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THE IMPACT OF PUBLIC DEBT ON THE TWIN IMBALANCES IN EUROPE: A THRESHOLD MODEL***

ABSTRACT: *Recent empirical research rejecting twin deficits in indebted countries and current account imbalances adjustment in Europe led to the idea to test the twin imbalances at different public debt-to-GDP intervals. The analysis covers 14 EU countries over the time period 1995-2012. A panel data threshold model with fixed effects estimates two debt-to-GDP thresholds (40.2% and 96.6%), which determine three debt-to-GDP intervals in the twin relationship. If public debt-to-GDP is less than 40.2%, the model determines a negative relationship (twin divergence) between budget balance and current account. Twin deficits (surpluses) are confirmed exclusively if debt-to-GDP is in the interval between 40.2% and 96.6%. A twin divergence is also confirmed if public debt-to-GDP is more than 96.6% (e.g., as in Greece and Italy). The results confirm that increased indebtedness in European countries contributed to their current account imbalance adjustment.*

KEY WORDS: *twin imbalances, twin deficits, twin divergence, public debt, panel data threshold model*

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1. INTRODUCTION

The current globalised world is characterised by the existence of global imbalances, manifested in different macroeconomic indicators such as current account, public and external debt, savings, and investment. Very recently, global imbalances have followed a clearly increasing path. However, the World Economic Outlook of the International Monetary Fund (IMF) (International Monetary Fund 2014) reveals that current account deficits have decreased in Italy, Spain, Portugal, and Greece; i.e., in countries with a large public indebtedness. According to the IMF (2014), the main driver was a downshift in domestic output and demand. In other words, a high level of public debt is accompanied by a decrease in aggregate demand, which can be seen in the context of Ricardian equivalence (Barro 1989) and the non-linear relation between public debt and economic growth (Checherita-Westphal and Rother 2012). The following question emerges from the evidence: Has high public debt contributed to the re-balancing of current account imbalances in deficit countries?

Twin imbalances, and mainly twin deficits, began to be discussed in the 1980s, after the simultaneous increase in both deficits in the United States. The discussion was renewed when increasing current account and fiscal imbalances influenced both world and European economies. According to the traditional twin deficit hypothesis (e.g., Abell 1990), there is a positive relationship between fiscal and current account deficit, i.e., an increase in fiscal deficit is accompanied by an increase in current account deficit. However, recent empirical studies on twin deficits give mixed results. Some of them (Trachanas and Katrakilidis 2013; Forte and Magazzino 2013) confirm the existence of twin deficits. Others (Muller 2008; Algieri 2013) reveal a Ricardian equivalence, i.e., no relationship between the two deficits. According to Ricardian equivalence (Barro 1989), an alternative hypothesis is that there is no 'twin relationship' between fiscal and current account deficits. There might even be twin divergence (Kim and Roubini 2008); i.e., a negative relationship between fiscal and current account deficits.

The aim of the paper is to contribute to the discussion on twin deficits and the currently decreasing current account imbalances by analysing twin deficits and twin surpluses (i.e., twin imbalances) in times of increasing fiscal imbalance; i.e., testing the validity of twin imbalances in the context of public debt. Our intention is to determine the intervals of the public debt, in which we confirm

the existence of twin imbalances. Thus, we aim to explain the decreasing current account imbalances in Europe. To this end, we estimate a panel data threshold model quantifying the public debt breaks in the relation between budget and current account balance, i.e., identifying several intervals of the public debt. If twin imbalances are not confirmed, an increase in budget deficit (surplus) is not accompanied by an increase in current account deficit (surplus), i.e., one imbalance does not create the other, which points to a possible way to reduce them.

The paper is organised as it follows. First, we review empirical research on twin deficits. Second, we explain the role of public debt in the validity of twin imbalances. Then we describe our data and methodology, the panel data threshold model. In the initial analysis we estimate panel data models without threshold effect. Finally, we estimate the threshold model and discuss the results.

2. PUBLIC DEBT AND TWIN IMBALANCES

Traditionally, the twin relationship between budget balance and current account has been explained by the Keynesian theory of absorption and the Mundell-Fleming model (Mundell 1963 and Fleming 1962), which state that an increase in budget deficit is accompanied by an increase in current account deficit.

However, Barro (1989) offers a different view of the relation between budget deficit and current account deficit and introduces so-called Ricardian equivalence. Barro (1989) explains that an expansionary fiscal policy does not affect aggregate domestic demand. When government spending rises, domestic consumers take into account the increasing public debt and higher future taxes and decrease their consumption. In other words, a decrease in government savings is fully compensated by an increase in private savings. Therefore, an increase in government expenses has no effect on the current account balance: as private savings increase and private investment decreases there is no need to borrow from abroad, i.e., there is no current account deficit. That is why, according to Barro (1989), budget deficit is not linked to current account deficit and there is no need to consider twin imbalances.

Ricardian equivalence led to the idea that the twin relationship depends on the debt-to-GDP ratio, and that there is a certain threshold value of public debt

beyond which there is no positive relationship between budget balance and current account.

The idea of the presence of a debt-to-GDP threshold value in the twin imbalances relationship can be derived from the non-linear inverted U-shaped relation between debt-to-GDP ratio and economic growth, which has been documented theoretically as well as empirically. This means that public debt has a certain threshold value; the relationship between public debt and economic growth is positive below the threshold, but becomes negative beyond it. If the public debt reaches a certain critical value, economic agents expect a necessary consolidation, anticipate an increase in taxes in the short-run, and consequently increase their savings, which is known as a Ricardian negative effect of public debt on economic growth.

Blanchard (1990) developed a theoretical approach to the existence of a threshold in the relation between public debt and economic growth. Blanchard's model induced further models predicting effects of the fiscal impulse on national saving, consumption, and output (e.g., Perotti (1999), Blanchard and Perotti (2002)). As for the most recent theoretical models, Arai et al. (2014) develop a dynamic general equilibrium model and derive an inverted U-shaped relationship between public debt and economic growth.

Numerous studies have estimated the public debt-to-GDP threshold value at which a positive relation between public debt and economic growth turns negative: 90%–100% (Checherita-Westphal and Rother 2012), 98% (Chang and Chiang 2012), 90% (Presbitero 2012), and 95% (Baum et al. 2013).

These theoretical approaches, and the existence of a debt-to-GDP threshold value in the relation between public debt and economic growth, means that the validity of twin deficits depends on the level of public debt and that there is a certain determining public debt threshold value beyond which twin deficits are not confirmed. In order to determine this threshold, we estimate a panel data threshold model. The model allows quantifying the relation between budget balance and current account in different public debt intervals.

3. EMPIRICAL RESEARCH ON TWIN IMBALANCES

Empirical research on twin imbalances concentrates mainly on twin deficits, i.e., testing whether there is a positive relation between budget deficit and current

account deficit. The many research papers to date provide different forms of the relationship between the two deficits, yet the results remain ambiguous.

Firstly, empirical research reveals a positive relation between budget and current account balance and confirms the so-called twin deficit hypothesis. Many authors have estimated Vector Autoregression (VAR) or a Vector Error Correction Model (VECM) for the United States and confirm a positive impact of budget balance on current account, most often through the transmission mechanism of interest rate and exchange rate (e.g., Rosensweig and Tallman 1993; Bahmani-Oskooee 1995). Šuliková et al. (2014) also estimate a VECM model and confirm the twin deficit hypothesis for the Baltic countries. Piersanti (2000) confirms a positive relation between the two balances for the OECD countries through an optimising general equilibrium model. Chinn and Prasad (2003) apply cross-section and panel data regressions for 18 industrialised countries and 71 developing countries, and Salvatore (2006) applies regressions with lagged variables for G7 countries, also confirming a positive impact of budget balance on current account. Beetsma et al. (2008) estimate panel VAR for 14 European countries and reveal that an increase in government spending deteriorates external balance. As for more recent studies, Bussière et al. (2010) apply panel regressions for 21 OECD countries and similarly confirm that budget deficit is an important determinant of the current account. Forte and Magazzino (2013) estimate a panel data model with fixed effects and a dynamic panel data model for 33 European countries, which reveal that chronic budget deficits generate current account deficits.

Secondly, using mainly VECM and Granger causality testing, some empirical studies conclude that there is no clear positive relation between budget balance and current account balance (e.g., Normandin 1999; Kouassi et al. 2004). Corsetti and Muller (2006) apply Structural VAR and also reveal a limited impact of budget shocks on external balance in the United States and Australia. More recent studies, such as Kim and Roubini (2008) and Muller (2008), even confirm twin deficit divergence in the United States, as the estimated VAR reveals that current account balance leads to a surplus after a budget deficit shock. Algieri (2013) tests twin deficits in PIIGS countries by Granger causality testing and concludes that there is no clear relationship between budget balance and current account.

Thirdly, empirical research only confirms twin deficits under certain conditions. Nickel and Tudyka (2014) estimate an interacted panel VAR and reveal that the

effect of government spending shocks on trade balance is negative (twin deficits are confirmed) but turns positive beyond a certain level of public debt (twin divergence is revealed). Holmes (2011) researches the relation between budget balance and current account applying a threshold VECM and finds that twin deficits are confirmed only if the budget balance passes a certain threshold value.

4. DATA

The analysis covers 14 EU countries, i.e., the EU15 minus Luxembourg. The annual panel data covers the time period 1995 to 2012. Like other common panel data models of twin deficit (e.g., Chinn and Prasad 2003; Salvatore 2006; Forte and Magazzino 2013), current account balance is an explained variable and budget balance is an explicative variable. Public debt plays an important role in our model because we define it as a threshold variable. This enables determining the relation between the two balances separately in several debt-to-GDP ratio intervals, which are also determined by threshold model estimation.

The model is enriched by other explicative variables that explain the current account balance. Nickel and Vansteenkiste (2008) recommend adding an output gap, which defines the phase of the economic cycle. The data for output gap are the estimates of the International Monetary Fund, which calculates it as actual GDP less potential GDP; and is expressed as a percentage of potential GDP. We expect that an increase in output gap, i.e., an increase in the positive gap between actual gross domestic product and its potential level, will deteriorate the current account. Further, we take into account trade openness (cf. Chinn and Prasad 2003): if trade openness increases the current account will grow (Nickel and Vansteenkiste 2008). Then we add 10-year government bond interest rates. An increase in bond rates reflects increasing public debt, increasing budget deficit, and decreasing economic growth (Bernoth and Erdogan 2012), i.e., determines the current account balance. As imports are a function of national income, we also add real GDP growth (analogous to Forte and Magazzino 2013).

5. METHODOLOGY: PANEL DATA THRESHOLD MODEL

Hansen (1999) elaborated a panel data threshold model in which the estimated values of the threshold variable determine different 'regimes' of the relation

between an explained variable and an explicative variable. The threshold model resolves the problem of estimated regression functions between explained and explicative variables not being identical in the whole data sample, but being able to be divided into several sub-samples.

5.1 Threshold model

Hansen (1999) proposed a panel data threshold model with fixed effects. The model is defined in the following way:

$$y_{it} = \mu_i + \beta'_1 x_{it} I(q_{it} \leq \gamma) + \beta'_2 x_{it} I(q_{it} > \gamma) + e_{it} \quad (1)$$

The data has the form of a balanced panel $\{y_{it}, q_{it}, x_{it}: 1 \leq i \leq n, 1 \leq t \leq T\}$. The index i determines a country and the index t determines a time. The explained variable y_{it} is a scalar, the threshold variable q_{it} is a scalar, and the regressor x_{it} is a k-item vector. *I*(.) is an indicator of the function.

The threshold model can be rewritten in the following alternative form (Hansen 1999):

$$y_{it} = \begin{cases} \mu_i + \beta'_1 x_{it} + e_{it}, & q_{it} \leq \gamma \\ \mu_i + \beta'_2 x_{it} + e_{it}, & q_{it} > \gamma \end{cases} \quad (2)$$

Here, the panel data set is divided into two regimes, depending on whether the real value of the threshold variable q_{it} is greater or less than the estimated threshold (the estimated value of the threshold variable γ). These two regimes are distinguished by different estimated regression slopes β_1 and β_2. The random variable e_{it} is independent and has a normal distribution with an average value equal to zero and variance σ^2. Econometric modelling gives the estimation of the regression coefficients β_1 and β_2 and of the threshold γ.

The described model is a threshold model with one threshold. The double threshold model (i.e., the model that estimates two threshold values of the threshold variable) is defined in the following way:

$$y_{it} = \mu_i + \beta'_1 x_{it} I(q_{it} \leq \gamma_1) + \beta'_2 x_{it} I(\gamma_1 < q_{it} \leq \gamma_2) + \beta'_3 x_{it} I(q_{it} > \gamma_2) + e_{it} \quad (3)$$

where the estimated threshold $\gamma_1 < \gamma_2$ (Hansen 1999).

According to Hansen (1999), the estimation of thresholds γ_1 and γ_2 consists of an iteration procedure searching for values of γ equalling the distinct values of q_{it} in the sample. For each of these threshold values the regressions (which calculate β coefficients) are estimated, yielding the sum of squared errors. The regression with the smallest value of the sum of squared errors yields the threshold γ estimate.

5.2 Threshold model for twin imbalances

We suppose that the relation between current account and budget balance changes depending on the public debt-to-GDP ratio. Based on the above argumentation, we suppose that twin imbalances cease to be valid when public debt reaches a certain threshold level. If this is the case, Ricardian equivalence (Barro 1989) or even twin divergence (Nickel and Tudyka 2014) is confirmed. Public debt-to-GDP ratio is therefore fixed as a threshold variable, the values of which will determine the regimes of the twin imbalance's validity or non-validity. The panel data threshold model for twin imbalances is defined in the following way[1]:

$$\begin{aligned} CA_{it} = \mu_i &+ \beta_1 BB_{i,t-1} I\left(DEBT_{i,t-1} \leq \gamma_1\right) \\ &+ \beta_2 BB_{i,t-1} I\left(\gamma_1 < DEBT_{i,t-1} \leq \gamma_2\right) \\ &+ \beta_3 BB_{i,t-1} I\left(DEBT_{i,t-1} > \gamma_2\right) + \theta_1 GAP_{i,t-1} + \theta_2 OPEN_{i,t-1} \\ &+ \theta_3 IR_{i,t-1} + \theta_4 GDPG_{i,t-1} + e_{it} \end{aligned} \tag{4}$$

CA_{it}	is current account balance (in % of GDP)
$BB_{i,t-1}$	is budget balance (in % of GDP)
$DEBT_{i,t-1}$	is public debt (in % of GDP) - a threshold variable
$GAP_{i,t-1}$	is output gap (in % of potential GDP)
$OPEN_{i,t-1}$	is trade openness (in % of GDP)
$IR_{i,t-1}$	is 10-year government bond interest rate
$GDPG_{i,t-1}$	is real GDP growth (annual, %)

[1] Here we present a double-threshold model, as further estimation shows that the primary one-threshold model is not well specified and its regime-dependent coefficients β are not statistically significant.

When we compare this threshold model with the general model, then $q_{it} = DEBT_{i,t-1}$ and $x_{it} = BB_{i,t-1}$. Our threshold model distinguishes the regression coefficients depending on the regime of the threshold variable, i.e., depending on the regime of the public debt (coefficients of the budget balance $\beta_1, \beta_2, \beta_3$) and the regression coefficients independent of the public debt regime (which are the same in each of the three public debt regimes, i.e., coefficients $\theta_1, \theta_2, \theta_3, \theta_4$). In order to avoid an endogeneity bias, each explicative variable is lagged by one period, as recommended by Baum et al. (2013).

6. ESTIMATION RESULTS

6.1 Panel data model without threshold effect

The relation between budget balance and current account balance is initially estimated using the classical panel data model (cf. Chinn and Prasad 2003; Forte and Magazzino 2013). Our panel data model, without any threshold effects for the moment, can be written in the following way.

$$CA_{it} = \beta_0 + c_i + \beta_1 BB_{i,t-1} + \beta_2 GAP_{i,t-1} + \beta_3 OPEN_{i,t-1} + \beta_4 IR_{i,t-1} + \beta_5 GDPG_{i,t-1} + u_{it} \quad (5)$$

The model is estimated by within, random effect, and GMM estimators.

Wooldridge's test for serial correlation in the fixed effect model shows the presence of serial correlation (chisq = 307.8644, p < 2.2e-16). The estimation in Table 1 already shows the results obtained by robust variance-covariance matrix estimation according to the Arellano method (Arellano 1987). Standard errors in the random effect model are also corrected through Arellano's robust variance-covariance matrix estimation. The Hausman test (chi-square = 0.6355, p = 0.9863) concluded that both the fixed effect model and the random effect model are consistent and do not differ significantly. Even though the independent variables are lagged by one period, we decided to check for endogeneity bias by Generalized Method of Moments (GMM) estimation. The estimated GMM model is robust to the fixed effect and random effect models, which means that there is no endogeneity bias.

Table 1: Fixed effect panel data model, random effect model, and GMM model estimation

		Fixed Effect Model		**Random Effect Model**	
Coefficient		Estimate	(Error)	Estimate	(Error)
Intercept	β_0			-9.0290 ***	(2.6163)
$BB_{i,t-1}$	β_1	0.0584	(0.0587)	0.0908	(0.0631)
$GAP_{i,t-1}$	β_2	-0.4109 ***	(0.0849)	-0.4071 ***	(0.0831)
$OPEN_{i,t-1}$	β_3	0.1081 *	(0.0447)	0.0836 *	(0.0323)
$IR_{i,t-1}$	β_4	0.5275 ***	(0.1055)	0.4679 ***	(0.1100)
$GDPG_{i,t-1}$	β_5	0.0680	(0.0422)	0.0287	(0.0365)
		GMM Model			
Coefficient		Estimate	(Error)		
Intercept	β_0				
$BB_{i,t-1}$	β_1	0.0060	(0.0768)		
$GAP_{i,t-1}$	β_2	-0.3849 ***	(0.1154)		
$OPEN_{i,t-1}$	β_3	0.0944 **	(0.0341)		
$IR_{i,t-1}$	β_4	0.5771 ***	(0.1537)		
$GDPG_{i,t-1}$	β_5	0.0499	(0.0512)		

Notes: ***=.001, **=.01, *=.05, .=0.1 indicate 0.1%, 1%, 5%, 10% significance level.

Source: Authors' calculations

However, the estimated fixed effects model and random effects model reveal that the budget balance (β_1) does not influence the current account balance as there is no significant relation between them.

6.2 Panel data threshold model

The threshold model estimates two threshold values of the public debt-to-GDP ratio: 40.2% and 96.6% (see Table 2). Public debt therefore divides the relation between current account and budget balance into three intervals: i) debt-to-GDP smaller than 40.2%, ii) in the interval 40.2% – 96.6%, iii) higher than 96.6%. As the threshold model estimates different coefficients β_1, β_2, and β_3, it determines different regressions between current account and budget balance in each of the three public debt regimes.

First, if public debt-to-GDP is smaller than 40.2% there is a significant negative relation between budget balance and current account (Table 2). In other words, the model concludes a twin divergence (an increase in current account surplus is accompanied by an increase in budget deficit). This is observed mainly in Northern Europe, where the countries have permanent current account surpluses and moderate budget deficits.

Second, if public debt-to-GDP is in the interval 40.2% – 96.6%, there is a significant positive relation between budget balance and current account balance (Table 2), i.e., the model confirms twin deficits and twin surpluses.

Table 2: Threshold model for twin imbalances; explained variable: current account balance (in % of GDP)

Variables		Coefficients	Error	t-stat.
$BB_{i,t-1}$ $(DEBT_{i,t-1} \leq 40.2)$	β_1	-0.375 **	(0.131)	-2.863
$BB_{i,t-1}$ $(40.2 < DEBT_{i,t-1} \leq 96.6)$	β_2	0.103 *	(0.044)	2.341
$BB_{i,t-1}$ $(DEBT_{i,t-1} > 96.6)$	β_3	-0.249 *	(0.120)	-2.075
$GAP_{i,t-1}$	θ_1	-0.495 ***	(0.084)	-5.893
$OPEN_{i,t-1}$	θ_2	0.130 ***	(0.019)	6.842
$IR_{i,t-1}$	θ_3	0.444 ***	(0.095)	4.674
$GDPG_{i,t-1}$	θ_4	0.121 .	(0.071)	1.704
The estimated threshold values of DEBT: 40.2 and 96.6				

Notes: Threshold model with two thresholds; ***=.001, **=.01, *=.05, .=0.1 indicate 0.1%, 1%, 5%, 10% significance levels. We also estimated a model with one threshold; however, the regression coefficient depending on public debt regime (β) was not significant. Therefore, we decided to take a model with 2 thresholds, i.e., with 3 debt-to-GDP intervals. Here, all regression coefficients depending on public debt regime (β_1, β_2, β_3) are statistically significant. The estimated threshold model is a panel data model with fixed effects taking into account individual (i.e., country specific) fixed effects. The presence of individual fixed effects was revealed by the Least Squared Dummy Variable model.

Source: Authors' calculations

Third, if the public debt-to-GDP ratio is higher than 96.6% there is a significant negative relation between the two balances (Table 2) and the model reveals a twin divergence between budget balance and current account. Therefore, if the public debt-to-GDP ratio is higher than 96.6% an expansionary fiscal policy contributes neither to the stimulation of consumption nor to the stimulation of gross domestic product. The result is in accordance with studies that research

the impact of public debt on economic growth through a non-linear model and identify a debt-to-GDP threshold beyond which the relation between public debt and economic growth turns negative: for instance, Checherita-Westphal and Rother (2012), for 12 euro area countries during 1970–2010 with a debt-to-GDP threshold of 90%–100%; or through the threshold model estimation, e.g., Baum et al. (2013) for 12 euro area countries during 1990–2010 with a debt-to-GDP threshold of 95%.

Regarding the variables independent of public debt regimes, as expected there is a significant negative relation between output gap and current account balance. An increase in output gap is considered as an increase in gross domestic product over its potential level, which is then accompanied by an increase in imports and current account deficit. Trade openness has a positive impact on current account. Further, there is a significant positive relation between bond yields and current account balance. An increase in bond yields reflects an increase in indebtedness and a decrease in economic growth, i.e., higher bond yields induce a current account surplus. Surprisingly, there is a positive relation between real GDP growth and current account balance; however, its impact on current account is not statistically significant.

The estimated threshold model (Table 2) determines three different public debt-to-GDP-ratio regimes: i) < 40.2%, ii) 40.2% – 96.6%, and iii) > 96.6%. Table 3 gives the percentage of the analysed countries corresponding to the particular public debt regime, for each year.

The public debt-to-GDP regime of the majority of countries is in the interval 40.2% – 96.6% (Table 3), which in the estimated threshold model confirms twin deficits or twin surpluses. During the last seven years a public debt-to-GDP regime smaller than 40.2% (in which the model determines the existence of twin divergence) has been found mainly in Northern European countries (Sweden, Denmark, and Finland) with current account surpluses. A public debt-to-GDP regime higher than 96.6% (in which we also confirm a twin divergence) is found mainly in Southern European countries (Greece, Italy, and Portugal).

Table 3: Percentage of countries corresponding to particular public debt-to-GDP regimes

	Public debt-to-GDP ratio		
	< 40.2% Negative relation between BB and CA	**40.2% – 96.6%** Positive relation between BB and CA	**> 96.6%** Negative relation between BB and CA
Year	= twin divergence	= twin deficit / surplus	= twin divergence
1996	0%	79%	21% (BE, GR, IT)
1997	0%	79%	21% (BE, GR, IT)
1998	0%	86%	14% (BE, IT)
1999	0%	86%	14% (BE, IT)
2000	0%	86%	14% (BE, IT)
2001	7% (IE)	71%	21% (BE, GR, IT)
2002	14% (IE, UK)	64%	21% (BE, GR, IT)
2003	14% (IE, UK)	64%	21% (BE, GR, IT)
2004	14% (IE, UK)	64%	21% (BE, GR, IT)
2005	7% (IE)	79%	14% (GR, IT)
2006	14% (DK, IE)	71%	14% (GR, IT)
2007	29% (DK, FI, IE, ES)	57%	14% (GR, IT)
2008	29% (DK, FI, IE, ES)	57%	14% (GR, IT)
2009	29% (DK, FI, ES, SE)	57%	14% (GR, IT)
2010	0%	86%	14% (GR, IT)
2011	7% (SE)	79%	14% (GR, IT)
2012	7% (SE)	57%	36% (BE, GR, IR, IT, PT)

Notes: BB = budget balance, CA = current account; BE = Belgium, DK = Denmark, FI = Finland, IE = Ireland, IT = Italy, GR = Greece, PT = Portugal, ES = Spain, SE = Sweden, UK = United Kingdom; in the estimated model, public debt-to-GDP is lagged by one period, i.e., year 1996 (2012) corresponds to the public debt-to-GDP from year 1995 (2011).

Source: Authors' calculations.

7. RESULTS AND DISCUSSION

The estimation of the panel data threshold model for twin deficits leads to several conclusions. Our model estimates two public debt-to-GDP thresholds (40.2% and 96.6%), which determine three public debt intervals, i.e., debt-to-GDP i) inferior to 40.2%, ii) in the interval 40.2% – 96.6%, and iii) higher than 96.6%. In each of these three intervals the threshold model

estimates a different relationship between budget balance and current account balance. The impact of budget balance on current account is statistically significant in each interval of public debt (see Table 2).

It should be noted that according to the panel data models without threshold effects (fixed effect model, random effect model, and GMM model, see Table 1) the impact of budget balance on current account balance is not statistically significant. Therefore, the inclusion of threshold effect in our model leads to statistical significance of the estimated coefficients of budget balance, which are either positive or negative depending on the interval of public debt-to-GDP. This result also points to the advantage of the threshold model over the classical panel data model without any threshold effect. Hence, if the estimated coefficients are not significant we suggest considering the inclusion of the threshold effect, which could potentially explain the impact of a given variable.

The panel data threshold model (Table 2) distinguishes three cases of the 'twin relationship' (the relation between budget balance and current account), which depend on the public debt interval:

1) If public debt-to-GDP is less than 40.2%, the threshold model determines a significant negative relation, i.e., a twin divergence between budget balance and current account. If a country is positioned in this public debt interval it has the advantage that application of expansionary fiscal policy will not deteriorate the current account balance. The threshold model reveals that this has been the case in Sweden, Finland, and Denmark.
2) The existence of twin deficits (surpluses) is confirmed exclusively when public debt-to-GDP is in the interval between 40.2% and 96.6%, in which the threshold model determines a significant positive relation between budget and current account balance. The model reveals that the majority of the analysed countries were positioned in this public debt interval, mainly during the period 1996–2006. Hence, we can conclude that these years were marked by the existence of twin deficits in Europe.
3) A twin divergence is again confirmed if public debt-to-GDP is more than 96.6% (e.g., in Greece and Italy). Here, fiscal stimulus stimulates neither consumption nor output, and the current account balance does not deteriorate but fiscal stimulus leads to current account deficit adjustment. This means that countries with both budget deficits and high indebtedness can adjust their current account imbalances. This result supports the stylised fact of decreasing current account deficits in Southern Europe in recent times.

8. CONCLUSION

This paper aims to contribute to existing empirical research on twin imbalances by estimating a panel data threshold model that enables identifying the intervals of public debt and testing the twin deficit hypothesis. The analysis covers 14 European countries, described by annual data covering the period 1995–2012.

Firstly, we estimated a panel data model without a threshold effect. The estimation result showed that the impact of budget balance on current account balance is positive but not statistically significant. Ricardian equivalence theory (Barro 1989) in the context of twin deficits and recent empirical research rejecting the validity of the twin deficit hypothesis in highly indebted countries led to the idea to test the twin relationship in different public debt-to-GDP intervals. The idea is supported by the theory and empirical research that shows a non-linear inverted U-shaped relation between public debt-to-GDP and economic growth (see Blanchard 1990; Checherita-Westphal and Rother 2012).

In order to take into account the impact of public debt, i.e., to determine different intervals of public debt-to-GDP and the relation between budget balance and current account in each public debt interval, we estimated a panel data threshold model (Hansen 1999). The decision to use a panel data threshold model is supported by the statistical non-significance of the relation between budget balance and current account in the panel data model without threshold effects, and by its statistical significance in each of three public debt intervals in the threshold model. Hence, we suggest that neglecting the threshold effects of public debt can lead to spurious rejection of the twin deficit hypothesis in general.

Finally, our results confirm that increasing public debt-to-GDP ratios of over 96.6% in Southern European countries (which are marked by budget deficits), accompanied by a fall in aggregate demand and consequent decrease in imports, contributed to the adjustment of European current account imbalances.

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