Supplementary Appendix to

Fiscal Sustainability in Ageing Societies: Evidence from Euro Area countries

This supplementary appendix is divided into four sections. In Section S1 we present the results from the panel unit root tests. In Section S2 we provide the empirical estimations obtained for the Central and Peripheral EA counties using the FE, RE and POLS estimation methods. In Section S3 we offer the empirical estimations obtained for the relatively old and relatively young EA counties using the FE, RE and POLS estimation methods. In Section S4 we present the empirical estimations obtained for the more relatively indebted and the less relatively indebted EA counties using the FE, RE and POLS estimation methods. Lastly in Section S5, we summarise the procedure used to standardize regression coefficients and to calculate relative contributions.

S1: Panel unit root tests

	Level						
Test Statistic	Primary balance	Debt/potent GDP	Real GDP	Findevelop	Outputgap	Infl	Olddep
LLC							
Level	-3.1901 (0.0007)	0.6351 (0.7373)	-1.9936 (0.0231)	-2.2845 (0.012)	-4.6744 (0.0000)	-7.3022 (0.0000)	-3.0469 (0.0012)
Trend	-0.3496 (0.3633)	1.0647 (0.8565)	-0.1749 (0.4306)	2.1890 (0.9857)	2.1883 (0.9857)	-4.0875 (0.0000)	-5.4840 (0.0000)
HT							
Level	0.8625 (0.0027)	0.9938 (0.9981)	0.9869 (0.9952)	0.9738 (0.9788)	0.8563 (0.0012)	0.8759 (0.0139)	0.9937 (0.9981)
Trend	0.8152 (0.4290)	0.8953 (0.9830)	0.8865 (0.9691)	0.9553 (0.9995)	0.8213 (0.4984)	0.6960 (0.0002)	0.9914 (1.0000)

Breitung							
Level	-5.0275 (0.0000)	4.3621 (1.0000)	10.5162 (1.0000)	5.0659 (1.0000)	-3.6394 (0.0001)	1.2556 (0.8954)	14.7526 (1.0000)
Trend	-2.3727 (0.0088)	2.8297 (0.9977)	2.2790 (0.9887)	6.1252 (1.0000)	-2.4536 (0.0071)	-0.0300 (0.4880)	11.0467 (1.0000)
IPS							
Level	-1.6872 (0.0458)	5.0608 (1.0000)	2.2740 (0.9885)	2.8657 (0.9979)	-1.8222 (0.0342)	-3.4805 (0.0003)	5.0432 (1.0000)
Trend	-2.3955 (0.0083)	-1.2685 (0.1023)	0.6358 (0.7375)	2.1328 (0.9835)	-2.3066 (0.0105)	-5.4065 (0.0000)	4.9108 (1.0000)
Fisher							
Level	4.1737 (0.0000)	-1.1203 (0.8687)	-1.1136 (0.8673)	-0.0108 (0.5043)	5.1730 (0.0000)	6.7573 (0.0000)	2.1920 (0.0142)
Trend	2.5324 (0.0057)	-0.2579 (0.6017)	-1.7370 (0.9588)	-1.1994 (0.8848)	2.6635 (0.0039)	5.9086 (0.0000)	0.0721 (0.4713)
	First Difference						
Test Statistic	Primary balance	Debt/potent GDP	Real GDP	Findevelop	Outputgap	Infl	Olddep
LLC							
Level	-9.2821 (0.0000)	-10.1842 (0.0000)	-10.3979 (0.0000)	-5.6496 (0.0000)	-10.2644 (0.0000)	-9.7704 (0.0000)	-2.5208 (0.0059)
Trend	-5.6867 (0.0000)	-7.5054 (0.0000)	-8.7174 (0.0000)	-4.0792 (0.0000)	-5.8588 (0.0000)	-3.9593 (0.0000)	-3.8345 (0.0001)
HT							
Level	0.2614 (0.0000)	0.2328 (0.0000)	0.1770 (0.0000)	0.4045 (0.0000)	0.2871 (0.0000)	0.0690 (0.0000)	0.9357 (0.6743)
Trend	0.2647	0.2996	0.4189	0.4236	0.2910	0.0879	0.9507

	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.9999)
Breitung							
Level	-8.2906 (0.0000)	-5.6975 (0.0000)	-7.7981 (0.0000)	-7.6012 (0.0000)	-7.7752 (0.0000)	-9.2000 (0.0000)	4.7596 (0.0000)
Trend	-9.1508 (0.0000)	-6.3500 (0.0000)	-7.7815 (0.0000)	-5.8203 (0.0000)	-8.9282 (0.0000)	-10.3983 (0.0000)	4.7136 (0.0000)
IPS							
Level	-9.4120 (0.0000)	-8.3864 (0.0000)	-8.9589 (0.0000)	-7.1371 (0.0000)	-9.2627 (0.0000)	-12.4111 (0.0000)	4.0753 (0.0000)
Trend	-9.4223 (0.0000)	-8.5043 (0.0000)	-9.4198 (0.0000)	-7.3197 (0.0000)	-9.3268 (0.0000)	-12.5983 (0.0000)	4.0000 (0.0000)
Fisher							
Level	14.5558 (0.0000)	7.3459 (0.0000)	9.2274 (0.0000)	3.6583 (0.0001)	13.0439 (0.0000)	28.2315 (0.0000)	4.9382 (0.0000)
Trend	9.0533 (0.0000)	2.7657 (0.0028)	6.5074 (0.0000)	1.3316 (0.0915)	7.8466 (0.0000)	25.6732 (0.0000)	4.8439 (0.0000)

Note: Numbers in parenthesis are p-values.

S2: Detail empirical results for Central and Peripheral EA countries

Table S2.1. Parameter estimates for the empirical model: Central EA countries

	FE	RE	POLS
GPB_{it-1}	0.4545***	0.4776***	0.4776***
	(0.0376)	(0.0343)	(0.0618)
$\Delta debt_{it}$	-0.0578***	-0.0569***	-0.0569***
	(0.0109)	(0.0107)	(0.0100)
g_{it}	0.0048***	0.0056***	0.0056**
	(0.0013)	(0.0011)	(0.0024)
$\Delta findev_{it}$	-0.0103	-0.0117*	-0.0117*
	(0.0070)	(0.0067)	(0.0064)
$outputgap_{it}$	0.3012***	0.2897***	0.2897***
	(0.0264)	(0.0254)	(0.0402)
inf_{it}	-0.0653***	-0.0604***	-0.0604***
	(0.0199)	(0.0192)	(0.0183)
Δold_{it}	-54.6054***	-48.4968***	-48.4968***
	(11.9922)	(11.1476)	(12.3465)
Constant	0.3942***		0.3505***
	(0.0865)		(0.0966)
Country FE	Yes	Yes	No
Year FE	Yes	Yes	No
N	234	234	234
R^2 overall	0.8224	0.8234	0.8234
R^2 within	0.8161	0.8154	
R^2 between	0.9298	0.9501	
BIC	371.31	375.69	376.59
AIC	343.67	344.16	348.94
Endogeneity test of all regressors	2.362 [0.1243]		
Breusch and Pagan test (POLS vs RE)	0.000 [1.0000]		
F test for fixed effects (POLS vs FE)	1.01 [0.4139]		
Haussman test (FE vs RE)	5.09 [0.4049]		

Notes: In the ordinary brackets below the parameter estimates are the corresponding *z*-statistics, computed using White (1980)'s heteroskedasticity-robust standard errors. In the square brackets below the specification tests are the associated *p*-values. *, ** and *** indicate significance at 10%, 5%, and 1% respectively.

Table S2.2. Parameter estimates for the empirical model: Peripheral EA countries

	FE	RE	POLS
GPB_{it-1}	0.6826***	0.6861***	0.6861***
	(0.0382)	(0.0382)	(0.0463)
$\Delta debt_{it}$	-0.0399***	-0.0463***	-0.0463***
	(0.0093)	(0.0093)	(0.0169)
g_{it}	0.0260***	0.0216***	0.0216***
	(0.0034)	(0.0031)	(0.0031)
$\Delta findev_{it}$	-0.0096	-0.0067	-0.0067
	(0.0058)	(0.0058)	(0.0067)
$outputgap_{it}$	0.1081***	0.1043***	0.1043***
	(0.0189)	(0.0183)	(0.0323)
inf_{it}	-0.0169	-0.0015	-0.0015
	(0.0109)	(0.0095)	(0.0122)
Δold_{it}	-8.0904*	40.3551*	40.3551
	(12.4508)	(20.8013)	(26.3365)
Constant	-0.1149		-0.2568*
	(0.1359)		(0.1405)
Country FE	Yes	Yes	No
Year FE	Yes	Yes	No
N	195	195	195
R^2 overall	0.8812	0.8844	0.8844
R^2 within	0.8884	0.8863	
R^2 between	0.7944	0.8655	
BIC	410.55	420.65	422.65
AIC	384.37	390.22	396.47
Endogeneity test of all regressors	2.643 [0.1040]		
Breusch and Pagan test (POLS vs RE)	0.000 [1.0000]		
F test for fixed effects (POLS vs FE)	2.93 [0.0223]		
Haussman test (FE vs RE)	14.72 [0.0116]		

Notes: In the ordinary brackets below the parameter estimates are the corresponding *z*-statistics, computed using White (1980)'s heteroskedasticity-robust standard errors. In the square brackets below the specification tests are the associated *p*-values. *, ** and *** indicate significance at 10%, 5%, and 1% respectively.

S3: Detail empirical results for relatively old and relatively young EA counties

Table S3.1. Parameter estimates for the empirical model: Relatively old EA countries

	FE	RE	POLS
GPB_{it-1}	0.5234***	0.5267***	0.5267***
	(0.0332)	(0.0319)	(0.0483)
$\Delta debt_{it}$	-0.0362***	-0.0365***	-0.0364***
	(0.0072)	(0.0075)	(0.0107)
g_{it}	0.0068***	0.0061***	0.0061**
	(0.0011)	(0.0010)	(0.0025)
$\Delta findev_{it}$	-0.0286***	-0.0241**	-0.0241***
	(0.0063)	(0.0064)	(0.0069)
$outputgap_{it}$	0.2630***	0.2445***	0.2445***
	(0.0186)	(0.0181)	(0.0329)
inf_{it}	-0.0460**	-0.0211***	-0.0211***
	(0.0082)	(0.0068)	(0.0082)
Δold_{it}	-54.5766****	-22.3425**	-22.3425*
	(11.9974)	(10.5641)	(12.3379)
Constant	0.4704***	0.2640***	0.2640***
	(0.0763)	(0.0658)	(0.0860)
Country FE	Yes	Yes	No
Year FE	Yes	Yes	No
N	273	273	273
R^2 overall	0.8916	0.8990	0.8980
R^2 within	0.9020	0.8978	
R^2 between	0.9176	0.9537	
BIC	399.70	422.56	428.66
AIC	370.82	405.33	399.79
Breusch and Pagan test (POLS vs RE)	0.00 [1.0000]		
F test for fixed effects (POLS vs FE)	4.83 [0.0001]		
Haussman test (FE vs RE)	28.13 [0.0000]		

Notes: In the ordinary brackets below the parameter estimates are the corresponding *z*-statistics, computed using White (1980)'s heteroskedasticity-robust standard errors. In the square brackets below the specification tests are the associated *p*-values. *, ** and *** indicate significance at 10%, 5%, and 1% respectively.

Table S3.2. Parameter estimates for the empirical model: Relatively young EA countries

	FE	RE	POLS
GPB_{it-1}	0.5641***	0.5518***	0.5518***
	(0.0454)	(0.0458)	(0.0571)
$\Delta debt_{it}$	-0.0523***	-0.0672***	-0.0672***
	(0.0139)	(0.0129)	(0.0216)
g_{it}	0.0402***	0.0299***	0.0299***
	(0.0062)	(0.0051)	(0.0053)
$\Delta findev_{it}$	0.0008	0.0021	0.0021
	(0.0060)	(0.0061)	(0.0051)
$outputgap_{it}$	0.0866***	0.1022***	0.1022***
	(0.0230)	(0.0220)	(0.0331)
inf_{it}	-0.0140***	-0.0237	-0.0237
	(0.0192)	(0.0185)	(0.0158)
Δold_{it}	5.0022	14.4282	14.4282
	(19.2050)	(18.1720)	(18.9968)
Constant	-0.4039***	-0.2972***	-0.2972***
	(0.1317)	(0.1199)	(0.1159)
Country FE	Yes	Yes	No
Year FE	Yes	Yes	No
N	156	156	156
R^2 overall	0.8224	0.8278	0.8278
R^2 within	0.8343	0.8310	
R^2 between	0.3594	0.6873	
BIC	341.72	349.52	350.65
AIC	317.32	323.25	326.25
Breusch and Pagan test (POLS vs RE)	0.00 [1.0000]		
F test for fixed effects (POLS vs FE)	2.85 [0.0398]		
Haussman test (FE vs RE)	6.07 [0.4153]		

Notes: In the ordinary brackets below the parameter estimates are the corresponding *z*-statistics, computed using White (1980)'s heteroskedasticity-robust standard errors. In the square brackets below the specification tests are the associated *p*-values. *, ** and *** indicate significance at 10%, 5%, and 1% respectively.

S4: Detail empirical results for more relatively indebted and less relatively indented EA counties

Table S4.1. Parameter estimates for the empirical model: More relatively indebted EA countries

	FE	RE	POLS
GPB_{it-1}	0.1519***	0.1849***	0.1849***
	(0.0291)	(0.0274)	(0.0309)
$\Delta debt_{it}$	-0.0171***	-0.0175***	-0.0175***
	(0.0043)	(0.0043)	(0.0053)
g_{it}	0.0108***	0.0126***	0.0126***
	(0.0014)	(0.0013)	(0.0021)
$\Delta findev_{it}$	0.0005	-0.0024	-0.0024
	(0.0046)	(0.0046)	(0.0046)
$outputgap_{it}$	0.4460***	0.4311***	0.4311***
	(0.0152)	(0.0147)	(0.0187)
inf_{it}	0.0150**	0.0094**	0.0094**
	(0.0062)	(0.0047)	(0.0044)
Δold_{it}	25.4034**	20.3751**	20.3751**
	(12.1541)	(9.3622)	(9.0072)
Constant	-0.0220	0.0114	0.0114
	(0.0734)	(0.0549)	(0.0580)
Country FE	Yes	Yes	No
Year FE	Yes	Yes	No
N	117	117	273
R^2 overall	0.9869	0.9873	0.9873
R^2 within	0.9879	0.9876	
R^2 between	0.9595	0.9781	
BIC	5.25	12.50	14.10
AIC	-16.85	-6.89	-7.99
Breusch and Pagan test (POLS vs RE)	0.00 [1.0000]		
F test for fixed effects (POLS vs FE)	4.20 [0.0175]		
Haussman test (FE vs RE)	11.50 [0.0742]		

Notes: In the ordinary brackets below the parameter estimates are the corresponding *z*-statistics, computed using White (1980)'s heteroskedasticity-robust standard errors. In the square brackets below the specification tests are the associated *p*-values. *, ** and *** indicate significance at 10%, 5%, and 1% respectively.

Table S4.2. Parameter estimates for the empirical model: Less relatively indebted EA countries

	FE	RE	POLS
GPB_{it-1}	0.5677***	0.5820***	0.5820***
	(0.0344)	(0.0326)	(0.0454)
$\Delta debt_{it}$	-0.0824***	-0.0830***	-0.0830***
	(0.0088)	(0.0087)	(0.0143)
g_{it}	0.0084***	0.0080***	0.0080***
	(0.0014)	(0.0013)	(0.0030)
$\Delta findev_{it}$	-0.0020	-0.0018	-0.0018
	(0.0051)	(0.0050)	(0.0044)
$outputgap_{it}$	0.1140***	0.1017***	0.1017***
	(0.0173)	(0.0165)	(0.0288)
inf_{it}	-0.0420***	-0.0247***	-0.0247***
	(0.0113)	(0.0102)	(0.0044)
Δold_{it}	-22.4860*	-6.3690	-6.3690
	(12.6003)	(11.4833)	(12.5943)
Constant	0.1640**	0.0681	0.0681
	(0.0771)	(0.0707)	(0.0919)
Country FE	Yes	Yes	No
Year FE	Yes	Yes	No
N	312	312	312
R^2 overall	0.7898	0.7924	0.7924
R^2 within	0.7920	0.7899	
R^2 between	0.8490	0.8918	
BIC	618.74	631.45	633.83
AIC	588.80	600.58	603.89
Breusch and Pagan test (POLS vs RE)	0.00 [1.0000]		
F test for fixed effects (POLS vs FE)	2.10 [0.0432]		
Haussman test (FE vs RE)	13.16 [0.0405]		

Notes: In the ordinary brackets below the parameter estimates are the corresponding *z*-statistics, computed using White (1980)'s heteroskedasticity-robust standard errors. In the square brackets below the specification tests are the associated *p*-values. *, ** and *** indicate significance at 10%, 5%, and 1% respectively.

S5. Procedure to standardize regression coefficients and to calculate relative contributions

Bring (1994) suggested an approach to calculate the standardized coefficient, multiplying the ordinary coefficient $\hat{\beta}_i$ by the partial or conditional standard deviation,

$$\hat{\beta}_i = \beta_i \cdot s_i^*$$

where the partial or conditional standard deviation s_i^* can be estimated by regressing x_i on the other independent variables. This estimated can obtain by using the variance inflation, VIF. When *y* is regressed on $x_1, x_2, \ldots, x_k$ each independent variable is associated with a VIF:

$$VIF = \frac{1}{1 - R_{k-1}^2}$$

where R_{k-1}^2 is the coefficient of determination when x_i is regressed on the $k-1$ other independent variables. Then the partial standard deviation is

$$s_i^* = \frac{s_i}{\sqrt{VIF_i}} \sqrt{\frac{n-1}{n-k}}$$

The individual relative contributions of the explanatory variables after normalization would be

$$rc\_x_i = \frac{\left|\hat{\beta}_i^*\right|}{\sum_{i=1}^{k} \left|\hat{\beta}_i^*\right|} \times 100, \quad i = 1, 2, \ldots, k.$$