

Asymmetries and Spillover Effects in the Greek Real Estate Equity Market

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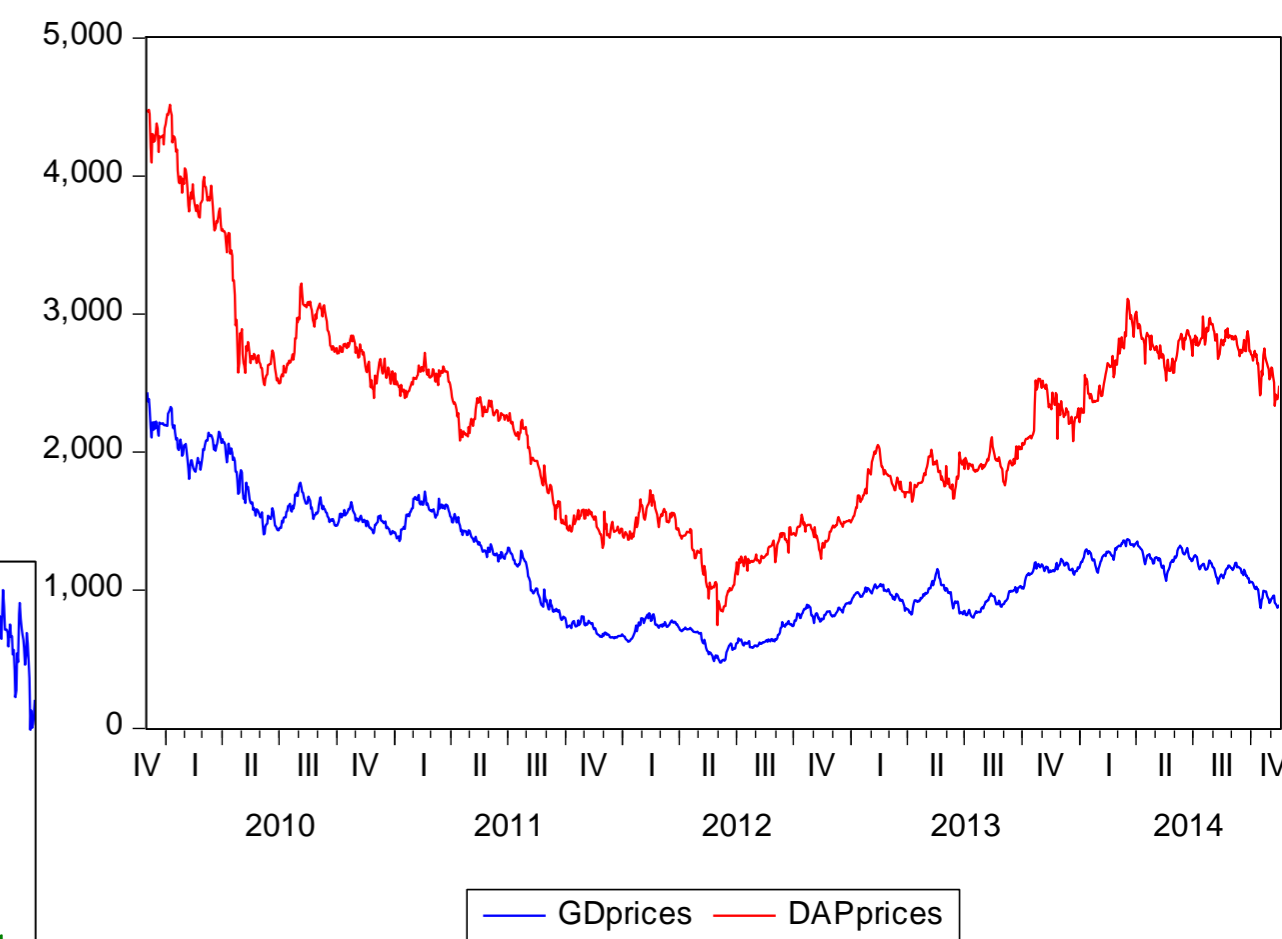
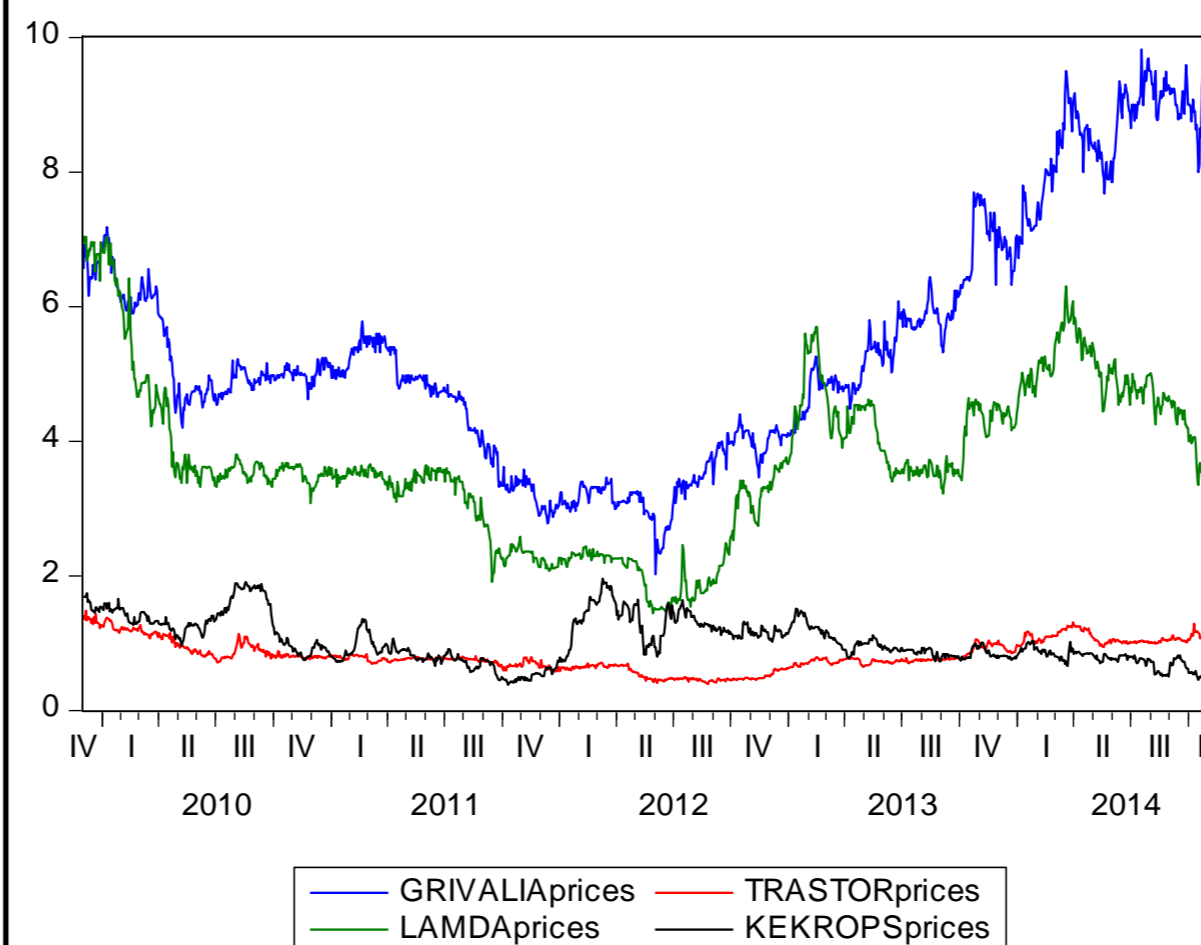


1. Data

December 2009* - November 2014
1294 observations (daily data)

- **General Index - GD**
- **Greek Real Estate Index - DAP** (FTSE/ATHEX Real Estate)

*The Greek real estate index, first launched in December 2009.



DAP Constituents:

- I. Grivalia Properties REIC (former Eurobank Properties REIC)
- II. Trastor REIC
- III. Lamda Development
- IV. Kekrops

2. Main questions

- Which **GARCH** model better describes the **Greek real estate index returns & volatility** ?
- Are there any **asymmetries**?
- Are there any **return and volatility linkages** between the Greek real estate index and the general index, as well as, between each REIT and its **parent bank**?

3. GARCH Models & Results

• **Mean equation:** $x_t = \beta_0 + \beta_1 x_{t-1} + \beta_2 GD_t + u_t$ $+ \beta_3 Mon + \beta_4 Tue + \beta_5 Wen + \beta_6 Fri$

• **Variance equation:**

GARCH (Bollerslev, 1986):

$$h_t = a_0 + a_1 h_{t-1} + a_2 u_{t-1}^2 + a_3 GD_t + a_4 Mon + a_5 Tue + a_6 Wen + a_7 Fri$$

GJR-GARCH(1,1)(Glosten, Jagannathan and Runkle, 1993):

$$h_t = a_0 + a_1 u_{t-1}^2 + a_2 u_{t-1}^2 d_{t-1} + a_3 h_{t-1} + a_4 GD_t + a_5 Mon + a_6 Tue + a_7 Wen + a_8 Fri$$

EGARCH(1,1) (Nelson, 1991):

$$\log(h_t) = a_0 + a_1 \frac{u_{t-1}}{\sqrt{h_{t-1}}} + a_2 \frac{u_{t-1}^2}{\sqrt{h_{t-1}}} + a_3 \log(h_{t-1}) + a_4 GD_t + a_5 Mon + a_6 Tue + a_7 Wen + a_8 Fri$$

- **Asymmetries** are present in Grivalia and Kekrops, where negative shocks (news) have greater impact on the conditional variance than positive shocks.

- EGARCH(2,1) model also seems to have the best fit for the Greek real estate index (DAP) when we include "day of the week" dummy variables.

- All the other time series representations are more explanatory with the GARCH process.

- **No significant impact of the day of the week effect.**

- The general index (**GD**) has a **positive impact** on the Greek real estate index mean and slightly positive on the variance equation.

- All of the index constituents' mean equations are influenced positively (Kekrops has the greatest impact & Grivalia the smallest).

- In terms of variance the general index has a positive impact only on Kekrops. The most negative effect was reported on Grivalia's variance.

4. Multivariate GARCH Model & Results

Multivariate GARCH modelling (BEKK) (Engle and Kroner, 1995)

The diagonal elements in matrix A: capture the own ARCH effect

Matrix A off-diagonal elements: cross market effects such as shocks

$$H_t = CC' + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}'$$

cross market effects such as volatility spillovers

own GARCH effect

Conditional covariances

$$h_{11,t} = c_{11}^2 + a_{11}^2 \varepsilon_{1,t-1}^2 + 2a_{11}a_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + a_{21}^2 \varepsilon_{2,t-1}^2 + b_{11}^2 h_{11,t-1} + 2b_{11}b_{21}h_{21,t-1} + b_{21}^2 h_{22,t-1}$$

$$h_{22,t} = c_{21}^2 c_{22}^2 + a_{12}^2 \varepsilon_{1,t-1}^2 + 2a_{12}a_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + a_{22}^2 \varepsilon_{2,t-1}^2 + b_{12}^2 h_{11,t-1} + 2b_{12}b_{22}h_{21,t-1} + b_{22}^2 h_{22,t-1}$$

$$h_{12,t} = c_{11}c_{22} + a_{11}a_{12}\varepsilon_{1,t-1}^2 + (a_{21}a_{12} + a_{11}a_{22})\varepsilon_{1,t-1}\varepsilon_{2,t-1} + a_{21}a_{22}\varepsilon_{2,t-1}^2 + b_{11}b_{12}h_{11,t-1} + (b_{21}b_{12} + b_{11}b_{22})h_{12,t-1} + b_{21}b_{22}h_{22,t-1}$$

Own effects Cross market effects

BEKK GARCH(1,1)

Variance-Covariance equation

Variable	GD-DAP		Trastor-Piraeus bank		Grivalia-Eurobank	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistic
c ₁₁	0.0051*	4.3353	0.0048*	5.1564	0.0183*	12.703
b ₁₁	0.9422*	44.210	0.9697*	135.46	0.5030*	5.8652
b ₂₁	0.0093	0.2634	-0.0077	-1.5335	-0.0141	-1.3637
a ₁₁	0.2469*	6.4131	0.2162*	8.7756	0.5269*	9.0917
a ₂₁	-0.0176	-0.4936	0.0084	0.6843	0.0518*	4.0741
c ₂₁	0.0114*	8.3516	0.0153*	5.1162	0.0154*	7.4357
c ₂₂	0.0051	1.4447	0.0117*	2.4695	0.0001	0.0229
b ₁₂	0.0892*	1.9600	0.0059	0.2049	0.1291	0.8765
b ₂₂	0.6799*	12.8984	0.8475*	39.647	0.9042*	71.243
a ₁₂	-0.0701	-1.3307	-0.0879	-1.3149	-0.1302	-1.3644
a ₂₂	0.4654*	9.3330	0.4442*	10.477	0.3597*	11.027
Loglikelihood		6494.36		4868.78		4952.04
Avg. log likelihood		5.0344		3.7742		3.8388
Schwarz criterion		-9.9688		-7.4485		-7.5776

Notes: * indicates significance at the 5 percent level or higher

- Unidirectional slightly positive **volatility linkage** running from the general index to the real estate index.
- Slightly positive unidirectional **shock** transmission running from Eurobank to Grivalia.
- No volatility spillover between the two Greek REITs and their parent banks.

5. Summary

- The Athens stock exchange general index has a significant impact on real estate stock returns.
- No significant impact in respect of the day of the week effect.
- The asymmetry of the volatility response to news seems to be present.
- There is evidence of unidirectional slightly positive volatility linkage running from the general index to the real estate index and slightly positive unidirectional shock transmission running from Eurobank to Grivalia.
- There is not any volatility spillover between the two Greek REITs and their parent banks.