sciendo

Financial Internet Quarterly „e-Finanse" 2018, vol. 14/ no. 3, s. 76-86

DOI: 10.2478/fiqf-2018-0021

DETERMINANTS OF PUBLIC INDEBTEDNESS IN EUROPEAN UNION COUNTRIES

Janusz Kudła[1]

[2]**Abstract**

The paper strives to determine the impact of fiscal variables on factors determining the dynamics of public debt in European Union countries. Based on the literature, the dynamics of public debt are determined by changes of three elements: the primary balance, interest-rate-growth-differential and the change of government assets. Therefore, it seems reasonable to estimate the dynamics of these three values to find the variables crucial for limiting the growth of public debt. Three groups of dynamic panel regressions were estimated based on the one-step Generalized Method of Moments. The data was collected for the 1995-2015 period for 27 EU countries. Dependent variables included: primary balance, interest-rate-growth-differential and change of government assets. Independent variables consisted of: interest payable to GDP ratio, unemployment rate, squared unemployment rate, FDI stock to GDP, net FDI inflow to GDP, general government expenditures to GDP, share of social security expenditures and openness of the economy measured by the ratio of export and import to GDP. On the basis of statistical data, three components of debt changes were distinguished, and estimations of the dynamic panel regressions were applied to find the impact of independent variables. According to the basic models, the primary balance is lower for: countries with higher unemployment, greater FDI stock and higher general government expenditures. The interest-rate-growth-differential is lower in the case of: high subsidies and for a more open economy. However, unemployment and FDI remain the most important determinants of this variable. The change of government's assets ratio decreases as FDI net inflows or the share of expenditures to GDP increase as well as in the case of very high unemployment.

JEL classification: H71, H26, H72
Keywords: public debt dynamics, interest-rate-growth-differential, primary balance

Received: 11.03.2018 Accepted: 28.09.2018

1 University of Warsaw, Faculty of Economic Sciences, e-mail: jkudla@wne.uw.edu.pl, ORCID: 0000-0003-2485-6877.

Introduction

The increasing public debt exerts pressure on the fiscal stability of European countries. Therefore, it seems reasonable to identify and measure the determinants of the debt and the factors driving its behavior in a dynamic context. The dynamic context is particularly useful if we consider the probability of insolvency triggered by market perception of a government's inability to service its debt. It is especially vivid for European governments striving to cut deficits in order to regain credibility after the financial crisis.

According to Escolano (2010) the dynamics of public debt can be described as a change of three elements: interest-rate-growth-differential, the primary balance and the change of government assets. It should be noted that debt in year *t* can be expressed as:

$$D_t = (1+i_t)D_{t-1} - P_t + E_t \quad (1)$$

where D_t = public debt in the year *t*,

i_t = interest rate in the year *t*,

P_t = primary balance in the year *t*,

E_t = residual stock-flow of government assets (change of governmental assets).

The primary balance is the surplus of public revenues over expenditures but without interest paid. In other words, it is the public deficit plus the interest paid on i_t size. The residual stock-flow of government assets E_t is the change of government assets in an economy. The interpretation of this formula is straightforward: the debt can rise only because: the interest rate payment increases, government assets grow (e.g. purchases of new government assets) or the decrease of the primary balance.

Through an algebraic computation it can be presented as a formula including values related to GDP:

$$d_t - d_{t-1} = \frac{i_t - \gamma_t}{1+\gamma_t} d_{t-1} - p_t + e_t \quad (2)$$

where lower case of *d*, *p* and *e* stand for the ratios of debt, primary balance and change of government assets to GDP. It should be noted that GDP_t is equal to $GDP_{t-1}(1+\gamma_t)$ where γ_t is the nominal rate of GDP growth in time *t*. The relation of debt stock to GDP instead of the absolute debt facilitates the assessment of debt sustainability or, in other words, the stability of the relative indebtedness of governments over time.

Now the quotient standing by d_{t-1} in the formula (2) is the interest rate growth differential (λ_t) and represents the gap between interest rate on public debt (i_t) and the growth rate of the economy (γ_t) scaled by 1+ the rate of GDP growth (γ_t):

$$\lambda_t = \frac{i_t - \gamma_t}{1+\gamma_t} \quad (3)$$

The lambda for developed economies is considered to be positive (but see: Escolano, 2014) and is representing the so-called snowball effect. The snowball effect means that this factor induces debt acceleration even if the current deficit rests under control.

The interpretation of (2) is similar to the interpretation of (1) but referring to the ratios instead of levels: the change of the debt ratio to GDP depends on the previous debt ratio and three values in time *t*: λ_t, p_t and e_t.

If we can identify the determinants of these three factors, then we could explain the dynamics of the debt ratio and then we could indicate the recommendations for public debt policy.

The set of the considered explanatory variables is the same for all three groups of regressions and consists of:

1) variables directly affecting the distinguished factors of spending like: interest payable to GDP, subsidies to GDP, general government expenditures to GDP,

2) variables representing the social condition of the economy: unemployment rate, squared unemployment rate, social security expenditures to the total government expenditures and population growth,

3) variables reflecting the attractiveness of the economy to foreign partners: net FDI inflow to GDP, FDI in the economy stock to the GDP and export and import to GDP (openness of an economy).

Therefore, the main purpose of the article is to determine the variables affecting: primary balance, interest-rate-growth-differential and the ratio of government assets to GDP using a dynamic econometric method (dynamic panels system) for 26 EU countries (without Croatia and Germany) in the 1995-2015 period. The variables affecting the selected factors should be different showing the main forces shaping the debt ratio in European economies.

The article is constructed as follows. The first part describes the methods of estimation with a brief survey of literature on the topic. The second part describes the data used. The third and most important part of the study

includes the results of econometric models. The paper ends with a summary containing the main conclusions of the research as well as key recommendations for public debt management.

The method

Macroeconomic data (like data about debt and its factors) often exhibits persistency and is predetermined by its former values. This situation supports the use of lagged dependent variables as regressors. The simplest form of dynamic panel estimation involves the Generalized Least Squares (GLS) estimation with fixed effects for panels, where some explanatory variables are lagged values with dependent variables. Nevertheless, the application of an ordinary GLS model with fixed effects produces biased and inconsistent estimates, because the assumption about the strict exogeneity of the variables is violated. Variables are endogenous, predetermined but not necessarily strictly exogenous (not correlated with the error term). In general, fixed effects are correlated with the lagged value of a dependent variable (Dańska-Borsiak, 2009). To deal with this problem several methods have been proposed. One of them is the Generalized Method of Moments (further GMM).

The Arellano-Bond GMM estimator (Arellano, Bond, 1991) eliminates the fixed effect by utilizing deeper lags of the dependent variable as instruments for differenced lags of a dependent (endogenous) variable. The Arellano-Bond GMM estimator can be calculated if there is no autocorrelation of idiosyncratic errors. The autocorrelation is tested with the Arellano-Bond test with zero hypothesis of no serial autocorrelation. To pass the test the first differences should be correlated (small p-value) and the second differences should not be correlated (high p-value). It is met in all regressions but the regression of lambda. In order to improve the result of the test the model has been augmented by the addition of a second lag of the dependent variable. The first type of dynamic panel regression is constructed according to this proposition.

For high variance of the fixed effect across individual observations or the stochastic process of a dependent variable similar to a random walk, the lagged dependent variables are weak instruments and the System GMM (Arellano & Bover, 1995; Bond & Blundell, 1998) should be applied. The System GMM increases the number of used instruments in an instrumental variable matrix by differences of lagged dependent variables. This form of estimation is the second type of dynamic panel regression and it seems to be the most appropriate and will be treated as basic.

The dynamic panel models estimation can be a one-step or two-step estimation. The estimation is one-step when the weight matrix is calculated from the variance of the errors. The estimation is two-step if the weight matrix is derived from residual vectors of the one-step estimator. According to S. Bond (2002, p. 9) the one-step estimator is the better option than the two-step because: "simulation studies have suggested very modest efficiency gains from using the two-step version, even in the presence of considerable heteroskedasticity, but more importantly because the dependence of the two-step weight matrix on the estimated parameters makes the usual asymptotic distribution approximations less reliable for the two-step estimator." It is not without significance that errors in the two-step estimation are underestimated so the Windmeijer's correction (Windmeijer, 2005) is required. Therefore, the results of the two-step System GMM with Windmeijer's correction are reported in the last form of the dynamic panel regression but its results should be treated with special caution.

The dynamic panel analysis is widespread in the contemporary literature on fiscal debt. For example, Zeng (2014) applies the dynamic panel model with fixed effects to the country's primary balance. However, in this approach the primary balance is explained only by the first lag of primary balance in ordinary GLS panel estimation with fixed effects. The variables used in this setting are different than those proposed in this study and they include: Debt-Stabilizing-Fiscal Balance, public debt ratio, savings, inflation, country risk, corruption, share of population of age over 65 or terms of trade. The primary balance increases with: debt stock, inflation and risk index. The results are not surprising because higher debt requires higher interest payments and consequently a higher primary balance to cover them. Similarly, the growth of risk increases the interest paid and inflation accelerates the budgetary revenues to a greater extent than expenditures. Thus, it seems unnecessary to put these variables into the dynamic panel regressions.

This line of research should be distinguished from the estimation of the Fiscal Policy Reaction Function (Bohn, 1998, 2007) where the primary balance is regressed

against lagged debt and a set of explanatory variables. Contrary to our purpose this type of analysis strives to estimate the stability of the public debt ratio in the long run.

The application of the System GMM in the context of debt also includes the work of Kumar and Woo (2014). Nevertheless, they only assessed the impact of debt on the GDP growth omitting components of the public debt per se.

Several studies follow the Escolano proposition in determining the factors affecting dynamics of debt. For example, Abbas et al. (2011) investigates the debt dynamics of 178 IMF countries with respect to: primary balance, interest-growth differential and the stock-flow adjustment. They found asymmetric impact of these factors with primary balance playing a key role in reduction of debt and stock-flow adjustment responsible for the surge of debt. The first part of the statement was also corroborated by Baldacci et al. (2012).

The proposed method was also applied to non-European countries. For example, Ncube and Brixiova (2015) examined the role played by the primary balance and interest-rate-growth-differential in assessing fiscal sustainability of African countries. The study reveals the interest-rate growth differential as the main source of debt reduction in African economies during the period 2007-2012. However, the cited study does not explain the factors responsible for this change, as is proposed in our study.

The factors affecting interest-rate-growth were scrutinized by Escolano, Shabunina and Woo (2016). They showed that "large negative interest-rate-growth-differentials in emerging and developing economies are largely due to real interest rates well below market equilibrium – stemming from financial repression and captive and distorted markets – whereas the income catch-up process plays a relatively modest role. Therefore, the interest-rate-growth-differential in non-advanced economies is likely to rise with financial market development and financial global integration, perhaps even before their GDP per capita converges to advanced economy levels."

Finally, the determinants of policy response to the changes of debt-to GDP was analyzed on the sample of 55 countries in the last two hundred years (Mauro et al., 2015). According to this paper, primary balance reacted to debt increase more weakly if: borrowing costs were low, inflation high or potential economic growth worsened unexpectedly. However, the set of explanatory variables was narrow, and it referred only to a small extent to contemporary economies.

The data

We decided to estimate the determinant of the debt on the sample of data taken from Eurostat (2017) for 26 EU countries (without Croatia and Germany for which the data were incomplete) in the 1995-2015 period. The focus on the data from one geographic region with partially common anti-excessive-debt-legislation can facilitate the extraction of factors which are responsible for debt dynamics. The situation of the indebtedness was diversified by covering the economies with relatively low levels of debt (e.g.: Bulgaria, Estonia, Luxemburg) as well as high level of debt (e.g.: Belgium, Greece, Italy, Portugal) and including countries which experienced disturbances in debt repayment (e.g.: Greece, Ireland, Italy, Portugal, Spain) or those remaining credible all the time (e.g.: Sweden, Netherlands, Czech Republic). Last but not least, the choice of economies from one region was prescribed by the consistency of data provided by Eurostat, stemming from the common methodology of data collection.

The dependent variables in the three models are: primary balance ratio (the relation of primary fiscal balance to GDP), interest rate growth differential (interest payment divided by GDP minus the change of GDP to the GDP and divided by one plus the change of GDP to the GDP) and public asset change to GDP. The change of government assets to GDP was computed as the change of the public general government debt between two consecutive years plus primary balance and minus interest payments. This is because the data about government assets is not credible. Some part of it is perfectly assessed because they consist of acquisition of assets at market prices but the other part is not tradable or their value is uncertain. Therefore, the calculation of the government assets value changes on the basis of a formula (2) to make this valuation more reliable.

The relationships between the three factors affecting debt dynamics have been estimated, using the data on: the primary balance, interest payments, GDP at market prices, export, import, FDI net inflow, population, total government expenditures, unemployment and expenditures on social protection from Eurostat Database

Table 1: Correlations between independent variables

	Interestr	Expendi-turer	Subsi-diesr	Unem-ploy-ment	Unem-ploy2	Social-pref	Popula-tion	FDI-stockr	FDInet-flowr	Open-ness
Interestr	1									
Expenditurer	0.41	1								
Subsidiesr	0.17	0.48	1							
Unemployment	0.16	0.03	-0.20	1						
Unemploy2	0.14	0.03	-0.18	0.96	1					
Socialpref	0.06	0.49	0.15	-0.07	-0.03	1				
Population	0.01	0.12	0.11	-0.33	-0.29	0.27	1			
FDIstockr	-0.38	-0.28	0.08	-0.29	-0.24	-0.04	0.35	1		
FDInetflowr	0.01	-0.07	0.02	0.12	0.09	-0.23	-0.14	0.00	1	
Openness	-0.30	-0.29	0.04	-0.23	-0.18	-0.06	0.17	0.79	-0.02	1

Source: Own calculation in Stata based on (Eurostat, 2017)

(2017). However, the data was transformed to reflect the indicator form of dependent variables. In most cases it required the division of the raw data by the GDP in market prices. The independent variables were split into three groups. The first group relates to the ratios of expenditures: in total (Expenditurer), for interest payable (Interestr) and for subsidies (Subsidiesr). The variables are used to capture the determinants of debt factors in overspending, law credibility or high indebtedness and active policies subsidizing different sectors of the economy.

The second group includes social determinants of government policy: rate of unemployment (Unemployment) and square of unemployment rate (Unemploy2), preference for social expenditures as the relation of social expenditures to total expenditures (Socialpref) and rate of population growth (Population). The unemployment generally increases expenditure of government and the effect can be nonlinear. Low unemployment does not require the intense adjustment of government spending but when unemployment becomes substantial it can rapidly inflate the expenditures. To cover the latter effect the square value of unemployment has been added to the model. We expect the signs of the two unemployment variables to be opposite if this hypothesis is valid.

The third group of variables describes the attractiveness of a country from the foreign point of view. The stock or foreign direct investment in the economy (FDIstockr), the net foreign direct investment (FDInetflowr) and the sum of export and import (Openness) are all indicators of foreign attractiveness which makes the maintenance of solvency easier. All these variables were divided by the GDP in market prices to obtain the ratios.

The correlations between explanatory variables are small and do not exceed 0.5 with two exceptions. The first exception is correlation between unemployment rate and squared unemployment rate which is as high as 0.96. However, we know that the square function is not linearly dependent on the starting values, so in fact this correlation is illusory. The second case regards the relation between openness and the stock of foreign investment. The higher foreign trade coexists with higher foreign investments, but these two variables are not in causal relationship because international trade can be substitute to investment in the country. It is confirmed by the opposite sign of coefficient in the panel regression explaining all three factors (when they are significant). Taking all together, there is no need to drop some of the variables from the estimated models.

The estimation results

The results of the estimation are presented in the three following tables (2,3,4) and each of them includes estimates obtained with three dynamic specifications of dynamic panel regressions.

The first group of regression explains the primary balance ratio. As one can see, most of the variables in the one-step System GMM is significant at 10% significance level. The exceptions are FDI net inflow and the change of population size. Estimated parameters confirm that primary balance is positively affected by high interest payments, and the high ratio of expenditures decreases

Table 2: The results of regression models for primary balance ratio

Pbalancer	Arellano-Bond GMM onestep	System GMM onestep	System GMM with Windmeijer's correction twostep
L.Pbalancer	0.20*** (0.03)	0.24*** (0.03)	0.18 (0.15)
Interestr	2.08*** (0.14)	1.97*** (0.12)	2.61*** (0.95)
Expenditurer	-0.69*** (0.03)	-0.67*** (0.03)	-0.67*** (0.10)
Subsidiesr	0.80** (0.39)	0.92*** (0.34)	1.38 (1.43)
Unemployment	-0.01*** (0.00)	-0.01*** (0.00)	-0.01** (0.00)
Unemploy2	0.00*** (0.00)	0.00*** (0.00)	0.00* (0.00)
Socialpref	0.32*** (0.06)	0.38*** (0.04)	0.34** (0.14)
Population	0.11 (0.15)	0.09 (0.14)	0.87 (1.37)
FDIstockr	-0.02*** (0.01)	-0.03*** (0.01)	-0.01 (0.02)
FDInetflowr	0.00 (0.01)	-0.00 (0.01)	-0.01 (0.01)
Openness	0.02*** (0.01)	0.04*** (0.01)	0.04 (0.03)
constant	0.15*** (0.03)	0.12*** (0.02)	0.11 (0.07)
Number of observations	329	358	358
Number of instruments	147	163	163
Arellano-Bond test for zero autocorrelation	-	-	-2.25 (0.025) -0.55 (0.584)

Source: Own calculation in Stata based on (Eurostat, 2017).

*Notes: Standard errors in parentheses. *** P<0.01; ** P<0.05; * P<0.1.*

its size, indicating that fiscal discipline matters. When the subsidies are high the primary balance is also high. It may be the effect of a strong fiscal position of a government offering greater subsidies when their budgetary position is outstanding. The unemployment affects primary balance negatively and the nonlinear effect of high unemployment is corroborated. We expect that when unemployment becomes substantial its impact on expenditures would be hampered. Similarly, as in the case of subsidies, the social orientation of government is accompanied by a larger primary balance ratio. Therefore, we can guess that the worsening situation in debt servicing would be mitigated in the first place, by cuts in expenditures on social protection and subsidies. Finally, the last group of variables reflects indirectly the differences between more and less developed economies. More developed economies are more open but simultaneously their stock of foreign investments in the economy to GDP is relatively small. The opposite is true for less developed members of the EU. The more developed economies can achieve a higher primary balance ratio probably because they have less fixed expenditures and better access to efficient sources of budgetary revenues. Thus, one can formulate the conclusion that differences in primary balance between EU countries can be mainly explained by the divergence in their wealth.

To test the hypothesis of the impact of economy development on the primary balance, the regressions have been recalculated: 1) for countries admitted to the EU after 2003 (less developed than former members of the EU) 2) for members of the EU in 2003 (old members) and separately 3) for all countries, but since 2007 (in the crisis era). The results are given in the appendix (Table 5). The general conclusion is that social variables are significant only for old EU members and the situation after the outburst of the crisis in 2007 does not reveal significant changes in primary balance determinants.

The second group of regressions describes the determinants of the interest rate growth differential (λ). The relations with various types of expenditures and foreign cooperation measures turned out to be especially important. The lambda is spurred by an expenditure with special emphasis on social protection, while higher subsidies make the lambda declining. However, it is not obvious whether there is any causal relationship from expenditure to lambda. More likely is the reverse impact: the high lambda allows for higher spending. Once again it seems to be remnant of the different development stages

Table 3:The results of regression models for lambda

Lambda	Arellano-Bond GMM onestep	System GMM onestep	System GMM with Windmeijer's correction twostep
L.Lambda	-0.06 (0.05)	-0.02 (0.04)	-0.10 (0.14
L2.Lambda	-0.17*** (0.05)	-0.14*** (0.04)	-0.18*** (0.08)
Interestr	1.36 (0.85)	-1.09 (0.68)	-2.00 (1.65)
Expenditurer	1.17*** (0.14)	0.92*** (0.12)	1.11** (0.51)
Subsidiesr	-2.71 (1.7)	-4.13*** (1.59)	-5.26 (5.72)
Unemployment	-0.00 (0.01)	0.01 (0.01)	0.01 (0.01)
Unemploy2	0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Socialpref	1.51*** (0.25)	1.11*** (0.2)	1.47 (1.09)
Population	0.82 (0.59)	-0.16 (0.52)	-0.06 (2.44)
FDIstockr	0.09*** (0.03)	0.13*** (0.03)	0.09 (0.08)
FDInetflowr	-0.08*** (0.03)	-0.09*** (0.03)	-0.08 (0.13)
Openness	-0.06 (0.04)	-0.13*** (0.03)	-0.09 (0.1)
constant	-1.01*** (0.12)	-0.69*** (0.09)	-0.91** (0.4)
Number of observations	310	338	338
Number of instruments	130	145	145
Arellano-Bond test for zero autocorrelation	-	-	-2.29 (0.022) -0.00 (0.999)

Source: Own calculation in Stata based on (Eurostat, 2017).

*Notes: Standard errors in parentheses. *** P<0.01; ** P<0.05; * P<0.1.*

of the EU countries, if we keep in mind that lambda tends to be lower for more developed economies. The less developed countries spend relatively more (comparing to GDP) and the expenditures are targeted at social protection. The affluent countries are more concentrated on subsidies and their share of expenditures in GDP is lower. This is consistent with the reaction of lambda on FDI variables and openness in the same manner as in the explanation of the primary balance behavior. Higher ratio of FDI stock coincidences with lower openness. The negative sign of FDI net inflow acknowledges that countries with lower growth or higher interest payment experience capital outflow.

As before, the estimations have been computed once again for the new and for the old members of the EU, as well as for the data of all the countries after 2007 (see Appendix, Table 6). Only the effect of expenditures remains stable and positive. The effect of FDI is negative and manifests particularly in the new member states. When discussing the differences, it should be pointed out that the lambda of old members is more sensitive to subsidies and to changes of population, while for the new members unemployment rate and preference for social expenses are more important. After the crisis the high ratio of subsidies substantially increased the negative pressure exerted on lambda.

The third group of regressions was to determine the change of government assets. In general, they are induced by three groups of variables: expenditures, unemployment and FDI. The government assets increase when: interest payments, unemployment rate or FDI stock is higher, and decreases when expenditures and FDI inflow are greater or the unemployment rate becomes very high. The most astonishing is the accrual of public assets when the interest payment is high. It can be justified if assets are treated as a form of collateral or they are used as a diversification of debt-imposed-risk. The liquidation of assets can be required when payments are becoming substantial (like in the cases of high mandatory expenditures or very bad economic condition - affirmed by a high unemployment rate). Similarly, the drop in public assets is expected when investment attractiveness of the country declines (negative FDI stock) or when a government sells its assets to foreigners (positive FDI net inflow).

Table 4: The results of regression models for government assets change

Govassetsr	Arellano-Bond GMM onestep	System GMM onestep	System GMM with Windmeijer's correction twostep
L.Govassetsr	-0.15** (0.06)	-0.08* (0.05)	-0.07 (0.16)
Interestr	2.03*** (0.42)	1.25*** (0.36)	0.23(1.51)
Expenditurer	-0.11 (0.08)	-0.16** (0.07)	-0.11 (0.17)
Subsidiesr	-0.87 (1.01)	0.16 (0.93)	-0.52 (3.32)
Unemployment	0.01*** (0.00)	0.01*** (0.00)	-0.00 (0.01)
Unemploy2	-0.00*** (0.00)	-0.00*** (0.00)	0.00 (0.00)
Socialpref	0.39*** (0.16)	0.20 (0.13)	0.19 (0.24)
Population	0.46 (0.38)	0.38 (0.39)	0.27 (0.41)
FDIstockr	0.02 (0.02)	0.03* (0.02)	0.05 (0.03)
FDInetflowr	-0.03 (0.02)	-0.03** (0.02)	-0.03 (0.04)
Openness	0.03 (0.02)	-0.00 (0.02)	-0.01 (0.03)
Constant	-0.20*** (0.08)	-0.08 (0.05)	-0.00 (0.1)
Number of observations	318	347	347
Number of instruments	131	146	146
Arellano-Bond test for zero autocorrelation	-	-	-2.39 (0.017) -0.18 (0.859)

Source: Own calculation in Stata based on (Eurostat, 2017).
*Notes: Standard errors in parentheses. *** P<0.01; ** P<0.05; * P<0.1.*

To shed some light on the details of the issue the regressions for new and old members have been estimated altogether with regression for post-crisis time (see Appendix, Table 7). It should be emphasized that there is no clear pattern for new member countries, because only FDI stock ratio turns out to be a significant parameter. Old member countries increase public assets in response to the increasing social orientation and excessive unemployment. This reaction is not observed between new member states. The FDI effects for old member countries are the same as noticed for the whole sample. After the crisis the reaction of governments has been altered. The impact of most of the variables on the government assets change has declined (with the exception of variables describing unemployment) and there has been a very rapid increase in the importance of interest paid. Perhaps it can be explained by the nationalization of some financial institutions in order to protect them from default.

Conclusions

It should be pointed out that the dynamic panel models are a very good tool for public debt analysis because they can deal with the problem of debt persistency, producing valuable results. It seems that one step estimation is less conservative in assessing the significance of parameters and allows for drawing more conclusions than the two-step estimation. Arellano-Bond GMM and System GMM are comparable in results but the latter is better adjusted to the samples with smaller number of periods than the number of units. It is especially important for data about debt components, which still remain shorter than the number of countries in the sample. It is because the data has been collected by Eurostat only since 1995.

The impact of individual variables on factors determining the behavior of public debt allows us to formulate a proposal that the behavior of governments, as well as the reactions of economies, are not constant over time and reveal differences, both between countries at different levels of development, and in time (for example

if we split data to cover periods before and after the financial crisis in 2007). In particular, we can observe the differences in reaction of the new and old EU members. These differences relate to the significance of variables describing the social situation such as unemployment and social spending. They are significant in regressions for primary balance ratio and for change of government asset ratio estimated on the subgroup of the old EU members, but they are not significant for the subgroup of new members. Simultaneously the opposite situation occurs for lambda regression. The FDI variables seem to play an important role in regression with lambda and government asset change ratio for the old members.

The crisis altered the dependences increasing the negative effect of subsidies on lambda and decreasing the meaning of variables related to unemployment and social policy. The smallest transformation in time reveals the behavior of the primary balance.

One can be aware of the limited explanatory power of the conducted study. The behavior of public debt dynamics is more complicated and certainly should be extended by inclusion of other variables driving the evolution of the three factors of debt.

References

Abbas, A., S., Belhocine, N., El-Ganainy, A. Horton, M., (2011). *IMF Economic Review. 59*(4), 717-742. Retrieved form: https://doi.org/10.1057/imfer.2011.24.

Arellano, M., Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies, 58*(2), 277-297.

Arellano, M., Bover, O. (1995). Another Look at the Instrumental Variable Estimation of Error-components Models. *Journal of Econometrics, 68*, 29-51.

Baldacci, E., Gupta, S., Mulas-Granados, C. (2012). Reassessing the Fiscal Mix for Successful Debt Reduction. *Economic Policy, 27*(71), 365–406.

Blundell, R., Bond, S. (1998). Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics, 87*, 115-143.

Bohn, H. (1998). The Behavior of U.asseS. Public Debt and Deficits. *The Quarterly Journal of Economics, 113*(3), 949–963.

Bohn, H. (2007). Are Stationarity and Cointegration Restrictions Really Necessary for the Intertemporal Budget Constraint? *Journal of Monetary Economics, 54,* 1837–1847.

Bond, S. (2002). Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice, Centre for Microdata and Practice (CEMMAP), *Working paper CWP09/02*. Retrieved from: http://cemmap.ifs.org.uk/wps/cwp0209.pdf.

Dańska-Borsiak, B. (2009). Zastosowania panelowych modeli dynamicznych w badaniach mikroekonomicznych i makroekonomicznych. *Przegląd Statystyczny, 56*(2), 25-41.

Escolano, J. (2010). A Practical Guide to Public Debt Dynamics, Fiscal Sustainability, and Cyclical Adjustment of Budgetary Aggregates. *Technical Notes and Manuals IMF, Washington DC. No. 2010/02*. Retrieved from: https://www.imf.org/external/pubs/ft/tnm/2010/tnm1002.pdf.

Escolano, J., Shabunina, A., Woo, J. (2016). The Puzzle of Persistently Negative Interest-rate-growth-differentials: Financial Repression or Income Catch-up? *Fiscal Studies.* Retrieved from: https://doi.org/10.1111/1475-5890.12103.

Eurostat. (2017). *Database,* Retrieved from: http://ec.europa.eu/eurostat/data/database.

Kumar, M.S., Woo, J. (2014). The Relationship Between Debt Levels and Growth. In C. Cotarelli, P. Gerson, A. Senhadji (Eds.), *Post-Crisis Fiscal Policy,* (pp. 97-125). London: MIT Press.

Mauro, P., Romeu, R., Binder, A., Zaman, A., (2015). A Modern History of Fiscal Prudence and Profligacy. *Journal of Monetary Economics, 76*(1), 55-70.

Ncube, M., Brixiova, Z. (2015). Public Debt Sustainability in Africa: Building Resilience and Challenges Ahead. *Development Policy Review, 33*(5),555—580.

Windmeijer, F. (2005). A Finite Sample Correction for the Variance of Linear Efficient Two-step GMM Estimators. *Journal of Econometrics, 126*, 25-51.

Zeng, Li. (2014). Determinants of Primary Fiscal Balance. In C. Cotarelli, P. Gerson, A. Senhadji (Eds.), *Post-Crisis Fiscal Policy*, (pp. 67-96). London: MIT Press.

APPENDIX

Table 5: The results of regression models for primary balance ratio in subgroups

Pbalancer	System GMM onestep (new members)	System GMM onestep (old members)	System GMM onestep (after crisis)
L.Pbalancer	0.23*** (0.04)	0.21*** (0.03)	0.16*** (0.04)
Interestr	1.78*** (0.25)	1.83*** (0.13)	1.66*** (0.3)
Expenditurer	-0.52*** (0.05)	-0.72*** (0.03)	-0.76*** (0.05)
Subsidiesr	0.28 (0.33)	3.88*** (0.55)	1.01* (0.6)
Unemployment	0.00 (0.00)	-0.01*** (0.00)	-0.01*** (0.00)
Unemploy2	-0.00 (0.00)	0.00*** (0.00)	0.00*** (0.00)
Socialpref	0.00 (0.07)	0.69*** (0.06)	0.44*** (0.00)
Population	0.13 (0.17)	-0.84*** (0.27)	0.07 (0.17)
FDIstockr	-0.01 (0.01)	-0.01 (0.01)	-0.03*** (0.01)
FDInetflowr	0.03 (0.03)	-0.00 (0.01)	0.00 (0.01)
Openness	0.02** (0.01)	0.01 (0.01)	0.05*** (0.01)
constant	0.15*** (0.03)	0.02 (0.03)	0.14*** (0.04)
Number of observations	157	201	130

Source: Own calculation in Stata based on (Eurostat, 2017).

*Notes: Standard errors in parentheses. *** P<0.01; ** P<0.05; * P<0.1.*

Table 6: The results of regression models for lambda in subgroups

Lambda	System GMM onestep (new members)	System GMM onestep (old members)	System GMM onestep (after crisis)
L.Lambda	-0.04 (0.06)	-0.05 (0.07)	-0.31*** (0.06)
L2.Lambda	-0.12** (0.05)	-0.26*** (0.06)	-0.22*** (0.06)
Interestr	1.74 (1.11)	0.56 (0.53)	-2.23* (1.26)
Expenditurer	0.79*** (0.18)	0.76*** (0.13)	0.81*** (0.2)
Subsidiesr	-1.12 (1.84)	-3.69** (1.62)	-9.26*** (2.71)
Unemployment	0.02** (0.01)	-0.00 (0.00)	0.02*** (0.01)
Unemploy2	-0.00** (0.00)	0.00** (0.00)	-0.00 (0.00)
Socialpref	1.06*** (0.32)	-0.04 (0.22)	1.28*** (0.34)
Population	-0.70 (0.72)	4.38*** (0.98)	0.39 (0.63)
FDIstockr	0.16*** (0.04)	0.06** (0.03)	0.01 (0.04)
FDInetflowr	-0.40*** (0.14)	-0.05*** (0.02)	-0.08** (0.03)
Openness	-0.18*** (0.04)	-0.03 (0.02)	-0.23*** (0.06)
constant	-0.66*** (0.13)	-0.34*** (0.1)	-0.54*** (0.18)
Number of observations	156	182	130

Source: Own calculation in Stata based on (Eurostat, 2017).

*Notes: Standard errors in parentheses. *** P<0.01; ** P<0.05; * P<0.1.*

Table 7: The results of regression models for government assets change in subgroups

Govassetsr	System GMM onestep (new members)	System GMM onestep (old members)	System GMM onestep (after crisis)
L.Govassetsr	-0.07 (0.07)	-0.22*** (0.07)	-0.26*** (0.09)
Interestr	0.32 (0.59)	0.62 (0.4)	5.17*** (1.01)
Expenditurer	-0.03 (0.09)	-0.12 (0.09)	-0.34*** (0.13)
Subsidiesr	0.24 (0.8)	-0.95 (1.41)	-0.22 (1.79)
Unemployment	0.00 (0.00)	0.01*** (0.00)	0.01* (0.01)
Unemploy2	-0.00 (0.00)	-0.00*** (0.00)	-0.00*** (0.00)
Socialpref	0.19 (0.16)	0.66*** (0.18)	0.09 (0.21)
Population	0.61 (0.38)	-0.13 (0.83)	0.38 (0.51)
FDIstockr	0.03* (0.02)	0.05** (0.02)	0.02 (0.03)
FDInetflowr	0.03 (0.06)	-0.04** (0.02)	-0.04** (0.02)
Openness	-0.00 (0.02)	-0.00 (0.02)	-0.01 (0.02)
constant	-0.07 (0.06)	-0.26*** (0.08)	-0.00 (0.09)
Number of observations	157	190	130

Source: Own calculation in Stata based on (Eurostat, 2017).

*Notes: Standard errors in parentheses. *** P<0.01; ** P<0.05; * P<0.1.*