

Spatio-temporal analysis of dependence between government bond yield in the world

Summary

The government bond yields reflect the country's economic and financial standing. The events that have taken place on the global financial market have provided evidence for the thesis that operating in close proximity can be a factor that intensifies the strength of mutual interactions between markets. However, the empirical analyses carried out to date have mainly non-spatial character, while the objects that co-create the global financial market should be treated as a system of interdependencies. These arguments were the main motivation to undertake research in this field of the work.

The general objective of the work was to examine the dependence between yield to maturity of ten-year government bonds, considering the location of issuing countries. The location of the objects analysed was understood in a twofold way. On the one hand, their location in the geographical space was taken into account, and on the other, it was an economic space, defined on the basis of established economic characteristics of the considered economies. A broad spectrum of analyses was ensured, in particular, by the diversity of distance measures used to quantify the proximity between the markets under consideration. The following specific objectives were also formulated:

- 1) identifying and measuring the dependence between the government bond yields in the world, taking into account the location of their markets;
- 2) assessing the impact of selected factors on the yield of government bonds under various circumstances (e.g. EU membership, before/after the subprime crisis);
- 3) verifying the significance of selected spatial channels of dependence between the government bonds' yield in selected countries in mutual market interactions;
- 4) construction of spatial and spatio-temporal econometric models describing changes in the government bond markets, depending on changes in the 'neighbouring' markets and established economic variables.

The following main research hypothesis was subjected to verification:

The relative location of markets in space affects the strength of dependence between government bonds' yield.

and three detailed hypotheses:

1. Apart from fundamental factors, the changes in the valuation of 10-year Treasury bonds in the period of 2008-2017 were influenced by the existence of spatial relations between the markets.
2. The economic distance is more important than the geographical (physical) distance as regards the dependence between the yield of government bonds.
3. Spatial dependence between the government bond yields are stronger in the conditions of financial crises than in the periods of no significant turbulence.

The work consists of an introduction, five chapters (the first three chapters are theoretical, including the last of the three – methodological, whereas the two subsequent chapters refer to empirical analyses), conclusion, list of tables and drawings, and bibliography.

The first chapter defines debt instruments, while focusing attention on the characteristics of bonds. Reference is made to the theory that explains the term structure of interest rates, and the factors affecting the government bonds yield are defined.

The bonds are considered in a broader spectrum of analyses in chapter two. The aim of government bond issuance has been defined as financing the budget deficit, while making a reference to the relationship between the deficit and public debt. A synthetic presentation of the evolution of the global debt problem has been made, while stressing that it is still a current problem. The costs of debt servicing have been discussed, together with possible solutions with respect to the situation when a country is unable to pay its liabilities in a timely manner. A particular attention has been paid to the risk associated with investing in bonds. In this chapter a reference has also been made to financial market integration processes, with particular emphasis on its relation to convergence processes in terms of its measurement and the contagion phenomenon, which is more likely to occur in an integrated environment.

Chapter three is methodological and relates to econometric modelling of spatial dependence in the context of analysing the dependence between the yields of government bonds in the world. Spatial aspects of shaping economic phenomena with particular reference to financial markets have been pointed out. The methods of

quantifying space with the use of matrices of neighborhood and distances with reference to their applications in the analysis of relations between government bond markets have been discussed. The concept of spatial autocorrelation is referred to and the methods of including it in the description of the spatial process structure are discussed. The chapter presents various possible variants of specification of spatial and spatio-temporal models. Special attention has been paid to spatial panel data models. The chapter concludes with comments on methods of estimation and verification of econometric spatial models.

Chapter four presents an empirical analysis of the dependence between the yields of government bonds in the world in spatial terms for particular years of the period under consideration. The consideration is commenced with a preliminary analysis of the data. Next, the results of estimation and verification of different cross-sectional data models are presented. Empirical analyses presented in each of the sub-chapters had been carried out with the use of various connectivity matrices.

Chapter five presents analyses made with the use of spatial panel data models. Three different scopes of the research have been considered: for the whole sample of 40 countries under consideration, for specific sub-periods (2008–2012 and 2013–2017) and two spatial regimes (selected EU countries and selected developing countries).

In the conclusion, the results of the conducted research are summarized, in particular with reference to the achieved objectives, as well as the results with regard to the verification of research hypotheses. Conclusions drawn at each stage of the study led to a general conclusion that corroborated the main research hypothesis. The obtained results, despite being sensitive to the applied method, in general also confirmed the validity of the first detailed hypothesis stating that *apart from fundamental factors, changes in the valuation of 10-year government bonds in the period 2008–2017 were influenced by the existence of spatial relationships between the markets*. However, the second detailed hypothesis which stated that *the economic distance is more important than the geographical (physical) distance as regards the dependence between the yields of government bonds*, has not been corroborated, as the disclosure of spatial dependence occurred mainly in the case of models using a geographical distance matrix. It should be noted, however, that the dependence between yields of government bonds quantified on the basis of economic distance

has also been confirmed on several occasions. The use of spatio-temporal approach in the form of different types of spatial panel data models allowed the development and specification of conclusions formulated earlier on the basis of purely spatial models.

The models estimated and verified jointly for all the objects under study confirmed the importance of the spatial factor in the process of forming the dependence between government bond yields in the world. Clear confirmations of the spatial aspect in the modelling of government bond yields have been observed both in the case of using spatial autoregressive models and models with spatially correlated random component, as well as spatial cross-regressive models, and spatial Durbin models. Thus, the validity of the main research hypothesis and the first detailed hypothesis has been confirmed.

On the contrary, the hypothesis of the loss of importance of physical distance in favour of economic distance in the analysis of government bond yield has not been sufficiently confirmed, also in the light of the results obtained with the use of spatial panel data models.

The division of the research horizon into two sub-periods, i.e. 2008–2012 and 2013–2017, made it possible to respond to the third detailed hypothesis, according to which the *spatial dependence between government bond yields are stronger in the conditions of financial crises than in the periods of no significant turbulence*. On the basis of the results of analyses with the use of spatial panel data models, spatial effects, more varied and in a larger scope, appeared in the latter period. This calls into question the third detailed hypothesis of the study. Distinction of two spatial regimes and conducting analyses separately for the EU and developing markets allows to examine whether the identification of spatial dependence occurs to a greater extent if the objects form a more homogeneous group.

A more frequent identification of significant spatial effects for EU countries, regardless of the type of connectivity matrix used, than in the case of developing countries, where significant spatial effects are determined mainly on the basis of a geographical matrix, is a general regularity that emerges from the comparison of results for the selected groups. In other words, based on the significance of spatial autoregressive parameters, but also parameters related to spatial effects in other types of the models, it can be stated more often that the level of yields on government bonds issued by the countries co-creating the European Union, in addition to the

changes in fundamental factors, is also motivated by the existence of influences that result from the existence of spatial dependence between countries, than it is stated in relation to the group of developing economies. Besides, the dependence that stem from economic connections appear to be stronger for EU countries than developing countries. However, the first detailed hypothesis appears to be confirmed in relation to both spatial regimes. This is also in line with the main research hypothesis.