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Examining the Relationship between Quarterly Investment and Government Bond Rates: The Case of Greece

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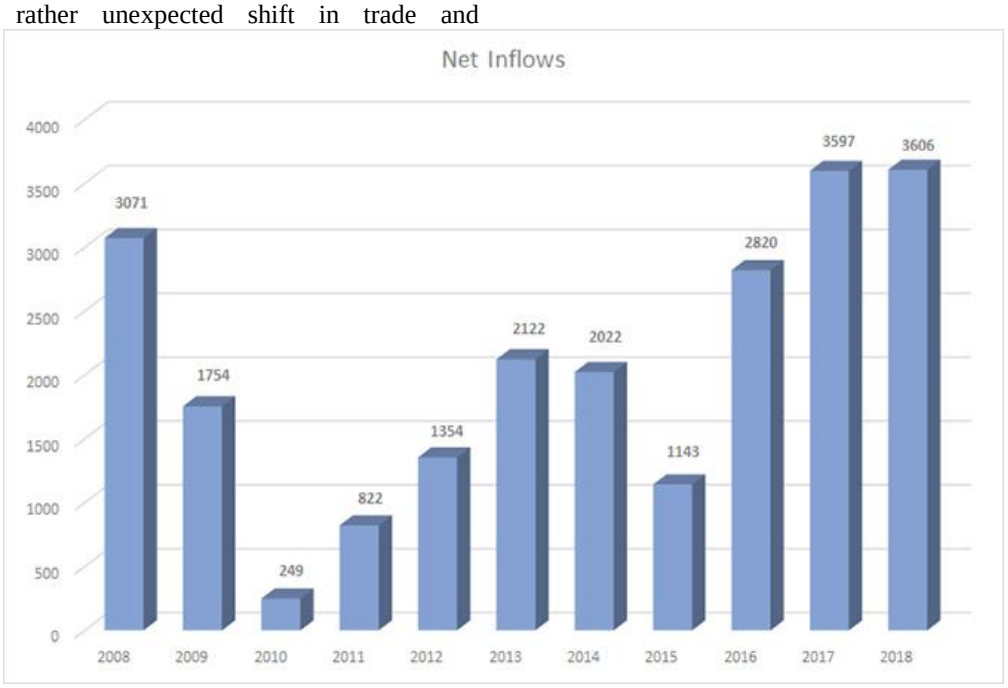
Abstract: ***It is extremely likely that the anticipated economic recovery will be delayed, mostly due to a serious lack of investment funding in Greece. Since it is common practice to GDP increase to investments, we see from 2009 onwards a collapse in terms of inward investments, creating an environment for technological hysteresis at least. We try in this paper to find any relation between quarterly investments and government bond rates, as the latter seem to be an alternative image of an economy's health in terms of foreign borrowing. There seems to be a research gap in this area, where government bond rates have not been examined against investment decisions as a way to find an explanatory pattern for the latter. Our findings depict a slight positive one-way relationship, indicating that changes in Greece's government bond rates tend to positively affect quarterly investments. nevertheless, we strongly suggest a new research of the subject after clarifying the effects of the economic crisis, since both of our main variables tend to be affected in qualitative terms.***

Keywords: investment, government bond rates, OLS analysis, ARCH effect

1. Introduction

In the course of the past 35 years, world FDI stock has increased from less than 1 trillion (or 6% of world GDP) to almost 25 trillion USD (or 33% of world GDP). 2008-2009 financial crisis suppressed international trade and capital flows, while FDI picked up after 2014 and reached 1.52 trillion USD in terms of cross-border flows in 2017. FDI's economic geography has dramatically shifted towards a greater participation of emerging economies right after year 2000. The leading role of OECD economies in capital inflows was surpassed by the share of non-OECD countries during the year 2012. The European economy as a whole experienced a rather unexpected shift in trade and investment patterns, which had a negative impact on capital flowing. There was a decline for both the EU and the euro-area in capital inflows, exacerbated by the financial crisis of 2008-09.

According to the latest Bank of Greece data (as of 2019), net Direct Investment inflows during 2018 reached € 3.606 million vs. € 3.204 million during 2017, an increase of 12.5%. The year 2018 is the third consecutive year of increased investment flows in Greece after an annual increase of 28.3% from 2016 to 2017 and of 118.5% from 2015 to 2016.



Graph 1.1: Net direct investment inflows-Greece
(Source: https://www.enterprisegreece.gov.gr/en/greece-today/why-greece/foreign-direct-investment)

Germany and France seem to be the pioneers in this massive investment inflow, mainly due to the investment of Deutsche Telecom in OTE and the acquisition of Greek banks by French ones, during prior to the beginning of the crisis.

It widely believed that investments in Greece are historically connected to GDP increase, and since 2009 they collapsed creating an environment of technological and competitiveness hysteresis. Funding from the Public Investment Plan (PIP) has been weak due to fiscal limitations, while Foreign Direct Investment (FDI) contributes less than 10% of total investments. Apart from that, Greece is characterised by a significant competitiveness deficit due to limited investments. Generally speaking, investment needs for 2017-2022 are estimated at around € 270 billion, but foreseeable funding flows are not enough to cover them. The structural difficulties in mobilising capital for investments are, mainly:

- The fact that companies offer low yields,
- The economy is under a major credit *squeeze*,
- Consumers' savings tend to decline,
- Non-performing loans are expanding,
- "Soft" financing has dwindled.[1]

2. Literature Review

In 2017 Economou F., Philippas N., and Tsionas E. examined the inflow determinants of FDI (Foreign Direct Investment) for 22 OECD countries. Their findings noted that lagged FDI, market size, gross capital formation and corporate taxation significantly affect FDI inflows.

Another view on FDI determinants was achieved by Sebastian Tocar (2018), when he focused on eleven different categories of non-economic factors which attract FDI. Namely, he focused on factors like technology, infrastructure, legal integration, and institutional-political factors to name a few. His findings conclude that , from the economic factors, market size is the most significant and most frequently mentioned factor, with an almost always positive impact on FDI. From the non-economic factors, those that play a crucial role in inward FDI are language, culture, and entrepreneurial matters.

Blonigen B. A. (2011) studied and categorised variables with high impact on FDI, such as , cultural distance factors, parent-country per capita GDP, relative labour endowments, and regional trade agreements, and low impact, such as multilateral trade openness, host country business costs, host-country infrastructure (including credit markets), and host-country institutions. Of particular note, his results suggested that many covariates found significant by previous studies are not robust.

Pihno A. and Barradas R. (2018) conducted an empirical examination of the determinants of the ten-, five- and one-year Portuguese government bond yields by performing a time series econometric analysis for the period between the first quarter of 2000 and the last quarter of 2016. Their results showed that there are no significant differences in the determinants of the Portuguese government bond yields among the different maturities, either in the long term or in the short term, and that three of the risk drivers (namely credit risk, global risk aversion and liquidity risk) have exerted a strong influence on the evolution of the Portuguese government bond yields.

Fields T. W. and Hart W. R. (2011), attempt to research why main textbooks imply no affect among government bond sales, interest rates, private investment and real output. Their main conclusion is that this phenomenon happens because most IS-LM models do not include the effect of financial wealth on money demand.

In 2017 PriceWaterhouseCoopers published an analytical report on Greece's effort to move from economic recession to investment recovery. The most significant conclusions have to do with the country's credibility and the ability for economic recovery. Since investment and credibility are positively related, it is worthwhile to have a look at these conclusions. Namely:

- The role of credit in the economy of Greece as a whole is vital for growth and stability. The lack of "credit space" squeezes business initiatives having, at the same time, a macroeconomic impact
- Factors such as economic downturns, which affect credit mobility can drive the economy into a non-investment cycle. However, credit may not be a necessary condition for growth
- Following a recessionary period, there are cases where the economic recovery without the corresponding credit is possible. Studies show that there are examples of economies that bounced back without the aid of credit and entered a period of "creditless recovery" which is however about 40% weaker than a recovery with credit.
- The Greek economy has all these characteristics that can potentially lead to a creditless recovery. This could be prevented by a strong investment environment, however, Greece is also in a tight spot in terms of investment interest
- Since 2009, there has been an investment gap which has a negative impact on Greek competitiveness and growth. This gap stems mainly from a 67% decline in the construction sector and the fact that the Greek economy does not attract foreign capital
- Increased private credit demand, limited bank funding, and the lack of equity of Greek companies exacerbate the negative investment climate and lead the economy to a slow and perhaps unfavourable adjustment
- It is important that Greece will introduce consistent policies that promote and facilitate investment.

These policies must include the strengthening of confidence in political processes and institutions, the active management of nonperforming loans, the acceleration of infrastructure investments, the restructuring of the housing market, the changing of the financial sector's architecture, the mobilization of institutional equity for SMEs, the increase of *soft financing*, and the adoption of a stable tax

[1] PriceWaterhouseCoopers 2018-19 'Investments in Greece' report.

system. All these policies can strengthen confidence in investment processes and act as drivers for a sustainable growth.

3. Methodology and data

3.1 Methodology

The selected method of analysis is the OLS method since we want to focus on the most recent data. This deprives us from data quantity and from the choices of applying other research methods, but helps us stay focused on the recent past of the economic crisis' period.

In more detail, we started by collecting 259 Greek government bond rate monthly observations source https://fred.stlouisfed.org/ from 01/06/1997 to 01/12/2018 and 119 quarterly data observations for direct investment in Greece from Eurostat (from 2003Q4 to 2018Q3). The following diagrams, 3.1.a and 3.1.b depict the clear similarity in terms of trending for both variables. More specifically, Direct Investments tended to be more unstable up until the last quarter of 2009. From the year 2010 onwards, there is a sudden increase in both Government bond rate and Direct Investments until the 4th quarter 2012. In Direct Investments we notice a slight temporary increase from the 4th quarter 2012 to 3rd quarter 2013, and after that period a clear decrease in both variables, with the Government bond rate falling more rapidly. Another interesting notion is the fact that when the Government bond rate reaches or stays at 5%, Direct Investments seem to drop to negative values.

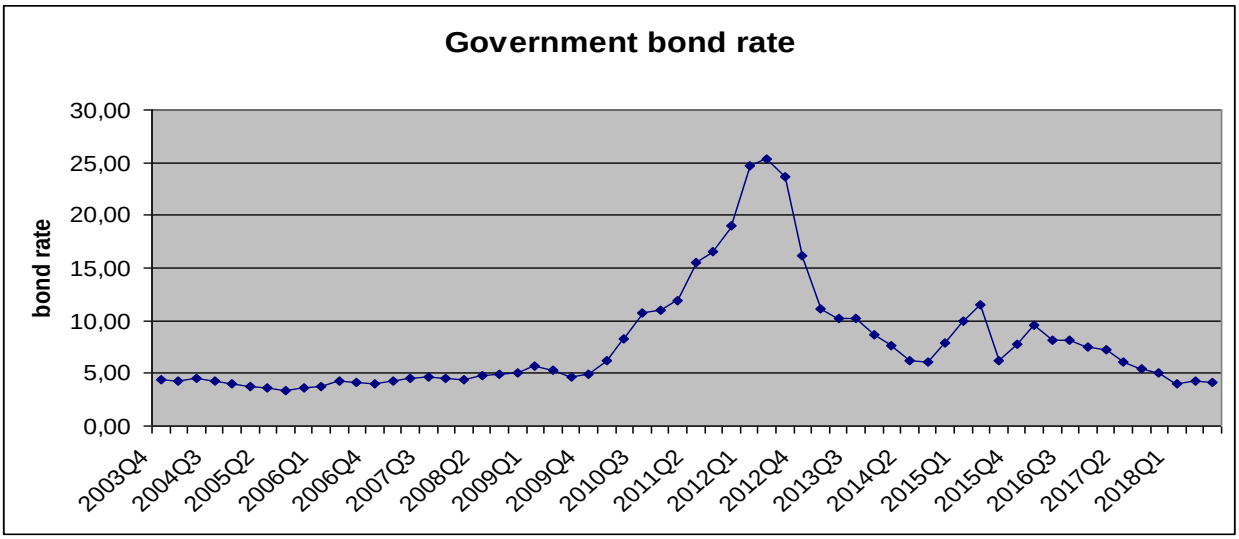


Diagram 3.1(a)

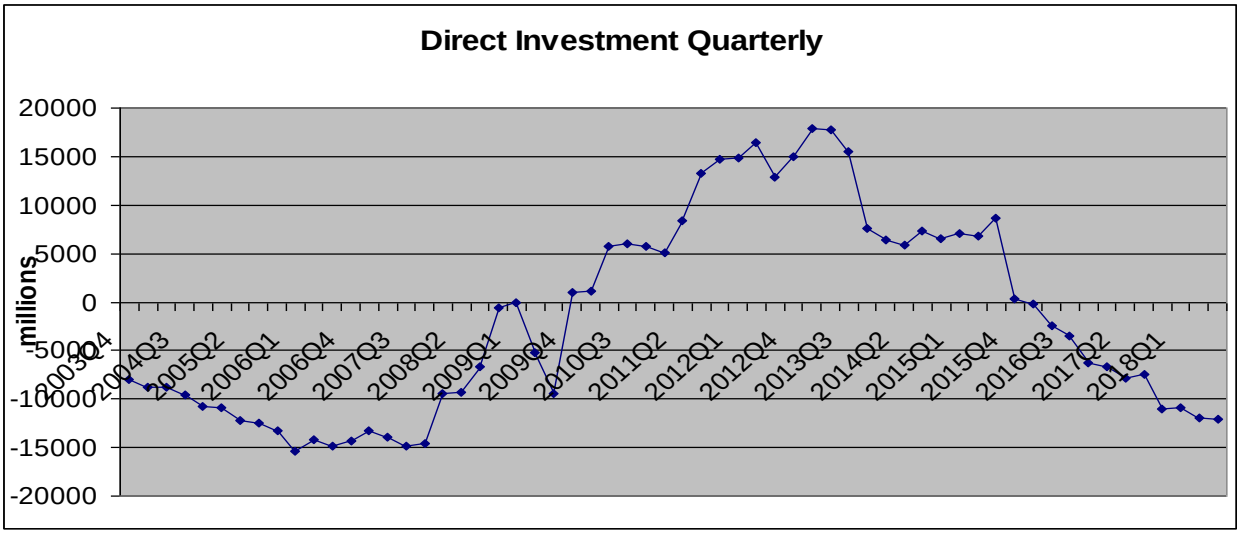


Diagram 3.1(b)

3.2 Data

The data used for Quarterly Direct Investment is derived from Eurostat database as mentioned above (in millions of Euros). According to the functional category of the data, the cross-border financial positions are classified as: 1) For the assets - Direct investment; Portfolio investment; Financial derivatives and employee stock options ; Other investment and Reserve assets. 2) For the liabilities - Direct investment; Portfolio investment; Financial derivatives and employee stock options and other investment. Raw data is 119 observations of Direct Investment. Data transformation is

described further on as far as log 10 differentiation is concerned.

The data for the Greek government bond rates are derived from the Federal Reserve Bank of St. Louis. 259 monthly data was collected, and in the process we had to make them quarterly and finally transform it to log 10 in order to be processed with the Direct Investment data. Thus, we ended with another 25 observations of Greek government bond rates.

The primary data OLS function (not logged) which we attempted to use contained clustering volatility, i.e. a signified pattern in the residuals results. Therefore, we used the 1st difference for each variable to overcome this issue.

1st difference OLS function: ddiq=c+dgbr
where,
diq=direct investment quarterly
gbr=government bond rate

The results are as follows in Table 3.2.a:

Table3.2.a

Dependent Variable: DDIQ
Method: Least Squares
Date: 03/12/19 Time: 11:35
Sample (adjusted): 2004Q1 2018Q3
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-67.59940	385.3169	-0.175438	0.8614
DGBR01	77.39227	205.6075	0.376408	0.7080

R-squared	0.002479	Mean dependent var	-68.08475
Adjusted R-squared	-0.015021	S.D. dependent var	2937.678
S.E. of regression	2959.659	Akaike info criterion	18.85685
Sum squared resid	4.99E+08	Schwarz criterion	18.92727
Log likelihood	-554.2770	Hannan-Quinn criter.	18.88434
F-statistic	0.141683	Durbin-Watson stat	1.912439
Prob(F-statistic)	0.708011		

Therefore our results prior to log transformation of the data is as follows:
ddiq=-67.59+77.39dgbr

Examining the residuals of the above function, we have the following results:

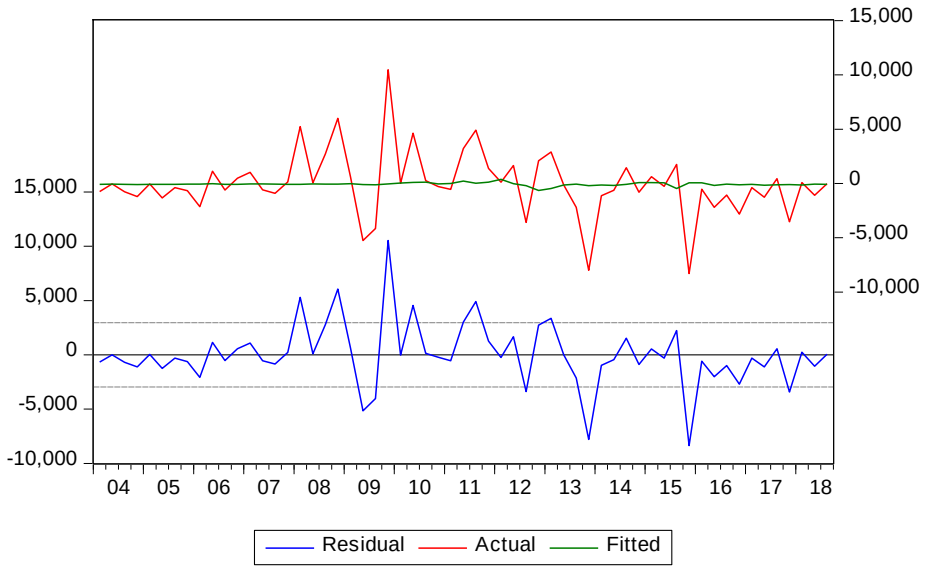


Diagram 3.2.b

Clustering effect is present here. It is clear that periods of low volatility are followed by periods of low volatility and periods of high volatility are followed by periods of high volatility. In order to overcome these issues, since variable diq was in absolute numbers and variable gbr in percentage rates, we had to log 10 the data and include only the positive values of diq variable. That led to having 25 matching up quarterly observations, as seen in the following table of results, that can be directly used in our final analysis.

Table 3.2(c): Log 10 data for OLS estimation

quarter	DIQ	log 10	GBR	log 10
2009Q4	1054	3,022841	4,97	0,70
2010Q1	1073	3,0306	6,24	0,80
2010Q2	5705	3,756256	8,30	0,92
2010Q3	5965	3,77561	10,79	1,03
2010Q4	5686	3,754807	11,03	1,04
2011Q1	5134	3,710456	11,86	1,07
2011Q2	8364	3,922414	15,50	1,19
2011Q3	13284	4,123329	16,61	1,22
2011Q4	14673	4,166519	19,03	1,28
2012Q1	14801	4,170291	24,74	1,39
2012Q2	16452	4,216219	25,40	1,40
2012Q3	12879	4,109882	23,69	1,37
2012Q4	14972	4,17528	16,16	1,21
2013Q1	17878	4,252319	11,14	1,05
2013Q2	17739	4,248929	10,24	1,01
2013Q3	15543	4,191535	10,23	1,01
2013Q4	7563	3,878694	8,60	0,93
2014Q1	6445	3,809223	7,59	0,88
2014Q2	5826	3,76537	6,17	0,79
2014Q3	7278	3,862012	6,03	0,78
2014Q4	6478	3,811441	7,93	0,90
2015Q1	7104	3,851503	9,91	1,00
2015Q2	6849	3,835627	11,46	1,06
2015Q3	8605	3,934751	6,27	0,80
2015Q4	310	2,491362	7,81	0,89

Hence, using the above data, we proceeded in applying our OLS function, the results of which are depicted at Table 3.2.d.

Table 3.2 (d)

Dependent Variable: DIQLOG
Method: Least Squares
Date: 03/25/19 Time: 10:18
Sample: 2009Q4 2015Q4
Included observations: 25

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.566438	0.371109	6.915600	0.0000
GBRLOG	1.232362	0.354157	3.479703	0.0020

R-squared	0.344885	Mean dependent var	3.834691
Adjusted R-squared	0.316402	S.D. dependent var	0.422542
S.E. of regression	0.349358	Akaike info criterion	0.811180
Sum squared resid	2.807175	Schwarz criterion	0.908690
Log likelihood	-8.139750	Hannan-Quinn criter	0.838225
F-statistic	12.10834	Durbin-Watson stat	1.178952
Prob(F-statistic)	0.002026		

Before analyzing our results, first we have to test our residuals from Table 3.2.d for stationarity issues, i.e. to examine whether the mean, variance and auto-covariance do not change over time periods, and the value of covariance between any two time periods depends only on the distance or gap or lag between the two actual periods and not on the actual time at which the covariance is computed.

Since we are using 1st difference data, along with stationarity issues we are obliged to check for any ARCH effects in our residuals. 1st difference data tends to exhibit wide swings, or volatility, suggesting that the variance of the time series data varies over time, or that the variance is *heteroscedastic*. We, therefore, apply a heteroscedasticity test to test for both stationarity and ARCH effect issues. The results are depicted at Table 3.2.e.

Table 3.2 (e)

Heteroskedasticity Test: ARCH

F-statistic	2.838927	Prob. F(1,22)	0.1061
Obs*R-squared	2.743043	Prob. Chi-Square(1)	0.0977

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/25/19 Time: 10:20
Sample (adjusted): 2010Q1 2015Q4
Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.036760	0.070268	0.523142	0.6061
RESID^2(-1)	1.236710	0.733991	1.684911	0.1061

R-squared	0.114293	Mean dependent var	0.110252
Adjusted R-squared	0.074034	S.D. dependent var	0.280476
S.E. of regression	0.269894	Akaike info criterion	0.298081
Sum squared resid	1.602542	Schwarz criterion	0.396252
Log likelihood	-1.576975	Hannan-Quinn criter.	0.324126
F-statistic	2.838927	Durbin-Watson stat	0.939232
Prob(F-statistic)	0.106141		

Since probability of chi square is greater than 5%, our data is stationary, and therefore there is no ARCH effect. The residual results from our OLS function with logged data (25 quarterly observations) show no pattern or clustering volatility.

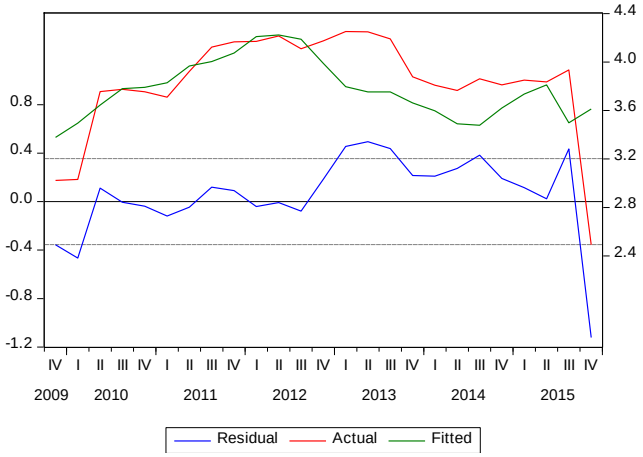


Diagram 3.2.f

4. Empirical results and Conclusions

The former data analysis provided us with the OLS results (t statistics in parentheses):

diqlog=2.566+1.232gbrlog
(6.915) (3.4790)

meaning that, for our 25 data sample, quarterly investments in Greece are positive affected by government bond rates by 1.232. Our t statistics are large enough, therefore we cannot accept the null hypothesis. Our p-values lead also to this decision, since they are 0 for all estimate results, meaning that there is a high probability that our t-statistics can be greater than those observed, and therefore, we can reject the null hypothesis (here, that our sample population of 25 estimates correspond to the true estimates in total) with greater confidence.

Overall, the 1.232 coefficient shows that government bond rates seem to highly affect quarterly investment inflows. Apart from that, the fact that the function's residuals (Diagram 3.2.f) show no noticeable patterns can help at least derive some results about autocorrelation and heteroscedasticity issues. Since the probability of chi square is greater than 5%, our data is stationary, and therefore there is no ARCH effect whatsoever. So, we can safely say that, for our sample, there is a positive relationship between quarterly investments and government bond rates' fluctuations in the case of Greek economy, for the period 2009-2015 (quarterly based). Major macroeconomic coefficients can be included in a future similar statistical model as independent variables, namely GDP growth, level of taxation, technological shift. These main factors tend to crucially affect investment behavior in any economically advanced country.

The fact that there has not been an empirical thorough examination of the causality between investments and Greek government bonds' rates provides us with many opportunities for future similar research. Finding data in similar form that can be compared was a test for this research, since bond rates in percentage values cannot be directly examined with money-based data for investment. The log transformation and the differentiation for statistical purposes detract from the total of our data. Therefore, bigger

datasets counting more past values will be significantly helpful, in order to safely project future values of the variables. Finally, since there seems to be a slightly positive shift from the economic crisis in terms of investment, it will be interesting to examine how much this recession affected the Greek economy, and if there is a way to statistically examine any possibility of learning from the recent past.

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