Fiscal Sustainability in Flow Model: Panel Cointegration Approach for the EU-28

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Abstract

This paper assesses fiscal sustainability in 28 European Union economies in the period 1995-2018, using panel cointegration analysis for fiscal sustainability testing. The research is based on econometric framework of nonstationary, heterogeneous, and cross-sectional dependent panels, using robust Westerlund (2007) panel cointegration test, Mean Group, and Pooled Mean Group method of estimations. The results of cointegration analysis for EU-28 point to weak fiscal sustainability, with significant fiscal adjustment in average. However, heterogeneous coefficients show in which economies fiscal sustainability is achieved (whether it is strong or weak fiscal sustainability) and heterogeneous fiscal reactions. Robustness check confirmed existence of fiscal sustainability with heterogeneous fiscal adjustments in European Union economies, and indicated strong fiscal sustainability in the shorter period of time, namely after 1997 when Stability and Growth Pact is introduced.

Key words: Fiscal sustainability, Flow models, Panel cointegration, EU-28.
J.E.L. classification: C33, H50, H62.

1. Introduction

The issue of fiscal (un)sustainability attracted considerable attention in European Union (EU) economies during the past three decades, mainly as a result of high public expenditure, public revenues reduction, and excessive accumulation of public debt. Along with reasons related to fiscal aggregates, fiscal sustainability became questionable due to absence of supranational fiscal rules. Although EU economies are faced with the same fiscal policy framework defined in Maastricht Treaty (1992), Stability and Growth Pact (1997), and Fiscal Compact (2012), fiscal responsibility differ within EU economies. Strategies related to Quality of Public Finance are implemented, however, empirical studies argued that the convergence is weak or no exists (Ferreiro, García de Valle, and Gómez, 2012; Bertarelli, Censolo, and Colombo 2014). Following such considerations, heterogeneous results of fiscal assessment in EU economies in terms of long-run relationship between public revenues and public expenditure, as well as heterogeneous fiscal adjustments are the core of the analysis in this paper.

In the empirical literature, fiscal sustainability is the most often tested using traditional, cointegration approach, based on long-term (in)consistency between the tax policy and the public expenditure policies (flow approach). In this paper is analysed heterogeneity of fiscal sustainability assessments in panel of 28 European economies during 1995-2018, and the goal is twofold: (1) to estimate fiscal sustainability with flow models (panel cointegration approach), and (2) to analyse heterogeneity of fiscal reactions in EU economies in order to achieve fiscal sustainability.

Heterogeneous parameters in flow model are estimated using Meand Group (MG) and Pooled Mean Group method (PMG).The evidence of fiscal sustainability showed that cointegration between public revenues and public expenditure exists in the *weak* sense for average of European economies. However, the most important contribution of the paper is related to heterogeneous parameters in models, which provides information about fiscal sustainability and fiscal reactions in each European country.

The paper is organized as follows. After the introductory part, Section 2 briefly shows theoretical background. Section 3 elaborates used methods and data. Next, in Section 4, the estimation results for fiscal sustainability using panel cointegration analysis with heterogeneous parameters are given. In Section 5 main conclusions and policy recommendations are presented.

2. Theoretical background

Theoretical model of fiscal sustainability is related to intertemporal budget constrain, which could be empirically tested using two traditional approaches: (1) the analysis of stationarity of primary deficit and public debt (Hamilton and Flavin, 1986; Wilcox, 1989); and (2) cointegration analysis between public revenues and public expenditure (Hakkio and Rush, 1991; Quintos, 1995). According to the first approach, intertemporal budget constraint is satisfied when the value of public debt corresponds to the sum of future primary surpluses, and when present value of public debt approaches zero in infinity, which Afonso (2004) points out that could be tested by unit root tests. Namely, intertemporal budget constraint is achieved when primary deficit is stationary process, or when public debt is stationary in the first differences. Hakkio and Rush (1991) showed that second approach could be useful for fiscal sustainability assessment, namely, if public revenues and public expenditure are integrated of order 1, two variables could be cointegrated. If variables are cointegrated, with cointegration parameter b=1, fiscal policy is sustainable, otherwise, fiscal policy is unsustainable. Therefore, fiscal sustainability concept could be empirically tested using following equation for cointegration relationship (Hakkio and Rush, 1991):

$$t_t = \mu + b g_t^* + u_t \, , \qquad (1)$$

where t_t represents tax share in GDP, g_t^* is public expenditure share in GDP including expenditure for public debt servicing, μ is constant term or individual effects in panel data, u_t represents error term, and b is cointegartion parametar which is the issue of analysis, i.e. if $b = 1$, fiscal policy is sustainable. Contribution of Hakkio and Rush (1991) is introduction of condition $0 < b \leq 1$, as a sufficient for assessing fiscal sustainability.

Related to condition $0 < b \leq 1$, Quintos (1995) introduced new fiscal sustainability terminology, making distinction between *weak* and *strong* fiscal sustainability, and introducing d as government debt share in GDP:

(1) *strong* fiscal sustainability condition: $b = 1$ and $\Delta d \sim I(0)$;
(2) *weak* fiscal sustainability condition: $0 < b < 1$ and $\Delta d \sim I(1)$;
(3) fiscal *unsustainability*: $b \leq 0$ and $\Delta d \sim I(1)$.

Therefore, the main framework for fiscal sustainability flow model is $u_{it} = Y_{it} - \beta X_{it} \sim I(0)$, while the most common used panel cointegration test are Kao, McCoskey and Kao, Pedroni, Westerlund. Null hypothesis is no cointegration, while alternative hypothesis is existence of cointegration with homogeneous or heterogeneous assumptions. If public expenditure and public revenues are integrated of order 1, and cointegrated, fiscal deficit is stationary process; according to flow model, fiscal sustainability exists. This method of fiscal sustainability analysis is advances in comparison to unit root analysis, and it is a good indicator for annual data analysis. On the other hand disadvantage of cointegration analysis is absence of the analysis of the relationship over a longer period of time with stock variables, i.e. publc debt, which could be tested within multicointegration analysis.

Defined theoretical concept of fiscal sustainability is extensively used in empirical papers, using different samples and econometrical techniques: from time-series analysis to panel data analysis using unit root tests, cointegration tests of first and second generation, error correction models, methods of heterogeneous non-stationary panels based on common factor approach. In relation to sample of European Union economies, Alfonso and Raul (2007) analysed 15 EU economies for the period 1970-2006 using unit root tests of first and second generation, and results showed that fiscal policy is sustainable for the EU-15, as well as in the two separated sub-periods 1970-1991 and 1992-2006; Ehrhart and Llorca (2008) showed that fiscal policy is sustainable in six South-Mediterranean countries; Campeanu and Andreea (2010) analyzed fiscal sustainability and fiscal reactions in Central and Eastern European countries; Afonso and Rault (2015) showed that fiscal sustainability is questionable in some EU countries in the period 1960-2012; Josifidis et al. (2018) showed heterogeneous effects of different public policies on fiscal sustainability in EU-28.

In this paper, using sample of EU-28 for the period 1995-2018, following research hypotheses are tested:

H_1: Fiscal sustainability exists in the sample of EU-28 economies, i.e. cointegration relationship between flow variables exists in homogeneous and heterogeneous parameters.

H_2: Fiscal adjustment to long-run equilibrium relationship is heterogeneous in the sample of EU-28; i.e. in some economies adjustment is negatively and significant, while in others is positive and significant, or insignificant.

3. Research methodology

Hypotheses 1 and 2 defined in Section 2 are tested using the following econometric techniques: Westerlund cointegration test, Pooled mean group estimator and Mean group estimator. Due to often failure of residual-based cointegration tests which require "that the long-run parameters for the variables in their levels are equal to the short-run parameters for the variables in their differences" (Persyn and Westerlund, 2008), Westerlund proposed error-correction based panel cointegration test. According to Westerlund (2007), four new panel cointegration tests are developed and those tests are not based on residual dynamics, than on structural changes. First two tests have homogeneous alternative hypothesis (the panel is cointegrated as a whole), while other two tests have heterogeneous alternative hypothesis (at least one panel unit is cointegrated). The advantage of Westerlund test is the possibility of taking into account cross-sectional dependence in the model using the bootstrap approach.

Estimation of log-run cointegration relationship could be undertaken using Mean Group approach (MG) or Pooled Mean Group (PMG) estimator proposed by Pesaran, Shin, and Smith (1999). MG estimates N time-series regressions and averages coefficients, while PMG is based on pooling (equal long-run relationship across all panel units) and averaging of coefficients (short-line relationship). Hausman test could be used to distinguish whether restriction related to homogeneous long-run relationship in PMG model is true. If is true, PMG method gives efficient and consistent estimates, while heterogeneous long-run equilibrium relationships mean inconsistent PMG estimates. MG estimates are consistent in both cases. Baseline model is panel error-correction model described as:

$$\Delta lt_{it} = \Phi_i(t - \theta_i lg_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta lt_{i,t-1} + \sum_{j=0}^{q-1} \delta_{ij}^* \Delta lg_{i,t-j} + \mu_i + u_{it} \qquad (2)$$

where λ_{ij}^* represents coefficient of dependent variable with lag, δ_{ij}^* short-run parameters for each economy of the panel, θ_i long-run relationship, μ_i individual effects. Error-correction parameter, Φ_i, is the most important part of the model, showing speed of adjustment to long-run equilibrium relationship, in the case when Φ_i is negative and significant. Empirical analysis related to MG and PMG methods is based on Blackburne III and Frank-a (2007).

The source of data is International Monetary Fund, World Economic Outlook (April 2019), and used software is Stata 13.

4. Findings

The choice of the model that best fits the analyzed data is determined by potential problems of heterogeneity, cross-sectional dependency and nonstationarity of key variables. In the beginning, cross-sectional dependency is tested using Pesaran CD test (Table no. 1A). Results show that null hypothesis of cross-section independency has to be rejected in all cases. Due to the results of cross-sectional dependencies analysis, second generation panel unit root test is used – Pesaran CIPS test (2007) which allows for cross-sectional dependency (Table no. 1A). Because of significant decline in power of the test when trend is included, decisions are made on the basis of models with constant, and using Akaike information criteria to determine optimal lag in model. According to the results of CIPS Pesaran statistics, it is turned out that variables are nonstationary in the model with two lags. Namely, Pesaran panel unit root test fail to reject null hypothesis at 5% significance level. In the next step, the stationarity of first differences is tested, and results show that variables are stationary in first differences, which is base for cointegration analysis. Integration of order 1 of public revenues and public expenditure, indicate possible cointegration relationship, while integration of public debt of order 1 *weak* fiscal sustainability (according to condition 2 defined in Section 2of theoretical background).

Cointegration analysis is based on Westerlund (2007) test, where the lag and lead lengths structure are chosen using Akaike information criteria, for the model with constant (Table no. 1). The fact that Pesaran CD test indicated cross-sectional dependency in panel (Table 1A) relevant conclusions related to Westerlund (2007) test could be obtained only after bootstrap procedure. Bootstrap procedure for 400 steps is undertaken in order to get robust *p*-values. According to group mean tests (Gt and Ga) and using robust *p*-values, conclusion is that at least one panel unit is cointegrated, rejecting null hypothesis of no cointegration. Using pooled panel tests (Pt and Pa), null hypothesis is rejected indicating that all panel units are cointegrated. Conclusion related to Westerlund test is that at least one or all panel units are cointegrated.

Table no. 1 Westerlund (2007) cointegration test

Test	Value	Z-value	p-value	Robust p-value (bootstrap)
H_0: no cointegration H_1: at least one panel unit is cointegrated (heterogeneous assumption)				
Gt	-1.512	-2.726	0.003	**0.023**
Ga	-5.547	-2.030	0.021	**0.013**
H_0: no cointegration H_1: all panel units are cointegrated (homogeneous assumption)				
Pt	-9.233	-5.596	0.000	**0.010**
Pa	-5.883	-8.875	0.000	**0.005**
AIC selected lag length: 1				
AIC selected lead length: 2				

Source: Authors' estimation

With the intention to estimate long-run equilibrium relationship and heterogeneous fiscal adjustments, Mean Group and Pooled Mean Group methods are used (Table no. 2 represents homogeneous coefficients in model, while Table no. 3 shows heterogeneous coefficients). According to the results of homogeneous coefficients in both cases cointegration vector is significant and between 0 and 1, indicating *weak* sustainability (Quintos-a, 1995, $0 < \theta < 1$). Long-run relationship between public revenues and public expenditure in MG model is 0.582089, while in PMG 0.55747. In order to test whether lon-run cointegration vectors are equal to 0 or 1, Wald test is used, showing that hull hypothesis, $\theta = 0$, as well as null hypothesis $\theta = 1$ have to be rejected, confirming that $0 < \theta < 1$ and that *weak* fiscal sustainability exists in average of European Union members in both models. In comparison of two methods, higher fiscal adjustment is estimated for MG model, showing that 36.11% of deviations are corrected in one year, while according to PMG only 28.12%. However, using Hausman test conclusion is that restriction related to homogeneous long-run relationship in PMG model is true, meaning that PMG method is optimal, providing efficient and consistent estimates, while MG method provides consistent estimates.

Table no. 2 Homogeneous coefficients of Pooled Mean Group and Mean Group Estimators for EU-28 in the period 1995-2018

Dep. variable: log public revenues	Homogeneous long-run relationship (θ)		ΔlE		μ_i		Error correction (Φ_i)	
Mean Group Estimator	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
	0.582089	0.000	-0.0020	0.966	0.7528	0.000	-0.3611	0.000
$\theta = 1$	χ^2=8.30	0.004						
$\theta = 0$	χ^2=16.11	0.000						
PMG	0.55747	0.000	0.0041	0.928	0.4575	0.000	-0.2812	0.000
$\theta = 1$	χ^2=82.89	0.000						
$\theta = 0$	χ^2=131.55	0.000						
Hausman test for long-run relationship homogeneity								
	MG		PMG		MG-PMG			
Long-run relationship	0.582089		0.55747		0.02461			
Hausman test statistics			0.03					
p-value			0.8659					
ARDL (1,1)								

Source: Authors' estimation

Although Hausman test shows that long-run coefficients are not significantly different between countries (optimal model is PMG), the issue of this research is to find out in which countries precisely the problem of fiscal sustainability is presented. Therefore, in the Table no. 3 are shown heterogeneous coefficients for both models: efficient Pooled Mean Group, and consistent Mean Group estimates. Using Mean Group model, it is possible to test specific long-run equilibrium relationship for each country, and find out whether fiscal policy is sustainable, weak sustainable, or unsustainable in the period 1995-2018.

Tabel no. 3 Heterogeneous coefficients of Pooled Mean Group and Mean Group Estimators for EU-28 in the period 1995-2018

Dependent variable: log public revenues	Pooled Mean Group Estimator		Mean Group Estimator						
	Error-correction (Φ_i)		Error-correction (Φ_i)		Heterogeneous long-run relationship (θ)		θ=1		
Countries	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	χ^2	p-value	**Conclusion**
Austria	-0.651	0.000	-0.688	0.001	0.4622	0.009	9.32	0.0023	Weak sustainability
Belgium	-0.374	0.000	-0.368	0.002	0.5789	0.000	8.05	0.0046	Weak sustainability
Cyprus	-0.248	0.005	-0.245	0.018	0.5253	0.202			Unsustainable
Estonia	-0.688	0.000	-0.694	0.000	0.5972	0.000	17.85	0.0000	Weak sustainability
Finland	-0.303	0.025	-0.665	0.000	0.2693	0.000	209.0	0.0000	Weak sustainability
France	-0.272	0.005	-0.247	0.011	1.0157	0.001	0.000	0.9591	Sustainable
Germany	-0.040	0.727	-0.183	0.225	-0.3117	0.591			*Sustainable*
Greece	-0.117	0.151	-0.132	0.127	1.657	0.107			Unsustainable
Ireland	-0.083	0.365	-0.070	0.556	0.7584	0.534			Unsustainable
Italy	-0.377	0.004	-0.404	0.003	0.9933	0.000	0.00	0.9807	Sustainable
Latvia	-0.239	0.093	-0.240	0.125	0.6572	0.067	0.91	0.3391	Sustainable
Lithuania	-0.117	0.376	-0.226	0.107	-0.230	0.639			Unsustainable
Luxemburg	-0.197	0.129	-0.239	0.131	0.297	0.450			*Sustainable*
Malta	-0.174	0.048	-0.198	0.094	0.3181	0.601			Unsustainable

Netherlands	-0.201	0.103	-0.391	0.015	0.0223	0.921			Unsustainable
Portugal	-0.315	0.003	-0.315	0.007	0.5530	0.008	4.56	0.0327	Weak Sustainability
Slovak Republic	-0.326	0.026	-0.293	0.066	0.2762	0.397			Unsustainable
Slovenia	-0.172	0.186	-0.637	0.000	0.1704	0.004	200.9	0.0000	Weak sustainability
Spain	-0.177	0.044	-0.571	0.003	-0.1613	0.271			Unsustainable
Bulgaria	-0.277	0.043	-0.277	0.066	0.5447	0.406			Unsustainable
UK	-0.063	0.491	-0.179	0.192	0.1033	0.714			Unsustainable
Croatia	-0.233	0.168	-0.234	0.210	0.4963	0.583			Unsustainable
Hungary	-0.259	0.038	-0.252	0.089	0.6784	0.509			Unsustainable
Poland	-0.407	0.024	-0.390	0.047	0.2582	0.509			Unsustainable
Romania	-0.435	0.017	-0.418	0.037	0.7846	0.048	0.29	0.5879	Sustainable
Czech Republic	-0.206	0.088	-0.054	0.773	3.8909	0.780			Unsustainable
Denmark	-0.284	0.018	-0.437	0.037	0.2671	0.228			*Sustainable*
Sweden	-0.327	0.001	-0.352	0.001	0.8246	0.000	1.11	0.2931	Sustainable

Source: Authors' estimation

Using Wald test for heterogeneous cointegration vectors, it is possible to find out whether coefficient θ for each economy is equal to 1 in MG model (Table no. 3). Wald test indicates that long-run equilibrium relationships are not statistically different from 1 for France, Italy, Latvia, Romania and Sweden, meaning that fiscal sustainability in the *strong* sense exists in the listed countries. These results should be interpreted with caution, because estimated fiscal sustainability is related only to the flow variables, not taking into account public debt in the model directly, which is important indicator of fiscal sustainability. Weak sustainability is estimated for Austria, Belgium, Estonia, Finland, Portugal, and Slovenia. In Denmark, Germany and Luxemburg, cointegration relationships are not estimated, however, in situation when public revenues are higher than fiscal expenditure, fiscal sustainability is by default achieved. In analysed period average fiscal revenues in Denmark are 54.28 % of GDP and public expenditure 54.08 % of GDP, in Germany average public revenues are 44.26 % of GDP and public expenditure 44.05% of GDP, while in Luxemburg public revenues are 44.09 % of GDP, and public expenditure 42.18 % of GDP.

Based on results (Table no. 3), error-correction coefficients are the highest in Austria, Estonia (in both models), and Finland and Slovenia (using PMG model), meaning high fiscal adjustment - about 60 % of deviations from long-run equilibrium relationship is corrected in one year. The most weak but significant fiscal adjustment is estimated for the Malta (using both models), namely, only 17.4% (PMG), or 19.8% (MG) of deviations are corrected in one year. However, fiscal adjustments are not significant in Greece, Ireland, Lithuania, Netherlands, Slovenia, UK, Croatia, and this result could be related to crisis in fiscal sector in the majority of the mentioned countries. On the other hand, as it is expected, fiscal reactions in terms of public expenditure adjustments to long-run equilibrium relationship, are not significant in economies with higher public revenues in comparison to public expenditure, such as Germany and Luxemburg.

Finally, we can conclude that Hypothesis 1 is confirmed: *weak* fiscal sustainability exists in the sample of EU-28 according to homogeneous coefficients, as well as in some European economies in *strong* or *weak* sense. In relation to Hypothesis 2, fiscal adjustments to long-run equilibrium relationship are heterogeneous in the sample of EU-28; namely in some economies fiscal adjustments are negatively and significant with different magnitude of influence, while in others, insignificant.

5. Robustness check

Results based on Pool Mean Group and Mean Group method of estimation have at least two important restrictions: (1) models are based only on flow variables, and do not take into account for public debt directly in the models; this could have important implications on fiscal sustainability results especially in countries with high level of accumulated public debt, such as Belgium, France, Italy, Portugal, and (2) models do not account for cross-sectional dependency. Therefore, the relevance of the results could be analysed by robustness check in two ways: (i) in structural dimension, by reductions in *N* (Table no. 2A), and (ii) in time dimension, by reduction in *T* (Table no. 3A and 4A). Estimated model based on reduction in structural dimension is estimated for the EU-27 without Croatia, as the last economy entered in European Union (Table no. 2A). Presented results in Appendix confirmed validity of the results - weak sustainability in EU-28, with heterogeneous fiscal adjustments (fiscal adjustments are the same as in the initial model represented in Table no. 3). Model based on reduction in time dimension, is estimated without the first year used in analysis, the year 1995 (Table no. 3A), and without years 1995 and 1996 in the next model (Table no. 4A). Results showed that for the shorter period of time, long-run relationship between public revenues and public expenditure exists, and could not be consider statistically different from 1, meaning that in the period 1996-2018, and 1997-2018 *strong* fiscal sustainability exists in average of European Union economies according to MG model. This could be linked to Stability and growth pact from 1997 which provided better fiscal discipline in member states through stability programmes and through convergence programmes for economies in the accession phase.

6. Conclusions

Fiscal sustainability in EU-28 economies in the period 1995-2018 is analysed in this paper, using modern approaches for fiscal sustainability testing based on flow variables and panel cointegration analysis. The evidence of fiscal sustainability showed that cointegration relationship between public revenues and public expenditure exists in the *weak* sense for average of European economies, with heterogeneous fiscal adjustments, confirming by the result that public debt is integrated of level one. Error-correction coefficients are the highest in Austria, Slovenia and Finland, meaning high fiscal adjustments - about 60 % of deviations from long-run equilibrium relationship are corrected in one year, while the weakest adjustment is estimated for Malta (about 17-19% of deviations are corrected in one year). Robustness check in structural dimension (sample without Croatia) confirmed weak fiscal sustainability with heterogeneous fiscal adjustments, while reduction in time dimension, indicated better fiscal discipline in average of European Union Economies, indicating *strong* fiscal sustainability after introduction of Stability and Growth Pact in 1997.

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Appendix

Table no. 1A Pesaran CD test and Pesaran Unit Root Test

CD-test		**CD-test**	**p-value**	**Corr.**	**Abs. (corr.)**
Public revenues		8.85	0.000	0.093	0.349
Public expenditure		24.79	0.000	0.260	0.367
Public debt		6.2	0.000	0.77	0.507
CADF and CIPS test	**Lags**	**Model with constant[a]**			
Ho: I(1); H_1:I(0)		Level of variables		First difference of variables	
		$Z(\bar{t})$-statistika (CIPS)	p-value	$Z(\bar{t})$-statistika (CIPS)	p-value
Public revenues	**0**	-1.928	0.027	-21.263	0.000
	1	-3.472	0.000	-12.654	0.000
	2	**-0.474**	**0.318**	**-6.894**	**0.000**
Public expenditure	**0**	-4.342	0.000	-20.459	0.000
	1	-3.921	0.007	-11.796	0.000
	2	**-0.899**	**0.184**	**-5.752**	**0.000**
Public debt	**0**	3.039	0.999	-15.115	0.000
	1	-0.154	0.288	-8.025	0.000
	2	2.956	0.987	-3.565	0.005

Note: [a] Critical values for model with constant are: -2.070, -2.150, and -2.320 for the significance level 10%, 5% and 1%, respectively.

Source: Authors' calculations

Table no. 2A Robustness Check in Flow Model: EU-27 in period 1995-2018

Dep. variable: log public revenues	Homogeneous long-run relationship (θ)		ΔlE		μ_i		Error correction (Φ_i)	
Mean Group Estimator	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
	0.5852666	0.000	-0.0244	0.570	0.7646	0.000	-0.3658	0.000
$\theta = 1$	χ^2=7.60	0.0059						
$\theta = 0$	χ^2=15.13	0.0001						
PMG	0.5579138	0.000	-0.0179	0.663	0.4599	0.000	-0.2829	0.000
$\theta = 1$	χ^2=82.43	0.000						
$\theta = 0$	χ^2=131.28	0.000						
Hausman test for long-run relationship homogeneity								
	MG		PMG		MG-PMG			
Long-run relationship	0.5852666		0.5579138		0.0273528			
Hausman test statistics			0.03					
p-value			0.8577					
ARDL (1,1)								

Source: Authors' calculations

Table no. 3A Robustness Check in Flow Model: EU-28 in the period 1996-2018

Dependent variable: log public revenues	Homogeneous long-run relationship (θ)		Error correction (Φ_i)		ΔlE		μ_i	
Mean Group Estimator	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
	0.7956	0.040	-0.3759	0.000	-0.0018	0.968	0.8574	0.000
$\boldsymbol{\theta = 1}$	$\boldsymbol{\chi^2}$**=0.28**	**0.598**						
Pooled Mean Group Estimator	0.2257	0.000	-0.3105	0.000	0.0476	0.310	0.8946	0.000
$\theta = 1$	χ^2=538.0	0.000						
$\theta = 0$	χ^2=45.72	0.000						
Hausman test for long-run relationship homogeneity								
	MG		PMG		MG-PMG			
Long-run relationship	0.7956		0.22570		0.56999			
Hausman test statistics			1.83					
p-value			0.1757					
ARDL (1,1)								

Source: Authors' calculations

Table no. 4A Robustness Check in Flow Model: EU-28 in the period 1997-2018

Dependent variable: log public revenues	Homogeneous long-run relationship (θ)		Error correction (Φ_i)		ΔlE		μ_i	
Mean Group Estimator	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
	0.7156	0.021	-0.3744	0.000	-0.0008	0.968	0.8662	0.000
$\boldsymbol{\theta = 1}$	$\boldsymbol{\chi^2}$**=0.85**	**0.357**						
Pooled Mean Group Estimator	0.1918	0.000	-0.3029	0.000	0.0557	0.250	0.9113	0.000

$\theta = 1$	χ^2=615.1	0.000	
$\theta = 0$	χ^2=34.67	0.000	
Hausman test for long-run relationship homogeneity			
	MG	PMG	MG-PMG
Long-run relationship	0.7156	0.19185	0.5237
Hausman test statistics		2.45	
p-value		0.1175	
ARDL (1,1)			

Source: Authors' calculations