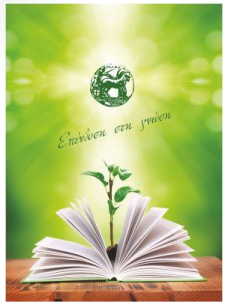

PhD research seminars
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ΤΜΗΜΑ ΟΙΚΟΝΟΜΙΚΩΝ ΕΠΙΣΤΗΜΩΝ
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ

Determinants of stock-bond market comovement in the Eurozone under model uncertainty

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Introduction

- Understanding time-variations in stock-bond return comovement is a fundamental question in financial economics.
- One of the most prominent issues within this stream of literature is related to exploring economic forces driving the time-varying stock-bond comovement.
- Stock and bond returns comove because the same economic factors are expected to influence their future cash flows and discount rates.
- This study investigates the dynamics of the stock-bond correlations in the Eurozone countries and attempts to indentify the economic factors driving their time-series behavior.

Background – Motivation (1)

- It is widely recognized that correlations between stock and bond returns do not remain constant over time.
- Kim at al. (2006) find that stock-bond correlations in most European countries, US and Japan have trended to zero and even negative since the mid 1990s.
- The evidence in the literature on what determines the time variation in stock-bond comovement is mixed.
- Using a long dataset for both the US and the UK, Yang et al. (2009) provide evidence on the prominent role of macroeconomic conditions including the business cycle, the inflation environment and the monetary policy stance on the stock-bond comovement.

Background – Motivation (2)

- Another strand of literature provides contradictory evidence on the importance of the macroeconomic factors on cross-asset comovement.
- Baele et al. (2010) use data for the US market and find that macroeconomic fundamentals play a minor role in explaining the stock-bond relationship.
- Apart from the macroeconomic variables, another important driver of the stock-bond comovement is the stock market uncertainty (e.g. Connolly et al. 2005, 2007).
- Most relevant studies investigate the drivers of the comovement between the two asset classes for the US or the major developed markets and only a limited number of studies examine the case of European or emerging markets.

Main research question

What are the economic factors that drive the dynamics of the stock-bond correlations in the Eurozone countries?

Main contributions

- The fact that there is no consensus in the existing literature on the determinants of the stock-bond relationship could indicate a high degree of uncertainty about the “true” empirical model.
- To our knowledge this is the first study to use a Bayesian model selection technique to examine the driving forces of stock-bond comovements.
- By focusing on the Eurozone countries after the monetary union we provide important information for selecting the optimal monetary policy in a national and EU level and shed more light on the divergent macro-finance behavior of Eurozone countries.
- By including a large crisis period in our sample enables us to examine the effect of financial crises on the dynamics of the stock-bond relationship.

Data

- A sample of eleven Euro-zone countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain).
- We use a combination of daily stock and bond returns and quarterly macroeconomic and financial variables.
- Sample period: from the second quarter of 1999 until the second quarter of 2016 including 4501 daily and 69 quarterly observations.
  - Non-crisis sample: 1999q2 – 2007q2
  - Crisis sample: 2007q3 – 2016q2
- Daily stock and bond returns are calculated based on the total return stock market indices and the 10-year benchmark bond market indices collected from Datastream.

Descriptive statistics of stock and bond market returns and realized correlations

		Whole sample		Pre-crisis period		Crisis period	
		Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Austria	Bond returns	0.010%	0.337%	0.000%	0.304%	0.020%	0.364%
	Stock returns	0.010%	1.160%	0.057%	0.743%	-0.033%	1.439%
	Correlations	-0.176	0.214	-0.088	0.174	-0.257	0.217
Belgium	Bond returns	0.010%	0.357%	0.000%	0.303%	0.019%	0.401%
	Stock returns	0.012%	1.172%	0.019%	0.988%	0.004%	1.319%
	Correlations	-0.132	0.259	-0.147	0.265	-0.119	0.257
Finland	Bond returns	0.008%	0.327%	-0.002%	0.291%	0.018%	0.356%
	Stock returns	0.002%	1.898%	0.023%	2.213%	-0.017%	1.553%
	Correlations	-0.282	0.224	-0.214	0.206	-0.343	0.226
France	Bond returns	0.010%	0.354%	-0.001%	0.333%	0.021%	0.371%
	Stock returns	0.007%	1.316%	0.025%	1.227%	-0.009%	1.393%
	Correlations	-0.252	0.256	-0.227	0.252	-0.275	0.261
Germany	Bond returns	0.010%	0.350%	-0.002%	0.306%	0.021%	0.386%
	Stock returns	0.007%	1.266%	0.017%	1.184%	-0.002%	1.336%
	Correlations	-0.316	0.269	-0.197	0.260	-0.425	0.230
Greece	Bond returns	-0.009%	1.642%	0.005%	0.292%	-0.021%	2.256%
	Stock returns	-0.061%	1.969%	0.012%	1.401%	-0.127%	2.371%
	Correlations	0.089	0.316	-0.083	0.199	0.246	0.324
Ireland	Bond returns	0.008%	0.512%	-0.001%	0.313%	0.016%	0.642%
	Stock returns	0.003%	1.357%	0.023%	1.053%	-0.016%	1.586%
	Correlations	-0.057	0.241	-0.153	0.163	0.031	0.269
Italy	Bond returns	0.009%	0.443%	0.000%	0.290%	0.017%	0.547%
	Stock returns	-0.011%	1.375%	0.012%	1.091%	-0.032%	1.591%
	Correlations	0.027	0.402	-0.183	0.258	0.219	0.417
Netherlands	Bond returns	0.010%	0.336%	0.000%	0.304%	0.020%	0.363%
	Stock returns	0.000%	1.300%	0.010%	1.203%	-0.009%	1.383%
	Correlations	-0.298	0.241	-0.239	0.249	-0.351	0.223
Portugal	Bond returns	0.007%	0.722%	0.001%	0.341%	0.012%	0.944%
	Stock returns	-0.013%	1.128%	0.019%	0.779%	-0.043%	1.372%
	Correlations	0.038	0.329	-0.118	0.200	0.181	0.360
Spain	Bond returns	0.010%	0.452%	0.002%	0.300%	0.017%	0.555%
	Stock returns	0.001%	1.345%	0.026%	1.105%	-0.022%	1.532%
	Correlations	-0.003	0.382	-0.176	0.259	0.156	0.409

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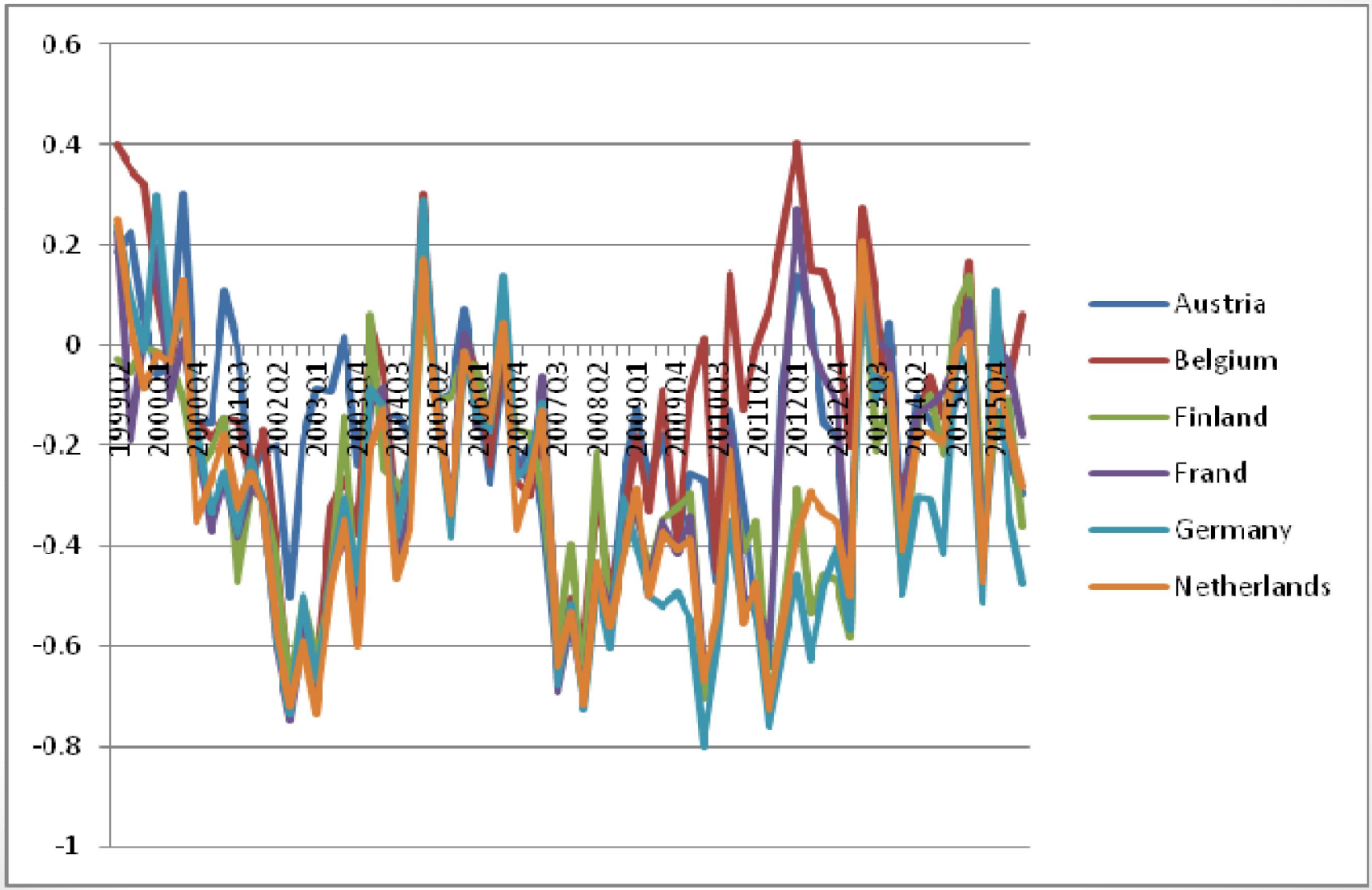
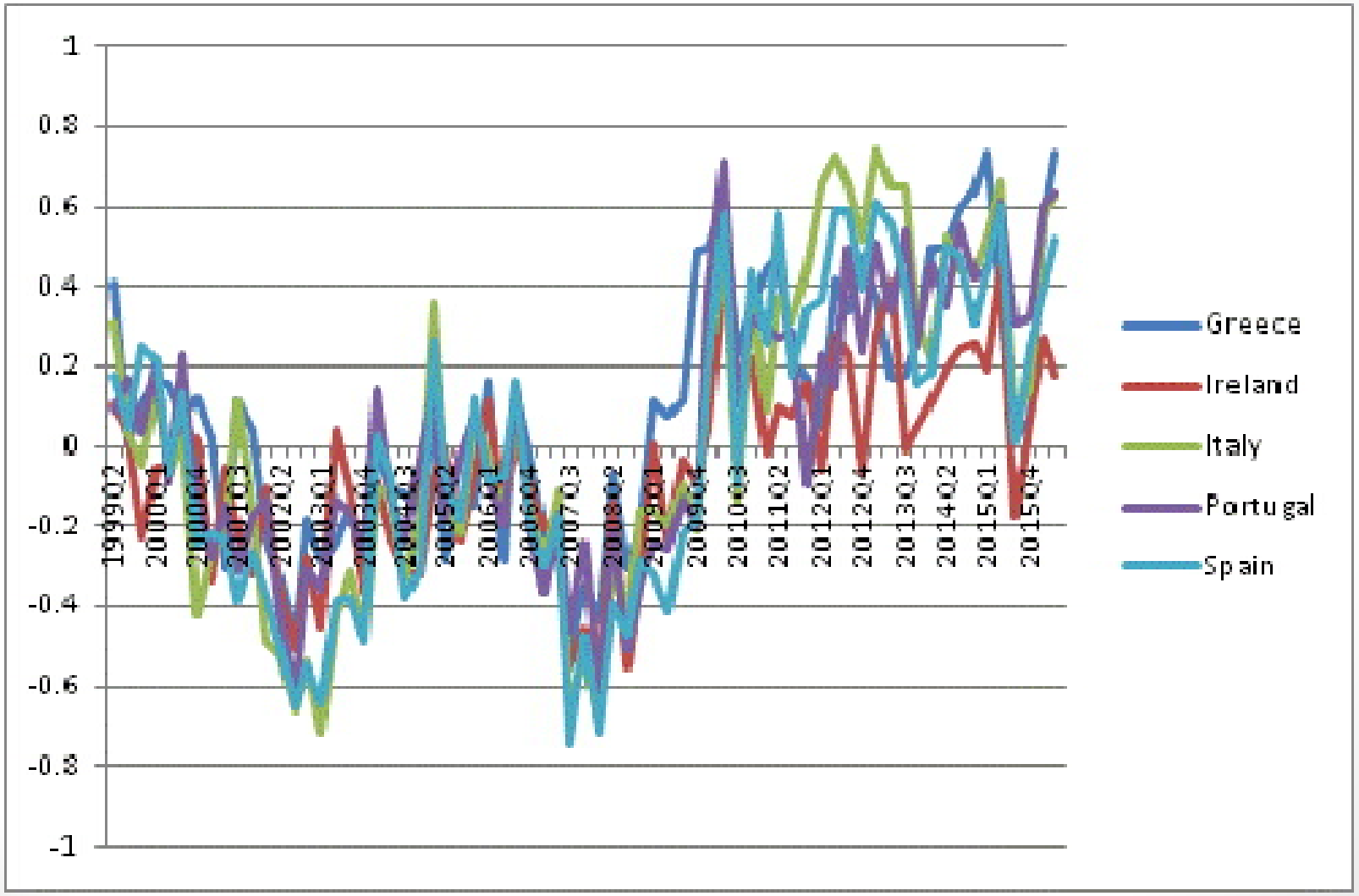
Stock-bond correlations in the core Eurozone countries



Stock-bond correlations in the peripheral Eurozone countries



Economic factors

- Inflation
- Term spread
- Short interest rate
- Real GDP growth
- Output gap
- Unemployment rate
- Composite leading indicator
- Consumer confidence indicator
- Trade
- VIX
- VSTOXX
- Monetary policy convergence
- Real economic convergence
- Stock market volatility
- Bond market volatility

Methodology - Background

- The lack of consensus in the existing literature about the key determinants of stock-bond correlations (and the appropriate model specification) indicate a high degree of uncertainty about the "true empirical model".
- A stream of the literature (Kim et al., 2006, Panchenco and Wu, 2009, Perego and Vermeulen, 2016) have used low-frequency data and panel regression techniques to explore the predictive power of macroeconomics fundamentals for the stock-bond comovement.
- Recent studies combine high-frequency asset market returns with low-frequency macroeconomic fundamentals exploiting the MIDAS-DCC econometric framework (e.g. Asgharian et al., 2015a, Conrad and Loch, 2016).

Advantages of BMA methodology

- A formal statistical framework that allows us to deal with both model and parameter uncertainty is Bayesian Model Averaging (BMA).
- BMA takes the model uncertainty explicitly into account, by analyzing the entire model space.
- Moreover, it helps to identify the regressors that are most likely to influence the dependent variable by estimating the posterior probability of each model (i.e. the probability that a given model specification fits the data the best).
- In a classical linear regression framework, by contrast, the results are based on just one or a small number of models and only a small set of explanatory variables is included.
- Testing the full model (i.e. including all the potential regressors) in such a framework may lead to the false rejection of variables due to the multi-collinearity issue and the fact that parameter estimates are not robust to alternative model specifications.

Description of BMA methodology (1)

- Consider a set of possible linear regression models, where model M_j, regresses the dependent variable, y, on a number of explanatory variables, k_j, chosen from a set of k variables

$$y = \alpha \iota_n + X_j \beta_j + \sigma \varepsilon$$

- Two prior distributions need to be specified
  - the prior of the parameter distribution given a specific individual model – uninformative priors for the parameters that are common to all models (α and σ) and a g-prior structure for β_j
  - the prior of inclusion of each explanatory variable in an individual model – a uniform distribution ($p_j = 2^{-k}$) implying a 50% a-priori probability of inclusion for a potential candidate variable
- Probability of inclusion of a specific regressor:

$$P_{\Delta/y} = \sum_{j=1}^{2^k} P_{\Delta/y,\mathrm{M}_j} P\left(M_j/y\right)$$

Description of BMA methodology (2)

- Regression coefficient: weighted average of all coefficients estimated for specific models and using the respective model probabilities as weights.
- Due to the very large number of possible models (2^k possible models for k candidate independent variables) it is infeasible to estimate the entire model space.
- We search the model space approximately by applying the MC^3 Sampler (Markov Chain Monte Carlo Model Composition) of Madigan and York (1995) as commonly done in the BMA literature.

Estimation issues

- Our dependent variable, stock-bond correlation, is measured as the inverse Fisher transformation of realized correlation between daily stock and bond market returns over a quarter.
- We run BMA regressions with lagged independent variables following similar studies (Li, 2002, Perego and Vermeulen, 2016) and allowing for our model to be used for forecasting purposes.
- By including country dummies to exploit the panel structure of the data, our estimations are consistent with that of a country fixed effects panel estimation in a classical regression framework.

BMA estimation results for the whole sample period

	Probability of inclusion	Effect
Bond market volatility	1.000	Positive
VIX	1.000	Negative
Inflation	1.000	Negative
Short interest rate	0.939	Positive
Output gap	0.795	Negative
Term Spread	0.531	Negative
Consumer confidence indicator	0.373	Positive
Composite leading indicator	0.240	Positive
Monetary policy convergence	0.145	Positive
Stock market volatility	0.098	Negative
Unemployment rate	0.096	Negative
Real economic convergence	0.085	Positive
Real GDP growth	0.064	Positive
VSTOXX	0.060	Positive
Trade	0.031	Positive

Note: This table presents marginal posterior probabilities and the sign of the effect from the BMA estimation for the whole period i.e. from the third quarter of 1999 until the second quarter of 2016.

BMA estimation results for the whole sample period

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Bond market volatility	1.000	Positive
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BMA estimation results for crisis and non-crisis periods

	Non crisis sample		Crisis sample	
	Probability of inclusion	Effect	Probability of inclusion	Effect
Stock market volatility	1.000	Negative	0.101	Positive
Unemployment rate	1.000	Negative	0.555	Negative
Bond market volatility	0.970	Positive	1.000	Positive
Short interest rate	0.624	Positive	0.368	Positive
Term spread	0.396	Negative	0.275	Negative
Trade	0.232	Positive	0.055	Positive
Real GDP growth	0.205	Positive	0.644	Positive
VSTOXX	0.199	Negative	0.156	Positive
Composite leading indicator	0.121	Negative	0.067	Positive
VIX	0.119	Positive	1.000	Negative
Consumer confidence indicator	0.092	Positive	0.064	Positive
Output gap	0.077	Positive	1.000	Negative
Monetary policy convergence	0.055	Negative	0.093	Negative
Real economic convergence	0.024	Positive	0.093	Negative
Inflation	0.005	Positive	1.000	Negative

Note: This table presents marginal posterior probabilities and the sign of the effect from the BMA estimations for the non-crisis period i.e. from the second quarter of 1999 until the second quarter of 2007 and the crisis period i.e. from the third quarter of 2007 until the second quarter of 2016.

BMA estimation results for crisis and non-crisis periods

	Non crisis sample		Crisis sample	
	Probability of inclusion	Effect	Probability of inclusion	Effect
Stock market volatility	1.000	Negative	0.101	Positive
Unemployment rate	1.000	Negative	0.555	Negative
Bond market volatility	0.970	Positive	1.000	Positive
Short interest rate	0.624	Positive	0.368	Positive
Term spread	0.396	Negative	0.275	Negative
Trade	0.232	Positive	0.055	Positive
Real GDP growth	0.205	Positive	0.644	Positive
VSTOXX	0.199	Negative	0.156	Positive
Composite leading indicator	0.121	Negative	0.067	Positive
VIX	0.119	Positive	1.000	Negative
Consumer confidence indicator	0.092	Positive	0.064	Positive
Output gap	0.077	Positive	1.000	Negative
Monetary policy convergence	0.055	Negative	0.093	Negative
Real economic convergence	0.024	Positive	0.093	Negative
Inflation	0.005	Positive	1.000	Negative

Note: This table presents marginal posterior probabilities and the sign of the effect from the BMA estimations for the non-crisis period i.e. from the second quarter of 1999 until the second quarter of 2007 and the crisis period i.e. from the third quarter of 2007 until the second quarter of 2016.

BMA estimation results for core and peripheral EU countries

	Core EU countries		Peripheral EU countries	
	Probability of inclusion	Effect	Probability of inclusion	Effect
Stock market volatility	0.999	Negative	0.502	Positive
Bond market volatility	0.993	Positive	1.000	Positive
Term spread	0.395	Negative	0.319	Negative
VIX	0.359	Negative	0.994	Negative
Output gap	0.300	Negative	0.256	Negative
Real GDP growth	0.237	Positive	0.027	Negative
Monetary policy convergence	0.207	Negative	0.114	Positive
Inflation	0.192	Negative	1.000	Negative
Real economic convergence	0.190	Negative	0.084	Positive
Consumer confidence indicator	0.165	Positive	0.127	Positive
VSTOXX	0.109	Negative	0.043	Negative
Composite leading indicator	0.096	Positive	0.851	Positive
Unemployment rate	0.057	Negative	0.132	Negative
Short interest rate	0.056	Positive	0.638	Positive
Trade	0.027	Positive	0.173	Positive

Note: This table presents marginal posterior probabilities and the sign of the effect from BMA estimations for the core EU countries (Austria, Belgium, Finland, France, Germany and Netherlands) and the peripheral EU counties (Greece, Italy, Ireland, Portugal, Spain) for the whole sample period i.e. from the second quarter of 1999 until the second quarter of 2016.

BMA estimation results for core and peripheral EU countries

	Core EU countries		Peripheral EU countries	
	Probability of inclusion	Effect	Probability of inclusion	Effect
Stock market volatility	0.999	Negative	0.502	Positive
Bond market volatility	0.993	Positive	1.000	Positive
Term spread	0.395	Negative	0.319	Negative
VIX	0.359	Negative	0.994	Negative
Output gap	0.300	Negative	0.256	Negative
Real GDP growth	0.237	Positive	0.027	Negative
Monetary policy convergence	0.207	Negative	0.114	Positive
Inflation	0.192	Negative	1.000	Negative
Real economic convergence	0.190	Negative	0.084	Positive
Consumer confidence indicator	0.165	Positive	0.127	Positive
VSTOXX	0.109	Negative	0.043	Negative
Composite leading indicator	0.096	Positive	0.851	Positive
Unemployment rate	0.057	Negative	0.132	Negative
Short interest rate	0.056	Positive	0.638	Positive
Trade	0.027	Positive	0.173	Positive

Note: This table presents marginal posterior probabilities and the sign of the effect from BMA estimations for the core EU countries (Austria, Belgium, Finland, France, Germany and Netherlands) and the peripheral EU counties (Greece, Italy, Ireland, Portugal, Spain) for the whole sample period i.e. from the second quarter of 1999 until the second quarter of 2016.

Robustness checks

- We test the robustness of our results to alternative methods for estimating asset correlations by employing the time-varying DCC method proposed by Engle (2002).
- The results of the BMA regression using DCC stock-bond correlations as a dependent variable do not differ significantly from the main results using realized stock-bond correlations
- Official forecasts of the European Commission for real GDP growth and inflation are added as dependent variables in the BMA regression.
- Consistent with our previous findings inflation forecast as well as current inflation are important drivers with a negative effect on stock-bond comovement while the probability of inclusion of real GDP growth level and forecast are lower than 0.5.

Conclusions

- Stock-bond market comovement in European countries has changed considerably over time and exhibits a substantial increase especially in the case of peripheral Eurozone countries following the spreading of the financial turnoil and the recent sovereign debt crisis.
- Domestic bond market uncertainty appears to be the key determinant during both normal and turbulent periods and for both core and peripheral Eurozone countries.
- The effect of the domestic stock market uncertainty on the stock-bond relationship is evident only during normal periods and it appears to be substituted by the effect of global stock market uncertainty during the crisis periods.
- Different patterns on the impact of macro-finance drivers on stock-bond comovement are revealed when examining separately the core and peripheral EU countries.
- These findings have important implications for both investors and policy makers.

THANK YOU!

Description of variables and data sources

Variable	Description	Source
Inflation	log difference of end of quarter harmonized consumer price index (HCPI)	Eurostat
Term spread	first difference in yield spread between the 10 year benchmark bond yield and the three month London interbank offer rate (LIBOR)	Datastream
Short interest rate	first difference of end-of-quarter three-month LIBOR	Datastream
Real GDP growth	log difference of quarterly seasonally adjusted real gross domestic product (GDP)	Eurostat
Output gap	the percentage difference between real GDP and its quadratic trend	Eurostat
Unemployment rate	first difference in quarterly unemployment rate	Eurostat
Composite leading indicator	log difference of end of quarter consumer leading indicator (CLI)	OECD
Consumer confidence indicator	log difference of end of quarter consumer confidence indicator (CCI)	OECD
VIX	(logarithm of) end-of-quarter VIX	CBOE
VSTOXX	(logarithm of) end-of-quarter VSTOXX	STOXX
Trade	first difference of (imports+exports) as a percentage of GDP	Eurostat
Monetary policy convergence	correlation of monthly HCPI inflation with Eurozone average over a quarter	Eurostat
Real economic convergence	correlation of monthly industrial production with Eurozone average over a quarter	Eurostat
Stock market volatility	log of quarterly sum of daily squared stock returns	Datastream
Bond market volatility	log of quarterly sum of daily squared bond returns	Datastream

Note: This table presents a list of the explanatory variables used in BMA panel estimation, a brief description and data sources.

BMA estimation results with DCC correlations

	Probability of inclusion	Effect
Bond market volatility	1.000	Positive
Inflation	1.000	Negative
Output gap	0.958	Negative
Short interest rate	0.928	Positive
VIX	0.917	Negative
Stock market volatility	0.670	Negative
Unemployment rate	0.536	Negative
Composite leading indicator	0.440	Positive
Consumer confidence indicator	0.321	Positive
Term spread	0.139	Negative
VSTOXX	0.092	Negative
Monetary policy convergence	0.084	Positive
Trade	0.082	Positive
Real economic convergence	0.062	Positive
Real GDP growth	0.065	Positive

Note: This table presents marginal posterior probabilities and the sign of the effect from BMA estimation with DCC stock-bond correlations as the dependent variable for the whole period i.e. from the third quarter of 1999 until the second quarter of 2016.

BMA estimation results including EC forecasts

	Probability of inclusion	Effect
Bond market volatility	1.000	Positive
Inflation forecast	1.000	Negative
VIX	0.924	Negative
Stock market volatility	0.752	Negative
Inflation	0.714	Negative
Term spread	0.640	Negative
Short interest rate	0.473	Positive
Unemployment	0.215	Negative
VSTOXX	0.126	Negative
Real GDP growth	0.069	Positive
Consumer confidence indicator	0.063	Positive
Composite leading indicator	0.054	Positive
Monetary policy convergence	0.046	Positive
Real GDP growth forecast	0.042	Positive
Output gap	0.053	Negative
Trade	0.025	Positive
Real economic convergence	0.024	Positive

Note: This table presents marginal posterior probabilities and the sign of the effect from BMA estimation including European Commission's forecasts for the whole period i.e. from the third quarter of 1999 until the second quarter of 2016.