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Sustainability of social security systems in EU countries: Panel cointegration analysis with multiple structural breaks under cross-sectional dependence

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Abstract. *In this study, the sustainability of social security policies in EU countries was analyzed by panel data method with multiple structural breaks under cross-sectional dependence for the 1990-2013 periods. The existence of cointegration was tested by Basher and Westerlund (2009) method and series were found to be cointegrated. Cointegration coefficients were estimated by AMG method and it was determined that social security policies are sustainable in a weak form in these countries; when the social security systems' expenditure is increased by 1%, revenues are increased by 0.86% and revenues of the system cannot compensate the expenses. Austria has the highest rate of sustainability of the social security system while Ireland and Finland have the lowest rates.*

Keywords: social security system, sustainability; cross-sectional dependence; panel cointegration with multiple structural breaks; European Union.

JEL Classification: H55, P21, Q01.

1. Introduction

Many countries in the world spend a lot of effort to produce more goods and services with their factors of production in order to be more powerful in terms of politics and economics. Since companies encourage their employees to work and produce more, their working conditions often become worse and there is an increase in the risk of work-related accidents, ill-health or death. In this regard, the necessity of an advanced social security system, which guarantees the safety of life and property and a peaceful life during and after working, has become very important all over the world. Today, countries attempt to create an effective and sustainable social security system that provides a comfortable and happy life for their people. A social security system typically includes health care, maternity benefits, occupational accident benefits, old age benefits, unemployment compensation and survivors' benefits (ILO, 2014). According to the European Union (EU), the sustainability of a social security system depends on solidarity, universality, social justice and rights, the judicial process and democracy (Council of Europe, 2011: 13). A useful way of achieving the objectives of a well-designed and manageable social security system is having more information about the financial development and situation of this system (Settergren, 2008). In this context, more information is needed about the social security system in order to enable the sustainability of the public social security system and to eliminate future shocks and uncertainties. In general, social security systems face three basic problems:

- The rapidly increasing rate of aging.
- Changes in the labour market.
- Changes in family structures.

(ILO, 2001: 3).

Both developed and developing countries encounter these problems (Holzmann and Jousten, 2012: 606). The International Social Security Association (ISSA) examines demographic changes and transformations affecting the social security system under seven topics as follows:

- Aging.
- A smaller and more irregular family structure.
- Extensive transformations in the labour market.
- Urbanization.
- Mismatches in the life cycle.
- Changes in immigration and
- Changes in social structure.

(ISSA, 2010: 6-17).

The aging population results in huge financial pressure on public pension systems (Staubli and Zweimuller, 2013: 18). This problem is more urgent for some regions and countries (Table 1).

Table 1. *Projections of population aging in the world*

	Population over 60 (% of total population)					Population over 80 (% of total population)				
	2000	2005	2010	2030	2050	2000	2005	2010	2030	2050
World	9.9	10.2	11.0	16.5	21.9	1.1	1.3	1.5	2.3	4.3
Developed regions *	19.5	20.1	21.8	28.8	32.6	3.1	3.7	4.3	6.4	9.5
Less developed regions**	7.5	8.0	8.6	14.2	20.2	0.7	0.8	0.9	1.6	3.5

* Developed regions comprise Europe, North America, Australia/New Zealand and Japan. ** Less developed regions comprise all regions of Africa, Asia (excluding Japan), Latin America and the Caribbean plus Melanesia, Micronesia and Polynesia. Source: ILO (2011). World Social Security Report 2010/11: Providing Coverage in Times of Crisis and Beyond. ILO, Geneva, 139-143.

Considering Table 1, it is clear that aging of the world population will rapidly increase and the most important socio-economic problem countries will face will be their aging populations and the sustainability of their social security systems. In recent years, the elderly dependency ratio seems to have been constantly increasing in most of the developed countries. Due to this increase, the taxes received from the active population are insufficient to maintain state pension funds.

In 2010 years, 20% of the EU population was over 60 years old and this ratio is expected to increase by 2030 by up to 30% (ISSA, 2013: 2). Particularly the immigrant population in the EU is contributing to the aging trend (Bolzman, 2012: 100). In addition, the majority of EU countries are experiencing serious difficulties in maintaining their state pension systems (European Actuarial Consultative Group, 2012: 17).

Low fertility rates and increases in life expectancy have forced the majority of European countries to make important legal changes to the rules on early retirement (Angelini, 2009: 3) and increase the mandatory retirement age (UN, 2013: 56). Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy and the United Kingdom have all legislated to increase the retirement age (Fuente and Doménech, 2013: 114). Developed countries are trying to take precautions by encouraging extended participation of elderly people in working life and by promoting complementary private pension systems in order to reduce the financial burden of pension obligations on the state. (United Nations, 2013: 56). In this context, the EU Commission proposes implementation of the following components for the pension reform (COM, 2012: 10-14):

- Establishing a link between increasing life expectancy and retirement age,
- Limiting early retirement or other ways for early retirement,
- Promoting longer working life by improving access to lifelong learning programs,
- Improving the relationship between the quality of labour and enterprises,
- Improving employment opportunities for older people,
- Supporting active and healthy aging,
- Equalization of the retirement age of women and men,
- Promoting the complementary pension system to increase the retirement income.

In EU countries, tax incomes have become the most important source of income for all coverage and sustainability of social security systems (O'Cinneide, 2010: 47). An important means of increasing tax income derived from the active population is to increase the participation rate of the population that are of working age (Woods, 2000: 27). Information about the participation rate of the labour force in the countries is presented in Table 2.

Table 2. *Projections of labour force to population ratios at ages 15–64 in the world*

	Labour force participation rates of population at ages 15–64 (%)			
	2000	2005	2010	2020
World	70.3	69.9	69.9	69.8
Developed regions *	71.3	71.7	72.3	73.1
Less developed regions**	70.1	69.5	69.3	69.2

* Developed regions comprise Europe, North America, Australia/New Zealand and Japan. ** Less developed regions comprise all regions of Africa, Asia (excluding Japan), Latin America and the Caribbean plus Melanesia, Micronesia and Polynesia. Source: ILO (2011). World Social Security Report 2010/11: Providing Coverage in Times of Crisis and Beyond. ILO, Geneva, 155-159.

Considering the data presented in Table 2, the participation rate of labour force was 70.3% worldwide in 2000; however, it is expected to fall down to 69.8% in 2020. In social security systems with premiums, actuarial balance is the criterion is widely used for assessing the financial stability of social insurance institutions. Actuarial balance for any period is the difference between the present value of annual incomes in that period and the current costs in the same period (Plamondon et al. 2002: 52-53; Billig and Ménard, 2013: 46).

In recent years, the sustainability of social security systems has become one of the most important issues in developed and developing countries. There are many studies on this issue. These studies have often focused on testing the sustainability of a current social security system and the effects of reforms undertaken to improve sustainability. In this regard, in the study of Brugiavini and Galaso (2004), to determine the sustainability of the social security system and identify political impacts of the aging in Italy, it has been stated that the impacts of reforms are positive and some new steps should be taken. Fehr and Haberman (2006) investigated the effects of pension reforms developed to improve the sustainability of the current pension system in Germany and concluded that reforms mitigate this burden by fifty percent on future generations. Bloom et al. (2007), via panel data analysis was applied for 63 countries for 1960-2000 periods; they found that aging damaged the sustainability of social system in these countries.

Chateau et al. (2008) investigated the impact of pension reforms and aging on the capital and labour market in the United Kingdom, Germany and France and stated that sustainnability of pension system is difficult to finance without debt in the long term. In the study of Zhang and Zhang (2009), which examined the relationship between human capital investments and economic growth, it has been determined that as the age of mandatory retirement gets lower, the level of savings and human capital reduces. In the same study, it has been stated that a lower mandatory retirement age reduces the growth rate.

Kitao (2013) tried to determine the sustainability of the US social security system by addressing the three social security policies as follows:

- Increasing income taxes by 6 points,
- Reducing one-third of the social aids allocated for employees,
- Increasing retirement age from 66 to 73 and reducing social aids provided for personnel.

In the analysis, it has been indicated that the social security system of the US is not sustainable. Staubli and Zweimüller (2013) studied the effect of increased retirement age in Austria on employment and determined that increased retirement age increases employment rates of male workers by 9.75% and female workers by 11% and improves the sustainability of the social security system. Burz (2013) created the social security sustainability index utilizing the socio-economic characteristics of EU countries. According to the study, Sweden, Ireland, Netherlands, Luxembourg and Finland have the highest index values, whereas Latvia, Lithuania and Bulgaria have the lowest index values.

In the study of Miyazaki (2014), the impact of increased official retirement age on economic variables was investigated and it was found that increased official retirement age does not increase the amount of production and this policy may reduce the benefits of social security system. In the empirical study of Bonasia and Siano (2014) conducted in Italy, the factors negatively affecting the sustainability of social security system were determined as a worsening in elderly dependency, decline in the birth and employment rates and early retirement.

The aim of this study was to investigate the sustainability of social security systems in EU countries by using the data of revenues and expenses for the period of 1990-2013 via panel cointegration analysis with multiple structural breaks under cross-sectional dependence. In the second section of the study, empirical analysis was conducted and study was completed with results and suggestion sections. Considering the analysis methods and actuality of the subject, we believe that this study will provide a contribution to research on this subject and draw the attention of policy makers on this issue once again.

2. Analysis

2.1. Data set

In this study, logarithmic forms of the data for incomes (IN) and expenditures (EXP) of social security system of 12 countries (Belgium, Denmark, Germany, Ireland, France, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, Switzerland) that we could obtain data sets of social security systems among EU15 countries for the period of 1990-2013 were used. The data was obtained from UNCTAD, the World Bank and IMF.

2.2. Model

In the study, the following model was developed, in order to examine the sustainability of social security policies, based on the Hakkio and Rush (1991) model, which was developed to analyze the sustainability of the budget deficit in the US and adapted to the analysis of sustainability of the current account in the US by Husted (1992).

$$IN_t = \beta_0 + \beta_1 EXP_t + \varepsilon_t \qquad (1)$$

In the studies of Hakkio and Rush (1991) and Husted (1992), under the existence of cointegration condition, when $\beta_1=1$, the policies discussed are accepted as sustainable. Quintos (1995) has flexed this condition a little bit and stated that the relevant policy is strongly sustainable if the coefficient is equal to one; however, it is sustainable in a weak form if the value of coefficient is between the range of zero and one.

2.3. Method

In the study, the relationship between cross-sections (counties) forming the panel was investigated by $CDLM_{adj}$ (Adjusted Cross-sectional Dependence Lagrange Multiplier) test, which was developed by Breusch and Pagan (1980) and adjusted by Pesaran et al. (2008). Stationarity of the series was tested by the method of PANKPSS (Panel Kwiatkowski-Phillips-Schmidt-Shin), which was developed by Carrion-i-Silvestre et al. (2005). This method considers the cross-sectional dependence and structural breaks in the series. The homogeneity of cointegration coefficients was tested by the method developed by Pesaran and Yamagata (2008). The existence of cointegration relationship between series was tested by the method developed by Basher and Westerlund (2009) which takes cross-sectional dependence and structural breaks in cointegration vector into account. Cointegration coefficients were estimated by using the AMG (Augmented Mean Group) method developed by Eberhart and Bond (2009) which considers the cross-sectional dependence.

2.3.1. Testing cross-sectional dependence

It is necessary to consider whether cross-sectional dependence significantly affects the results (Breusch and Pagan, 1980). Therefore, before starting the analysis, it is necessary to test the existence of cross-sectional dependence in series and cointegration equations, taking into account the choice of unit root and cointegration tests to be applied. Otherwise, the analysis will produce biased results (Pesaran, 2004: 14).

Studies to investigate the existence of cross-sectional dependence began with Berusch and Pagan (1980) CDLM test. This test gives biased results when the group average is equal to zero, but individual average values are not equal to zero. Pesaran, Ullah and Yamagata (2008) adjusted this deviation by adding variance and average value into test statistics. Therefore, its name was changed to $CDLM_{adj}$. The initial version of CDLM test statistics is as follows:

$$CDLM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^{2} \sim \chi^{2}_{\frac{N(N-1)}{2}} \qquad (2)$$

After making adjustments, the equation has become as follows:

$$CDLM_{adj} = \left(\frac{2}{N(N-1)}\right)^{1/2}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^{2}\,\frac{(T-K-1)\hat{\rho}_{ij}-\hat{\mu}_{Tij}}{\upsilon_{Tij}} \sim N(0,1) \qquad (3)$$

Where μ_{Tij} represents the average and v_{Tij} represents the value of variance. The test statistics obtained from this equation show standard normal distribution asymptotically. The null of this is no cross-sectional dependence (Pesaran et al., 2008). In this study, the existence of cross-sectional dependence in variables and cointegration equations was tested by $CDLM_{adj}$ test and the results obtained are presented in Table 3.

Table 3. *Cross-Sectional dependence test results*

Variables	Test statistics	Probability value
IN	7.419	0.000
EXP	7.111	0.000
Cointegration Equation	125.192	0.000

According to the results given in Table 3, the null hypothesis of the variables and regression model was strongly rejected and it has been concluded that there is a cross-sectional dependence among these countries. In this case, an economic shock suffered by one of these countries affects the others. Therefore, countries should consider practices of other countries while developing economic policies. In addition, while choosing methods to be used in the next steps of the analysis, test methods taking cross-sectional dependence into account were preferred.

2.3.2. Panel unit root test

The first problem encountered in the panel unit root test is whether cross-sections forming the panel are independent from each other. At this point, panel unit root tests are divided into two groups, namely first and second generation tests.

First generation tests are Maddala and Wu, (1999); Hadri, (2000); Choi (2001); Levin, Lin and Chu, (2002); Im, Pesaran and Shin, (2003) and Breitung, (2005) tests. These tests are developed on the assumption that cross-sections forming the panel are independent from each other and all cross-section units are equally affected by a shock received by a single unit of the panel. However, it is a more realistic approach that cross-section units are affected at different levels by a shock received by a single unit of the panel.

Second generation tests analyzing the stationarity by considering dependency between cross-sections are developed in order to correct this unrealistic approach offered by first generation tests. The major second generation unit root tests are Taylor and Sarno, (1998) MADF (Multivariate Augmented Dickey Fuller); Breuer, Mcknown and Wallace, (2002) SURADF (Seemingly Unrelated Regression Augmented Dickey Fuller); Bai and Ng (2004) and Pesaran, (2006a) CADF (Cross-sectional Augmented Dickey Fuller).

However, these tests give biased results, indicating that there is unit root when structural breaks exist in the series (Charemza and Deadman, 1997: 119). In order to correct these biased results, Carrion-i-Silvestre et al. (2005) have developed the PANKPSS test to check the stationarity of the series when cross-sectional dependency and multiple structural breaks exist. The aim of this test is being able to test the stationarity of the series in case of the existence of structural breaks in average values and trends of the series forming the panel. In addition, in each cross-section forming the panel, it allows structural breaks to occur at various numbers and different dates. Thus, the stationarity of the series can be calculated for both the whole panel and each cross-section separately (Guloglu and Ispir, 2011: 209). The test model is as follows:

$$Y_{it} = \alpha_{it} + \beta_{it}t + \varepsilon_{it} \qquad i = 1,2,\ldots,N \ and \ t = 1,2,\ldots,T \tag{4}$$

$$\alpha_{i,t} = \sum_{k=1}^{m} \theta_{i,k} D_{1_{i,t}} + \sum_{k=1}^{m} \gamma_{i,k} D_{2_{i,t}} + \alpha_{i,t-1} + u_{i,t} \quad (5)$$

$$\beta_{i,t} = \sum_{k=1}^{n} \varphi_{i,k} D_{1_{i,t}} + \sum_{k=1}^{n} \delta_{i,k} D_{2_{i,t}} + \beta_{i,t-1} + v_{i,t} \quad (6)$$

D_1 and D_2 are dummy variables and defined as follows:

$$D_1 = \begin{cases} 1, & t = T_B + 1 \\ 0, & otherwise \end{cases} \qquad D_2 = \begin{cases} 1, & t > T_B + 1 \\ 0, & otherwise \end{cases}$$

In this equation, T_B represents the breaking point and allows structural breaks (m-times) in the constant term and structural breaks (n-times) in the trend. The Carrion-i-Silvestre et al. test (2005) was designed to allow up to five structural breaks. This test identifies structural break dates as the points, where the sum squares of residual has the lowest value, by following the procedure of Bai-Perron (1998). Bai-Perron (1998) proposed two different processes to determine the structural break points: The first one is based on a modified version of the Schwarz information criterion developed by Liu, Wu and Zidek (1997) and the second is based on F statistics. Carrion-i-Silvestre et al. (2005: 164) used the first process for the model with trend and the second process for the model without trend while determining the number of structural breaks. The null of this test is stationary. Estimated test statistics are compared with critical values calculated using the bootstrap (Carrion-i-Silvestre, et al., 2005: 164). In this study, the stationarity of the series was tested by using the PANKPSS method and test statistics obtained and critical values are presented in Table 4.

Table 4. *Panel unit root test results*

	IN	*Break date*	*ΔIN*	*EXP*	*Break date*	*ΔEXP*
Belgium	3.454	1993;2000;2007	1.737***	6.035	1993;2001;2007	0.910***
Denmark	0.956	-	0.759***	2.851	-	0.643***
Germany	0.488	1991;1994;2001	0.581***	0.386	1991;1994;2001	0.643***
Ireland	0.379	1996;2000;2005	0.196***	0.379	1996;2001;2006	0.040**
France	3.450	1993;1999;2005	1.968***	2.172	1992;2000;2006	0.050**
Italy	0.351	1995;2001;2006	0.073**	0.296	1995;2002;2007	0.060**
Luxembourg	3.396	1993;1999;2006	0.124***	3.772	1993;2000;2007	0.436***
Netherlands	0.164	1998;2002;2007	0.139***	1.487	1992;2001;2007	0.323***
Austria	4.203	1992;1998;2006	0.143***	4.132	1992;1998;2006	0.707***
Portugal	1.355	1991;1999;2005	0.140***	1.289	1991;1999;2005	0.837***
Finland	3.262	1993;2000;2006	0.174***	6.029	1993;2002;2008	0.110***
Switzerland	0.177	1992;1999;2009	0.135***	1.525	1992;2000;2009	0.106***
Panel	125.425	-	12.38***	173.998	-	45.80***

Note: Critical values are obtained with 1000 replication by using bootstrap. ** and *** shows 5% and 1% significance levels respectively. Structural break dates were determined by the model which considers breaks in level and trend. Because of the short time dimension of the data set, it is allowed a maximum of three structural breaks.

Considering the results given in Table 4, series were found to be non-stationary in levels for the whole panel and countries, they became stationary when their first difference is taken, that is *I(1)*. In this case, the existence of the cointegration relationship among the series can be tested. The test method identified the structural breaks in countries successfully. According to the results obtained, the years of 1992-1993 correspond to the year when Maastricht criteria, which is also known as the Treaty on European Union, were accepted and the name of European Economic Community has been changed to European Community; the year of 1995 corresponds to the year when Austria, Sweden and Finland were accepted to the Community; the years of 1998-2000 corresponds to the year when non-member states Iceland and Norway were also included in the free movement area. In 2002, the Euro was accepted as the common unit of currency by 12 member states. In 2004, the number of member states increased up to 25 by including 10 more countries (the Czech Republic, Estonia, South Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia and Slovenia) and 27 in 2007 by accepting Bulgaria and Romania as members of the EU. In addition, the global economic crisis of 2008 significantly affected the data of the countries.

2.3.3. Testing the homogeneity of cointegration coefficients

The first studies regarding the homogeneity of slope coefficient in the cointegration equation was firstly conducted by Swamy (1970). The Swamy test was refined by Pesaran and Yamagata (2008). This test evaluates whether slope coefficients in the cointegration equation are different between cross-sections. The null of these slope coefficients are homogeneous. Pesaran and Yamagata (2008) have developed two different test statistics in order to test this hypothesis:

For larger samples:

$$\hat{\Delta}= \sqrt{N}\left(\frac{N^{-1}\tilde{S}-k}{2k}\right)\sim\chi_k^2 \tag{7}$$

For smaller samples:

$$\hat{\Delta}_{adj}= \sqrt{N}\left(\frac{N^{-1}\tilde{S}-k}{v(T,k)}\right)\sim N(0,1) \tag{8}$$

Where, *N:* the number of cross-sections, *S*: Swamy test statistics, *k:* the number of explanatory variables and $\upsilon(T,k)$ standard deviation, respectively. Homogeneity test of the slope coefficient for Equation (1) was performed and results obtained are presented in Table 5.

Table 5. *Slope homogeneity test*

	Test statistics	Probability value
$\tilde{\Delta}$	-1.137	0.872
$\tilde{\Delta}_{adj}$	-1.212	0.887

According to the results presented in Table 5, the null hypothesis is accepted and slope coefficients were accepted to be homogenous in the cointegration equation. In this case, comments on the whole panel is reliable.

2.3.4. Panel cointegration test with structural breaks

This method, which was developed by Basher and Westerlund (2009), was used to test the existence of cointegration relationship between non-stationary series in level in case of the existence of cross-sectional dependence and multiple structural breaks. This method allows structural breaks in constant term and trend. The test statistics developed by Basher and Westerlund (2009: 508):

$$Z(M) = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{M_i+1}\sum_{t=T_{ij-1}+1}^{T_{ij}} \frac{S_{it}^2}{(T_{ij} - T_{ij-1})^2 \hat{\sigma}_i^2} \tag{9}$$

Where:

$\hat{W}_{st}$ is the regression residual obtained by using any efficient estimator of the cointegration vector such as the fully modified least squares (FMOLS) estimator. $\hat{\sigma}_i^2$ is the usual Newey and West (1994) long-run variance estimator based on $\hat{W}_{st}$. *Z(M)* becomes the following when it is abbreviated by taking cross-sectional averages as follows:

$$Z(M) = \sum_{t=T_{ij-1}+1}^{T_{ij}} \frac{S_{it}^2}{(T_{ij} - T_{ij-1})^2 \hat{\sigma}_i^2} \sim N(0,1) \tag{10}$$

The test statistic obtained is distributed normally. The null of this test is existence of cointegration. In the study, Basher and Westerlund cointegration tests (2009) were conducted and results are presented in Table 6.

Table 6. *Panel cointegration with multiple structural breaks test results*

	Test Statistics	Probability Value	Decision
No Breaks in Level	-0.365	0.880	There is cointegration
No Breaks in Level and Trend	1.914	0.016	There isn't cointegration
Breaks in Level	19.712	0.256	There is cointegration
Breaks in Level and Trend	-16.871	0.764	There is cointegration

Note: Probability values are obtained with 1000 replication by using bootstrap.

Considering the results given in Table 6, there is cointegration relationship between the series. According to this finding, it has been concluded that these series act together in the long term, long term analyses to be conducted with level values will not include spurious regression problems and the results that will be obtained will be reliable. In addition, structural break dates estimated in cointegration equations of the countries are given in Table 7.

Table 7. *Dates of structural breaks estimated in cointegration equation*

Countries	Structural break dates
Belgium	1993; 1997; 2008
Denmark	1996; 2001
Germany	-
Ireland	1998; 2008
France	1996; 2004; 2008
Italy	-
Luxembourg	1999; 2004; 2008
Netherlands	-
Austria	1994; 2007
Portugal	1995
Finland	1993; 2005
Switzerland	-

Note: Structural break dates were determined by the model which considers breaks in level and trend. Because of the short time dimension of the data set, it is allowed a maximum of three structural breaks.

Structural break points given in Table 7 were included by dummy variables in the process of cointegration coefficient estimation.

2.3.5. Estimating cointegration coefficients and error correction model

The first estimator developed to estimate cointegration coefficients in case of the existence of cross-sectional dependence is Pesaran (2006) *CCE* method (Common Correlated Effects). This method calculates the cointegration coefficient of the whole panel by taking the arithmetic mean of the individual coefficients using *CCMGE* (Common Correlated Mean Group Effects) method after estimating individual cointegration coefficients. However, it is more reasonable to say that the impact of countries on the overall panel varies due to the differences in their economies. In the P*anel AMG (Augmented Mean Group)* method developed by Eberhardt and Bond (2009), the result of the entire panel was calculated by weighting the individual coefficients and taking cross-sectional dependences into account. It is more reliable than *CCMGE* (Eberhardt and Bond, 2009: 1). The *Panel AMG* method can take both common factors and dynamic impacts in the series into account, produce effective results even in unbalanced panels and can be used in the existence of the endogeneity problem related to the error term (Eberhardt and Bond, 2009: 4). In this study, cointegration coefficients were estimated by the method of *Panel AMG* and results are presented in Table 8.

Table 8. *Cointegration coefficients and error correction mechanism*

Countries	*EXP*	D_1	D_2	D_3	*Constant*	ECT_{t-1}
Belgium	0.91***	-0.016	0.015	0.006	0.87	-0.77***
Denmark	0.90***	-	-0.005	-0.059	0.83	-0.74***
Germany	0.88***	-	-	-	1.40	-0.70***
Ireland	0.70***	-	-0.019	-0.055	2.21	-0.52***
France	0.85***	0.004	-0.015	0.023*	1.75	-0.46***
Italy	0.96***	-	-	-	0.44	-1.01***
Luxembourg	0.90***	-0.003	-0.028	0.38	0.84	0.006
Netherlands	0.78***	-	-	-	2.32	-0.77***
Austria	1.02***	0.004	-	-0.006	-0.26	-0.68***
Portugal	0.94***	-0.061	-	-	0.49	-0.54**
Finland	0.70***	-0.068**	-	0.001	3.00	-0.51***
Switzerland	0.76***	-	-	-	2.26	-0.57***
Panel	0.86***	-0.011	-0.004	-0.004	0.93	-0.58***

Note: Autocorrelation and heteroscedasticity problems in estimations were corrected with Newey-West method. *, ** and *** %10, %5 and %1 significance levels, respectively.

According to the results presented in Table 8, since the coefficient of expenditure variable is smaller than one, social security policies in all countries are sustainable in a weak form. In these countries, when expenditures of the social security system are increased by 1%, their revenues also increase by 0.86% and revenues of the system cannot meet the expenditures. Austria seems to have the highest level of sustainability in terms of social security systems. In this country, revenues of the system exceed the expenditures and therefore their system is strongly sustainable. Ireland and Finland have the lowest level of sustainability for their social security systems. In these countries, revenues of the system can meet only 70% of the expenditures. The results are consistent with the studies of Chateau et al. (2008) and Burz (2013) in the literature.

In the analysis, the error correction model was estimated and coefficients of error correction term were also estimated by panel AMG methods. The findings are presented in the last column of Table 8. According to these results, the coefficient of error correction term was found to be negative and statistically significant in the panel in general and all countries except Luxembourg. Thus, deviations occurring in short term between the series acting together are eliminated and the series converges back to long-run equilibrium value. Long-term analyses for these countries are reliable.

3. Conclusions

In this section, the main findings of the study and various suggestions within the scope of analysis are proposed. In the study, the sustainability of social security policies were analyzed by taking logarithmic forms of the data for incomes and expenditures of social security system of 12 countries that we could obtain data sets of social security systems among EU15 countries for the period of 1990-2013 into account. The model to be estimated was developed by following Hakkio and Rush (1991), Husted (1992) and Quintos (1995).

The existence of cross-sectional dependence among countries was analyzed by $CDLM_{adj}$ test developed by Pesaran et al. (2008) and it has been decided that there is cross-sectional dependence among countries. Therefore, in the following sections of the analysis, second generation test methods considering this cross-sectional dependence was used. The stationary of series was tested by one of the second generation test methods PANKPSS developed by Carrion-i-Silvestre et al. (2005) and series were found to be non-stationary in levels, but they have become stationary in their first differences. The existence of cointegration relationship between series was tested by a method developed by Basher and Westerlund (2009) which considers cross-sectional dependence and structural breaks in cointegration vector. It has been determined that cointegration relationship exists between the series. The homogeneity of cointegration coefficients was analyzed by Pesaran and Yamagata (2008) method. Cointegration coefficients were estimated by AMG method, which takes cross-sectional dependence into account, developed by Eberhart and Bond (2009).

According to the results, social security policies in these countries are sustainable in a weak form. In these countries, when expenditures of the social security system are increased by 1%, their revenues also increase by 0.86% and revenues of the system cannot meet the expenditures. Austria has the highest level of sustainability. In this country, revenues of the system exceed the expenditures. Ireland and Finland have the lowest level. In these countries, revenues of the system can meet only 70% of the expenditures.

Based on findings of this study; the sustainability of social security systems in EU countries is partially weak and policy makers should take necessary measures by spending special effort in this area. EU countries couldn't overcome the negative impacts of the global crisis that took place in 2008 and there are countries such as Greece, Ireland, Italy, Spain and Portugal struggling with high public debt. It is clear, then, that having social security systems which don't have a deficit and positive effect on public deficit is important.

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