance of one market influences the performance of the other? The fact that equity markets are more liquid lead them to incorporate new information or market trends more rapidly than debt ones. Hence, we expect that if a causal relation exists it would be from the equity market to the debt market. Our objective is to provide new evidence on the subject without forgetting the existing literature support, which is reviewed in Chapter 2.

2 Literature Review

The linkage between both equity and debt markets is always a relevant topic in financial markets, since new findings can provide insight for new portfolio building and management techniques as market players always pursue higher profits. These issues have been studied for quite some time and with some divergent findings. Also, the methodologies applied to study this question as well as the datasets have been varied.

Kwan (1996) addressed this topic using a U.S.-based sample of bonds and its issuers' shares, regressing weekly variations of each bond yield over the same firm's weekly stock returns (leading, contemporaneous and lagged ones). Kwan has also included changes in riskless bonds as control variables in the model. With his study, he found that changes in bond yields are significantly correlated with both contemporaneous and lagged stock returns, meaning that the stock market leads bond market in incorporating new information regarding the issuer firm. Shiller and Beltratti (1992) conclude that "the stock market 'overreacts' to the bond market", as they used VAR estimations based on a dataset of U.S. and U.K. firms. However, after implementing formal causality testing they could not argue on the direction of the causal relation. This means that both markets are indeed linked, but there is no evidence of one market leading the other.

Downing et al. (2009) suggest that, using a "pooled time-series cross-sectional" methodology, stocks only can lead bond returns for non-investment grade non-convertible bonds. Also basing the analysis in the U.S. market, they implement also a Vector Autoregression (VAR) system to perform a formal Granger causality test. This formal test of causality resulted in two major findings: on one hand, highly rated bonds tend to follow the pattern of Treasury returns, as on the other hand poorly rated bonds tend to behave more like equity returns. Forte and Peña (2009) use a different approach, as they do not use returns to perform the analysis, but also use spreads. They also introduce Credit Default Swaps (CDS) as well as some European firms into the analysis, finding that stocks lead bonds (and CDS) in incorporating information into the market. In terms of methodology applied, Forte and Peña (2009) applied a Vector Error Correction Model (VECM) for explaining changes in the bond and CDS spreads. Stocks spreads are reached through implied credit spreads. Regarding the results, these authors argue than stocks lead both CDS and bonds in incorporating new information, as well as CDS lead bonds.

The paper from Hotchkiss and Ronen (2002) uses "daily and hourly data on high-yield bond transaction prices" and shares' returns from the U.S. market to try to answer the question: "Do stock returns lead corporate bond returns?" Their answer to the question is that "stocks do not lead bonds" in incorporating new information. Instead of regressing bond yield's returns over shares' returns, they regress the returns of a bond portfolio over the return of a share portfolio constituted by the same firms. Also, they perform formal Granger tests under a VAR approach. These findings are interpreted as being caused by the existence of correlation due to the fact that both markets react to the same information events.

In a more recent study, Bittlingmayer and Moser (2014) propose a different direction of the relation between stock and bond returns, using data from high-yield bonds traded in Over the Counter (OTC) markets. Considering monthly returns, they find that the bond market anticipates the stock market movements, especially when we are in presence of a decrease in returns. The analysis comprehends bonds and stocks from the U.S. and uses a "pooled regression model" to perform the analysis. On the same mindset, Vassalou and Xing (2004) explore the impact of default risk in equity returns, using a decomposition of equity returns between proxies of the "stock-market factors" of Fama and French (1992). They find that, for firms with high default risk, small firms have higher equity returns than larger firms. The same applies for firms presenting higher book-to-market ratios.

When starting this study, the expectation was to encounter a connection between both markets where shares' prices would lead bonds' yields and prices in incorporating new information. However, the existing literature on the topic has proved up to some extent otherwise. Although the correlation between both variables in undeniable, not always it turns into a formal causal relation. Kwan (1996) and Downing et al. (2009) argue that high rated bonds tend to be behave more like riskless bonds than like shares. This fact mitigates the possibility of shares' returns causing bonds' returns. However, both authors suggest that shares are capable of predicting bonds' returns for lower ratings, confirming the causal relation for this bond segment.

With this thesis, we tried to answer our research question with a mixed methodology. The reviewed literature usually applies a VAR methodology or a linear panel data regression; therefore we tried to implement both methodologies[1]. Since most of the literature uses samples of U.S. firms and securities, we enhanced our contribute to this subject by introducing a 100% European sample and providing insight for a different market than until now. The sample to be used comprehends the constituent firms of the EURO STOXX 50 Index, both its shares and bonds and also the index itself and short and long term riskless bonds. We performed also formal Granger causality tests in order to assess if there is an unquestionable lead-lag relationship between both markets in study.

The remaining of this thesis will be divided in three more chapters, Chapter 3 will discuss the dataset used and the methodology implemented to perform the analysis. Chapter 4 will present and comment the results obtained and Chapter 5 will discuss the results and conclude.

[1] Linear panel data regression models can be estimated through one of three estimation methods: Fixed Effects, Random Effects and Pooled Effects (a.k.a. Pooled Ordinary Least Squares). Although literature points to Pooled Effects (Bittlingmayer and Moser (2014) and Downing et al. (2009)) as being the most adequate to this study, we provide statistical evidence in Chapter 3.2 of which method is the most adequate for the sample used.

3 Data and Methodology

3.1 Data

We concentrated our analysis over the composing firms of the EURO STOXX 50 index, since it is the more often used index to benchmark the "Eurozone Stock Market". To perform the analysis we based our dataset in four sources of market information: bonds, shares, equity index and riskless bonds. The bond data used were obtained from Bloomberg and the stock data were gathered from Datastream, both using closing quotes. The market index considered is EURO STOXX 50 itself, and for the risk-free rates we used the European Central Bank's yield curve for 1 and 10 years. The time horizon covered by the dataset is of approximately 9 years and one quarter, starting on the January 1, 2005 and ending on the March 31, 2014.

The bond data used consists on the changes in both bid and ask yield-to-maturities. The stock data consists on the return of their prices. In Appendix 1 we provide the list of the EURO STOXX 50 composing firms and the number of bonds each firm has issued during the period of analysis and that were considered in the sample. In order for a bond issue to enter the dataset, it must fulfill the following criteria: the bond needs to be issued in Euros and in the same country as the issuing firm's shares are quoted, in order to eliminate nay exchange effects; the minimum amount issues has to be above one billion Euros for the banking sector and above 500 million Euros for all others. This will guarantee that the issues are large enough to reach the secondary markets and to be traded regularly. Concerning maturities, we require the bond issues to be non-perpetual, non-convertible and non-callable (or non-puttable), in order to exclude any "noise" from these settling methods. Finally, we impose bonds to be fixed couponed, so that the yield-to-maturity can the easily understood. After filtering the shares and bonds included in the dataset, we ended up with a sample of 350 bonds issued by 34 of the 50 firms initially considered. This results in a total of 286.679 daily observations over a 2004-2014 time period.

Regarding the model applied, it is based on the model presented by Kwan (1996), using two types of variables: "core variables", which are both stock and bond data; and "control variables", which include both the market index and riskless rates. Controlling for both these factors allows us to exclude any explanation of the results through aggregate market conditions, not specific to the firm itself. In order to enhance the conclusions of the study, we have made the analysis concerning three levels of analysis: an annual, a weekly and a daily analysis. To perform the computations, we have assumed a trading week of 5 days and a trading year with 250 days, as in the usual conventions.

We intend to regress bond yield changes[2] against stock returns, both contemporaneous and lagged ones. Contrarily to Kwan (1996), we will not include leading stock returns since we have performed our analysis using a VAR approach and we intend to maintain coherence in both approaches (VAR and panel regression). We include also the set of "control variables" for the purpose above described. From Appendix 2 we have that bond yield changes (in all three levels of analysis) are stationary in first differences, therefore we have to include a lagged bond yield change in the model. Hence, our model can be summarized as:

$$\Delta Y_{j,t} = \beta_0^{'} + \beta_1^{'} \Delta Y_{j,t-1} + \beta_2^{'} R_{j,t} + \beta_3^{'} R_{j,t-1} + \beta_4^{'} \Delta T1_{j,t} + \beta_5^{'} \Delta T10_{j,t} + \beta_6^{'} M_{j,t} + u_{j,t} \quad (1)$$

where,

$\Delta Y_{j,t}$[3] is the change in bond j's yield-to-maturity from *t-1* to *t,*

$R_{j,t}$ is the return on bond j's issuing firm's stock from *t-1* to *t,*

$\Delta T1_t$ is the change in the one-year risk-free bond from *t-1* to *t*,

[2] We are using changes in yields instead of the yield itself because bond data was gathered with no concern to coupon payment date. Kwan (1996) faced the same issue, being this one of the reasons why we have based our model in this author's one.

[3] When we refer to the dependent variable as only $\Delta Y_{j,t}$, not specifying if it is the Bid or Ask rate, it means that both cases can be applied.

$\Delta T10_t$ is the change in the ten-year risk-free bond from *t-1* to t,

$M_t$is the return on the market index from *t-1* to t,

$u_{j,t}$is the disturbance term.

In Table 1 we have a summary of the statistical properties of the variables computed. Both bid and ask yield-to-maturities present similar characteristics, having means close to 0 and standard deviations close to 1, indicating that are close to normally distributed. Regarding shares' returns, we find that these present both mean and standard deviation of 0. This means that the shares' returns values are more centered than in the case of the yield-to-maturities, which is the same as to say that the returns are, on average, very small. Because our sample comprehends the period from 2005 to 2014, it covers not only the real estate bubble but also the subprime crisis which justifies the high maximum and minimum for the shares' returns.

Tab. 1: Summary Statistics

Variable		Mean	St. Deviation	Median	Minimum	Maximum
Panel A: Daily Variables						
Change in Bond j's Bid YTM	$\Delta Y^b_{j,t}$	0.0017	1.1547	0.0030	-110.60	418.60
Change in Bond j's Ask YTM	$\Delta Y^a_{j,t}$	0.0017	1.1179	0.0030	-164.70	390.60
Return on Bond j's issuing firm's stocks	$R_{j,t}$	-0.0001	0.0026	0.0000	-2.4310	1.7270
Change in One-Year Riskless Bond	$\Delta T1_t$	0.0006	0.0046	0.0003	-4.1870	1.1070
Change in Ten-Year Riskless Bond	$\Delta T10_t$	0.0008	0.0049	0.0024	-2.7900	0.7146
Return on Market Index	M_t	-0.0001	0.0015	0.0000	-0.7188	0.3632
Panel B: Weekly Variables						
Change in Bond j's Bid YTM	$\Delta Y^b_{j,t}$	0.000	1.1547	0.003	-110.60	418.60
Change in Bond j's Ask YTM	$\Delta Y^a_{j,t}$	0.000	1.1179	0.003	-164.70	390.60
Return on Bond j's issuing firm's stocks	$R_{j,t}$	0.0000	0.0026	0.0000	-3.3550	1.8960
Change in One-Year Riskless Bond	$\Delta T1_t$	0.0000	0.0046	0.0004	-4.2910	1.1070
Change in Ten-Year Riskless Bond	$\Delta T10_t$	0.0000	0.0049	0.0024	-2.7900	0.7146
Return on Market Index	M_t	0.0000	0.0015	0.0000	-0.7188	0.4238
Panel C: Annual Variables						
Change in Bond j's Bid YTM	$\Delta Y^b_{j,t}$	0.0000	1.1547	0.0030	-110.60	418.60
Change in Bond j's Ask YTM	$\Delta Y^a_{j,t}$	0.0000	1.1179	0.0030	-164.70	390.60
Return on Bond j's issuing firm's stocks	$R_{j,t}$	0.0000	0.0026	0.0000	-3.3550	1.8960
Change in One-Year Riskless Bond	$\Delta T1_t$	0.0000	0.0046	0.0003	-4.2910	1.1070
Change in Ten-Year Riskless Bond	$\Delta T10_t$	0.0000	0.0062	0.0003	-4.2910	1.1070
Return on Market Index	M_t	0.0000	0.0015	0.0000	-0.7188	0.4238

3.2 Methodology

The conclusions driven from the unit-root (see Appendix 2) tests have an important implication regarding the methodology to apply in this study, as it invalidates the possibility of using static panels, requiring instead dynamic panels. A more straightforward approach is to use VAR processes. Based on the model defined in Chapter 3.1, we have estimated four sets of VAR processes: two using the ask yield, one with only the "core variables" and another introducing the "control variables"; and two using the bid yield, again one just considering the "core variables" and another with both sets of variables, "core" and "control". From the Schwarz Information Criterion we have retrieved that these processes have a length $p = 1$, being all VAR (1) or VAR processes with one lag (see Table 2).

Tab. 2: VAR's order p determination

Core Variables	Control Variables (Y/N)	Minimum SC	VAR (p)
Annual Variables			
$\Delta Y^a_{j,t} \Leftrightarrow R_{j,t}$	No	-0.4696	1
$\Delta Y^a_{j,t} \Leftrightarrow R_{j,t}$	Yes	-1.3811	1
$\Delta Y^b_{j,t} \Leftrightarrow R_{j,t}$	No	-0.4049	1
$\Delta Y^b_{j,t} \Leftrightarrow R_{j,t}$	Yes	-1.3166	1
Weekly Variables			
$\Delta Y^a_{j,t} \Leftrightarrow R_{j,t}$	No	-0.4696	1
$\Delta Y^a_{j,t} \Leftrightarrow R_{j,t}$	Yes	-1.3821	1
$\Delta Y^b_{j,t} \Leftrightarrow R_{j,t}$	No	-0.4049	1
$\Delta Y^b_{j,t} \Leftrightarrow R_{j,t}$	Yes	-1.3176	1
Daily Variables			
$\Delta Y^a_{j,t} \Leftrightarrow R_{j,t}$	No	-0.4696	1
$\Delta Y^a_{j,t} \Leftrightarrow R_{j,t}$	Yes	-1.3821	1
$\Delta Y^b_{j,t} \Leftrightarrow R_{j,t}$	No	-1.3821	1
$\Delta Y^b_{j,t} \Leftrightarrow R_{j,t}$	Yes	-1.3176	1

In order to completely answer our research question "Is there any relationship between equity and debt markets?" we have still to test the causality hypothesis between the variables. As shown in Chapter 2, one of the most widely accepted methodologies to study causal relations is the Granger Causality Test (Granger, 1969). Granger defines causality as "Y_t is causing X_t if we are better able to predict X_t using all available information that if the information apart from Y_t had been used". Indeed, Granger also specifies two types of causality: lagged causality, which is the case where is only considered the past information to predict the variable X_t; and instantaneous causality, which only considers the effect of the current value of Y_t on the prediction of X_t . The major assumption of Granger definitions is that both Y_t and X_t are stationary series.

However, the Granger's definition of causality has an irrealistic assumption that can be loosed to fit reality: the use of all available information to predict the series X_t. In order to be more accurate with reality, we can assume the utilization of all relevant information. But the definition of relevant information can lead to another problem: spurious causality. Spurious causality occurs when the model used to test causality does not include all relevant information. Wooldridge (2008) suggests the two independent variables cannot have a causal relation. This means that correlation is a premise to causality and if two variables are significantly correlated we can regress one over the other. To prove this premise, we present in Table 3 the Pearson's Correlation Matrix for all variables in the analysis and for all three frequencies of analysis.

Tab. 3: Pearson's Correlation Coefficients

Panel A: Daily Variables

	$\Delta Y^a_{j,t}$	$\Delta Y^b_{j,t}$	$R_{j,t}$	$\Delta T1_t$	$\Delta T10_t$	M_t
$\Delta Y^a_{j,t}$	1	0.1565	0.0747	0.1693	0.0817	0.0997
$\Delta Y^b_{j,t}$		1	-0.0390	-0.1128	-0.0669	-0.0246
$R_{j,t}$			1	0.1170	0.0639	0.5643
$\Delta T1_t$				1	0.6435	0.1792
$\Delta T10_t$					1	0.0672
M_t						1

Panel B: Weekly Variables

	$\Delta Y^a_{j,t}$	$\Delta Y^b_{j,t}$	$R_{j,t}$	$\Delta T1_t$	$\Delta T10_t$	M_t
$\Delta Y^a_{j,t}$	1	0,1565	0.0747	0.1693	0.0817	0.0997
$\Delta Y^b_{j,t}$		1	-0.0390	-0.1128	-0.0669	-0.0246
$R_{j,t}$			1	0.1170	0.0639	0.5643
$\Delta T1_t$				1	0.6435	0.1792
$\Delta T10_t$					1	0.0672
M_t						1

Panel C: Annual Variables

	$\Delta Y^a_{j,t}$	$\Delta Y^b_{j,t}$	$R_{j,t}$	$\Delta T1_t$	$\Delta T10_t$	M_t
$\Delta Y^a_{j,t}$	1	0.1565	0.0747	0.1693	0.1276	0.0997
$\Delta Y^b_{j,t}$		1	-0.0390	-0.1129	-0.0858	-0.0246
$R_{j,t}$			1	0.1170	0.0895	0.5643
$\Delta T1_t$				1	0.7439	0.1793
$\Delta T10_t$					1	0.1348
M_t						1

After testing for the significance of all Pearson's correlation coefficients, we conclude that these present an asymptotic p-value of 0 at the 95% confidence level. Hence, we can assume the Granger's causality test premise validated. Looking at Table 3, we see that all variables present a positive correlation to the ask yield-to-maturity and a negative correlation to the bid yield-to-maturity. Disregarding the control variables due to their function in this study, we can interpret the positive correlation between stock returns and ask yield-to-maturity's changes as the result of a change of investor's preferences. Whenever a stock faces positive returns, investors tend to increase their interest in it, meaning that they will decrease the demand for bonds, decreasing bonds' prices with it. Being the yield-to-maturity the discount rate at which the bonds cash flows are discounted, it will increase when the bond's price decreases in order to balance the equation. Because we are referring to the prices at which the investors buy the bonds, the corresponding yield shall be the ask one.

Given the same scenario, after the demand for shares increase and the demand for bonds decrease, the financial intermediaries will start to purchase the bonds the investors are selling. This process implies an increased demand on the behalf of the intermediary, which will increase the price paid by the intermediary (the bid price) and therefore decreasing the bid yield-to-maturity. Ultimately both these effects will narrow down the bid-ask spread of the bonds, since if the bid price reaches the ask one there will be room for arbitrage. This means that eventually both bid and ask prices (and therefore their corresponding yields-to-maturity) will converge to become the same.

In practice, the Granger causality test can be interpreted as a simple Wald-test over a well specified model. Under a null hypothesis of joint nullity of all variable coefficients, i.e., non-causality, rejecting this hypothesis ensures the existence of Granger causality. Since this is a methodology that can be implemented under a large variety of ways, we will analyze the Granger causality under a VAR approach, using a VAR with $p = 1$ lags and calculating the adequate F-statistic in order to assess the adequacy of the model.

4 Empirical Results

Tab. 4: Granger Causality Tests

H_0 :	Test-Statistic	DF1	DF2	Probability	Test-Statistic	DF1	Probability
Daily Variables					*Instantaneous Causality*		
$\Delta Y^a_{j,t} \Rightarrow R_{j,t}$	0,0001	1	573352	0.9814	1590.7	1	0,0000
$R_{j,t} \Rightarrow \Delta Y^a_{j,t}$	0.4938	1	573352	0.4822	1590.7	1	0,0000
$\Delta Y^b_{j,t} \Rightarrow R_{j,t}$	0.9359	1	573352	0.3333	435.8	1	0,0000
$R_{j,t} \Rightarrow \Delta Y^b_{j,t}$	0.7701	1	573352	0.3802	435.8	1	0,0000
Weekly Variables					*Instantaneous Causality*		
$\Delta Y^a_{j,t} \Rightarrow R_{j,t}$	0,0001	1	573352	0.9816	1590.7	1	0,0000
$R_{j,t} \Rightarrow \Delta Y^a_{j,t}$	0.4939	1	573352	0.4822	1590.7	1	0,0000
$\Delta Y^b_{j,t} \Rightarrow R_{j,t}$	0.9361	1	573352	0.3333	435.9	1	0,0000
$R_{j,t} \Rightarrow \Delta Y^b_{j,t}$	0.7699	1	573352	0.3802	435.9	1	0,0000
Annual Variables					*Instantaneous Causality*		
$\Delta Y^a_{j,t} \Rightarrow R_{j,t}$	0,0001	1	573352	0.983	1590.8	1	0,0000
$R_{j,t} \Rightarrow \Delta Y^a_{j,t}$	0.4922	1	573352	0.4829	1590.8	1	0,0000
$\Delta Y^b_{j,t} \Rightarrow R_{j,t}$	0.9343	1	573352	0.3338	436.2	1	0,0000
$R_{j,t} \Rightarrow \Delta Y^b_{j,t}$	0.7726	1	573352	0.3794	436.2	1	0,0000

Instantaneous Causality respects to contemporaneous variables, as Causality respects only to lagged variables.

As shown in Appendix 2, the application of a VAR process to our model is a valid methodology to implement Granger causality testing. Table 4 summaries the results of these tests. Influenced by the reviewed literature, we have estimated regressions and Granger tested the same regressions for three levels of analysis: annual data (considering a year of 250 trading days), weekly data (considering a week with 5 trading days) and daily data.

The results regarding annual data point to the non-existence of lagged Granger causality, either between $R_{j,t}$ and $\Delta Y_{j,t}$, nor between $\Delta Y_{j,t}$ and $R_{j,t}$. As suggested by Downing et al. (2009), high rated bonds tend to follow more the behavior of riskless bonds than equity securities'. This means that high performance firms will have independent performances of its equity and debt securities. Being our sample composed by the constituent firms of the Eurozone benchmark index, we may be in presence of such firms. However, we find evidence of instantaneous Granger causality in both ways, from stock returns to changes in yields and vice-versa. These findings suggest that any informational exchanges between both markets may occur in a more frequent scale than year trading.

Once we look at the weekly results, we reach similar conclusions than for annual data. As Kwan (1996), we find no evidence of lagged Granger causality between both variables, despite the correlation between them. Again, the presence of a two-way instantaneous Granger causality makes us look further into daily data, as it appears that any formal lead/lag relation between variables would vanish in the short-term. The analysis of daily results proves exactly this premise, as there are not any signs of Granger causality between both variables, except when instantaneous causality, from which we can conclude that the Eurozone financial market may be experiencing one of two possible scenarios: or there is a Granger causal relation between both variables that is lives very briefly on the intraday level, or both markets are so correlated that they react simultaneously to new information in the markets, meaning that there is no Granger causal relation between both variables. As the first scenario is closer to the findings of Kwan (1996), Downing et al. (2009) or Bittlingmayer and Moser (2014), despite in different directions of causality; the latter scenario is closer to the findings of Hotchkiss and Ronen (2002), which suggest that react to the same information events instead of reacting to each other.

5 Summary and Conclusion

With this study we tried to verify the existence of a formal causal relation between Debt and Equity markets. Using a representative dataset of the Eurozone market, we performed formal Granger causality tests for both stock returns and bond yields' changes concerning annual, weekly and daily data. Departing from Kwan (1996) model, we controlled for market index returns and riskless rates, both short and long term, achieving poor results. This can be seen as a rather large simplification of debt market mechanisms. One reason for this apparent simplification can be that Equity and Debt markets are increasingly producing new ways for investors to enter the market, usually through derivatives. The introduction of stock options, CDS contracts or non-traditional bonds (for example, CAT bonds or Eurobonds) can dilute the effect that traditional stocks and bonds can have in the market mechanisms and, consequently, in the outcomes of our study. The utilization of these "new" products to perform hedging strategies may influence both Equity and Debt markets in a similar way, preventing bad news and reducing its effect on both securities' prices (Hu and Black, 2008). However, Das et al. (2014) refute the possibility of CDS contracts improving bond market's efficiency since they state that "bond markets became less efficient relative to other securities and evidenced greater pricing errors and lower liquidity". Campbell and Ammer (1993) suggest that both equity and debt markets may not be influenced by each other but also by a set of other variables such as expectations on future cash-flows, future stock returns or future dividends. Also, the article suggests that both stock and bond returns can be forecasted using the same variables. Equity volatility is pointed out by Campbell and Taksler (2003) as a determinant of corporate bond yields, being as useful as credit ratings to explain "cross-sectional variation in yields" not only in the short-term but also in the long run.

The same explanations can be given to justify the non-existence of lagged Granger causality between stock returns and bond yield's changes. Merton (1974) characterized both stocks and bonds as "claims" over a firm's assets. This can mean that both securities returns are caused by changes not in each other, but yet in the value of the issuing firm. Also, we have to consider managerial decisions into both types of securities' performances (de Jong et al., 2011). If we consider the Debt market case, a bond's risk is dependent on the amount of debt already outstanding. The amount of debt outstanding that a firm has is determined by its management, according to the desired capital structure. This means that there is a possibility of bond's performance being independent from share's performance, as the influence of the management in the bond performance can mitigate the market influence on those securities.

Finally, our results suggest the existence of a formal instantaneous Granger causality at the daily level, meaning that any lead/lag between Equity and Debt markets occurs at an intraday level. The finding of Covas and Den Haan (2011) support this finding, since the existence of cyclicality in the financing of a firm can lead investors to increase their ability to predict shares and bonds' price movements. This would lead to an increase on the speed of price adjustments between both markets, ultimately meaning that they would not react to each other but simultaneously to new information.

Regarding the major limitations and difficulties faced in the development of the work, these concerned mainly the methodology implementation in the software R, due to both lack of experience and literature on how to implement it. There were also some difficulties when collecting information on the VAR methodology, which led to the impossibility of fully implementing this method.

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Appendices

Appendix 1 - List of EURO STOXX 50 Components

No.	Firm	Country	Supersector	Number of Bond issues in the sample
1	AIR LIQUIDE	France	Chemicals	6
2	AIRBUS GROUP NV	France	Industrial Goods & Services	0
3	ALLIANZ	Germany	Insurance	3
4	ANHEUSER-BUSCH INBEV	Belgium	Food & Beverages	12
5	ASML HOLDING	Netherlands	Technology	2
6	ASSICURAZIONI GENERALLI	Italy	Insurance	5
7	AXA	France	Insurance	4
8	BASF	Germany	Chemicals	10
9	BAYER	Germany	Chemicals	1
10	BCO BILBAO VIZCAYA ARGENTARIA	Spain	Banks	24
11	BCO SANTANDER	Spain	Banks	19
12	BMW	Germany	Automobiles & Parts	0
13	BNP PARIBAS	France	Banks	20
14	CARREFOUR	France	Retail	10
15	CRH	Ireland	Construction & Materials	2
16	DAIMLER	Germany	Automobiles & Parts	15
17	DANONE	France	Food & Beverages	10
18	DEUTSCHE BANK	Germany	Banks	7
19	DEUTSCHE POST	Germany	Industrial Goods & Services	3
20	DEUTSCHE TELEKOM	Germany	Telecommunications	0
21	E.ON	Germany	Utilities	0
22	ENEL	Italy	Utilities	6
23	ENI	Italy	Oil & Gas	14
24	ESSILOR INTERNATIONAL	France	Healthcare	0
25	GDF SUEZ	France	Utilities	18
26	GRP SOCIETE GENERALE	France	Banks	21
27	IBERDROLA	Spain	Utilities	0
28	INDITEX SA	Spain	Retail	0
29	ING GROEP	Netherlands	Insurance	5
30	INTESA SANPAOLO	Italy	Banks	49
31	L'OREAL	France	Personal & Household Goods	0
32	LVMH MOET HENNESSY	France	Personal & Household Goods	6
33	MUENCHENER RUECK	Germany	Insurance	0
34	ORANGE	France	Telecommunications	16
35	PHILIPS	Netherlands	Industrial Goods & Services	0
36	REPSOL	Spain	Oil & Gas	0
37	RWE	Germany	Utilities	1
38	SAINT GOBAIN	France	Construction & Materials	0
39	SANOFI	France	Healthcare	8
40	SAP	Germany	Technology	6
41	SCHNEIDER ELECTRIC	France	Industrial Goods & Services	10

42	SIEMENS	Germany	Industrial Goods & Services	0
43	TELEFONICA	Spain	Telecommunications	0
44	TOTAL	France	Oil & Gas	0
45	UNIBAIL-RODAMCO	France	Real Estate	12
46	UNICREDIT	Italy	Banks	33
47	UNILEVER NV	Netherlands	Food & Beverages	4
48	VINCI	France	Construction & Materials	2
49	VIVENDI	France	Media	14
50	VOLKSWAGEN PREF	Germany	Automobiles & Parts	0
			Total of Issues	350

Appendix 2 - Unit-Root Tests

Before we can apply our model, we need to check the stationarity of the variables as required by Granger (1969). To do that, we resort to Hensen (1995) Covariate-Augmented Dickey-Fuller test. This test is an extension of the classical Augmented Dickey-Fuller test to large panels with increased test power over the conventional tests. The use of this method is summarized in Table 6, showning that for all estimations proposed the dependent variable $\Delta Y_{j,t}$ has a unit root in levels, requiring the model to include its first difference ($d\Delta Y_{j,t}$). Since $d\Delta Y_{j,t} = \Delta Y_{j,t} - \Delta Y_{j,t-1}$, we can solve this problem by including in the model the variable $\Delta Y_{j,t-1}$, the change in bond j's yield-to-maturity from *t-2* to *t-1*, or the lagged $\Delta Y_{j,t}$. This happens because we are in presence of a CADF(0,0,0)[4] series, which is equivalent to a ADF(0) or a DF(1), which indicates the presence of stationarity in first differences of $\Delta Y_{j,t}$.

The implications of this result to our study are clear, the presence of a unit root in $\Delta Y_{j,t}$ implies that static panel estimations are not valid and dynamic panel inference is required for a successful implementation of the methodology proposed. However, there is a simpler alternative, which is to use VAR processes.

[4] Hensen (1995) presents the Covariate-Augmented Dickey-Fuller as a CADF(p, q_1, q_2) test, where (p, q_1, q_2) stand for the orders of the polynomials of the stochastic component of the dependent series and of the leads/lags of the independent series.

Tab. 6: Unit-root test results

Estimation	CADF Statistic	Probability
Panel A: Daily		
i	-536.8	0,0000
ii	-545.0	0,0000
iii	-535.7	0,0000
iv	-539.1	0,0000
Panel B: Weekly		
i	-536.8	0,0000
ii	-546.0	0,0000
iii	-535.7	0,0000
iv	-539.1	0,0000
Panel C: Annual		
i	-536.8	0,0000
ii	-544.6	0,0000
iii	-535.7	0,0000
iv	-539.1	0,0000

Estimations i and ii use Ask yields, iii and iv use Bid yields.

Estimations i and iii use Core variables, ii and iv use both Core and Control variables.