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Identifying relationship between macroeconomic and fiscal policy variables for EU countries and Turkey

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ABSTRACT

Following the 2008 global financial crisis, the European Debt Crisis has affected the world economy more than any other event. The member states of the European Monetary Union have deviated from the Maastricht Convergence Criteria (MCC) and this has led to the European Debt Crisis. We have used the 2000 Q1–2011 Q4 data and multivariate time series and panel data analysis for determining the relationship among the variables that establish the MCC comprising inflation, burden of net public debt, interest rate, budget deficit and exchange rate. The vector autoregression model/vector error correction model results have showed that there is an interaction between the variables. However, the panel cointegration results have confirmed increases in budget deficits and interest rates will increase the burden of net public debt and inflation will decrease it.

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1. Introduction

The efficiency of monetary and fiscal policies is closely related to the interaction between monetary and fiscal policies on reaching the same goals. This necessitates simultaneous, expansionary or contractionary monetary and fiscal policies depending on the existing economic conjuncture. The separation of rule-based and discretionary policies has been a matter of debate in financial policy implementations. A rule-based policy is a political preference that is associated with the implementation of a pre-selected formula to be used from period to period and it reflects financial and monetary conditions.

Taylor's Rule (Taylor, 1993) defines the rule-based policy preference in monetary policy. However, the preference is based on the Fiscal Rule implementation in fiscal policy (Debrun, Epsteinand, & Symansky, 2008). Taylor's Rule is based on the principle that a central bank may determine a rule of monetary policy and make decisions accordingly to protect the relationship between the predetermined target and the monetary policy variables. On the other hand, the Fiscal Rule implementation comprises permanent macroeconomic constraints on general financial performance indicators (Debrun et al., 2008). This application necessitates the practices

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aiming to bring amount and composition under control by setting numeric caps and goals to the means of voluntary fiscal policies such as budget deficit, noninterest surplus, magnitude of debt stock, borrowing sources, taxes, taxation authority and spending types (Aktan, 2010).

Contrary to rule-based policies, optional policies propose no rules and are determined case by case by monetary and fiscal policy-makers that revise the existing policies according to the present conditions (N. Eroğlu & I. Eroğlu, 2011). Later, this policy choice has led to budget deficits and unsustainable debt burdens. Thus, it has seriously damaged financial discipline and economic stability. Optional policies have become matters of debate. The rule-based monetary and fiscal policy implementations imposing sanctions on the violation of the rules will affect the success of policy implementations since the deterioration of financial indicators will have a contagious effect on other macroeconomic indicators and this will lead to economic crises by ruining the environment of trust.

The EU has decided that the European Central Bank (ECB) will follow monetary policy implementations independently in the process of economic structuring. During the process, all countries in the Eurozone have ensured the coordination of monetary union. However, no coordination has been ensured for fiscal policies because these countries have been away from financial discipline. Thus, this has led to a mismatch, and the financial indicators of many countries have deviated from the Maastricht Convergence Criteria (MCC), resulting in the outbreak of the 'European Debt Crisis'. This process has brought the presence of monetary union into question and caused worries about its future. The MCC and Stability and Growth Pact that were established in the framework of monetary union have failed to cope with the 'Debt Crisis' including Greece, Portugal, Italy and Ireland. The crisis has urged EU countries to take concurrent precautions. The 2008 Global Crisis has affected most EU member and candidate countries, and it is important to determine whether there is a relationship between the variables that establish the MCC.

The basic motivation of this study is, 'Do the MCC-determined variables affect each other and can a deviant variable deviate others?' Furthermore, the hypothesis of the study is based on the expectation that the MCC-determined variables play an active role in the European Monetary Union (EMU) countries becoming involved in the Debt Crisis.

The present study has two purposes: first, we will examine whether there is any relationship between macroeconomic variables and fiscal policy instruments in the member states of the EMU and in Turkey. We will use time series analysis for each country. Second, we will investigate whether other variables (budget deficit, interest rate, inflation and exchange rate) that establish the MCC have any explanatory effects on the burden of net public debt. We will use panel data analysis.

To the best of our knowledge, this is the first study to analyse the relationship between macroeconomic variables and fiscal policy instruments by the use of a quarterly data-set with panel data and time series analysis. First, we will provide a literature review. Second, we will present data collection and descriptive statistics. Third, we will present the econometric methods and empirical results. Last, we will give a brief summary of the paper and its recommendations.

2. Literature review

The EU countries have suffered from the adverse effects of the 2008 Financial Crisis. At the centre of today's academic studies are monetary and fiscal policies on this issue.

Georgantopoulos and Tsamis (2011) have tested the causal relationship between the budget deficit and other macroeconomic variables such as consumer price index (CPI), gross domestic product (GDP) and nominal effective exchange rate (NEER). They analysed the 1980–2009 period in Greece. Empirical findings are based on the vector error correction model (VECM) and variance decomposition estimates. There is cointegration between the variables. The analysis results have showed that there is one-way causality from NEER to budget deficit and from budget deficit to GDP. Furthermore, the Granger causality test has indicated that there is a two-way relationship between NEER and CPI in the Greece sample. However, these authors found no significant relationship between budget deficit and inflation.

Ganioğlu (2012) examined the factors affecting the financial crises in the 1970–2008 period for developing and developed countries. The author analysed the financial crises in 24 developed and 26 developing countries by the panel logit data technique. The analysis results showed that the current account deficit is an important risk factor for the two types of countries during a financial crisis. Rapid monetary and credit expansions have been sufficiently risky as to lead to financial crises in developed countries, especially in the last five years.

Garcia et al. (2009) proposed a fiscal policy rule for each of the 11 EMU countries. The authors used a seemingly unrelated regression estimation method and data from the 1984–2005 period. They assigned the cyclically adjusted primary surplus as the dependent variable and found that the coefficient of the output gap is –1.46 at minimum and 0.21 at maximum in the pre-1992 period. The appraised coefficient of debt is significant for five EMU countries in the pre-1992 period and for three EMU countries in the post-1992 period. From the analysis results, these authors concluded that: (a) many of the EMU countries have implemented pro-cyclical and non-binding fiscal policies prior to the MCC implementations; (b) as of 1992, most of the EMU countries have made modifications to non-binding fiscal policies in order to enable levels of public debt to help produce positively adjusted primary balances before and after the MCC implementations; (c) the transition to countercyclical and non-binding fiscal policies makes no important changes in the debt reaction; (d) the parameter regarding the effect of the debt–GDP ratio on primary balance must be positive in many cases; and (e) the EMU's fiscal policies can be sustained after the MCC implementations.

Candelon, Muysenk and Vermeulen (2009) examined fiscal rules and stability for the EMU countries in the pre- and post-Maastricht periods and discussed the difference between arbitrary and non-arbitrary policies. Furthermore, the author showed that there is a difference between small and large countries in terms of fiscal rule implementations, and that big countries have followed periodic arbitrary policies. The authors used the generalised method of moments to estimate fiscal rules from a dataset of the 1980–2004 period. The authors assigned real and structural budget deficits as the dependent variables. The independent variables were the lagged value of the dependent variable and debt with the whole output gap. The structural deficit assigned as the dependent variable showed a non-binding fiscal policy. The attitude of a non-binding policy to an output gap showed no change in the pre- and post-Maastricht periods, and non-binding fiscal policy has remained pro-cyclical. The authors found no significant difference in the coefficient of debt in the pre- and post-Maastricht periods and concluded that countries have reacted differently to implementing the MCC.

Caporaso and Min-Hyung (2012) argued that the PIIGS (Portugal, Italy, Ireland, Greece and Spain) crisis is due to the erroneous adaptation of the MCC, capital flows, budget deficits and the difference between the competitiveness of the central and peripheral countries. Price increases have been excessively high in all PIIGS countries except for Ireland. Furthermore, productivity increases have been at different levels in all PIIGS countries. Germany's score for price increases is behind its productivity increase and this has created a disadvantageous balance of foreign trade for the PIIGS countries. Buti and Carnot (2012) found that the increase in budget deficit has led to an increase in debt stock in PIIGS countries, posing a threat to economic stability. Furthermore, the increasing debt stocks have increased the risk and interest rates in these countries. Broner, Erce, Martin and Ventura (2014) assessed the relationship between the debt stock–GDP ratio and budget deficits, interest rates and growth rates for the central and peripheral countries in the Eurozone for the post-2008 period. The authors determined the differences between the PIIGS countries and Germany and France and found no significant differences in debt dynamics in the crisis period. However, growth rate is the main element leading to the differentiation between debt stock–GDP ratios. Thus, the PIIGS countries have undergone economic shrinkage. The decreased GDPs have increased the debt stock–GDP ratios. Furthermore, the cost of the increase in the debt stocks of Germany and France is still low because of low interest rates in the two countries. However, ever-increasing interest rates have raised the cost of the debt stocks of the PIIGS countries.

Lane (2012) stated that divergence from fiscal discipline is the underlying reason for the risk increase leading to the Debt Crisis in the Eurozone. For example, the debt stock–GDP ratios of Italy and Greece have been around 90% as of the 1990s and never dropped below 60% even after these countries joined the monetary union. The debt stock–GDP ratios of Germany and France were around 60% in the pre-crisis period. Portugal has constantly increased the debt stock since 2000. Compared to other peripheral countries, Ireland and Spain have relatively healthier structures for establishing financial discipline.

Arghyrou and Kontonikas (2012) examined the European Debt Crisis by dividing the 1999–2011 data period into two sub periods (pre-crisis and the crisis periods with August 2007 cut-off point) and found that there is contagiousness between the EU member countries. The contagiousness first derived from Greece and later spread to Ireland, Portugal and Spain.

De Grauwe and Ji (2012) found that the countries in the Eurozone are in better financial positions than the U.S.A. and the U.K. despite Greece's unsustainable level of debt and irretrievable budget deficit. However, the violation of the debt–GDP ratio has discouraged investors and deepened the crisis in the Eurozone.

Cristina, Hallett and Rother (2014) determined the public debt stock–GDP ratio for maximum growth. The authors set a model for 22 Organisation for Economic Co-operation and Development (OECD) countries, including 14 EU member states. Eleven of the 14 countries are in the Eurozone. The authors used the annual data from the 1960–2010 period. They concluded that the pro-growth public debt stock–GDP ratio must be under 50% for all member states and under 60% for the OECD countries.

Thomas et al. (2014) discussed the relationship between public debt and the increase in GDP with the Reinhart and Rogoff model. The authors used data on 20 developed countries and conducted a regression analysis of these 20 countries for the 1946–2009 period. They suggest that public debt exceeding 90% of GDP will affect the increase in GDP negatively.

Lewis (2010) analysed how the financial crisis has affected the responsibilities of eight Central and Eastern European countries for meeting the MCC. The increase in interest rates,

downsized economic growth and decrease in inflation appear to have affected the eight countries' debt stabilities considerably. The author found that Hungary, Latvia and Poland have suffered seriously from difficulties in meeting the debt criteria. In particular, inflation decreases as national income deficit shrinks in the Baltic countries. The depth of recession puts inflation rates under pressure for many years. The author suggested that the criterion for interest rates can be overcome because it has spread from the outbreak of the crisis.

3. Data and descriptive statistics

Sixteen member states of the EMU (Austria, Belgium, Cyprus, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, Malta, The Netherlands, Portugal, Slovakia, Slovenia and Spain) and Turkey are selected for the study. Turkey is incorporated into the analysis because it has showed a considerably better performance than member countries in terms of budget deficit and net public debt burden during the crisis. This has attracted European and Turkish policy-makers' interests. For all countries except Turkey, quarterly data on the variables (inflation, burden of net public debt, interest rate, budget deficit and exchange rate) have been collected from the EUROSTAT data bank for the 2000 Q1–2011 Q4 period. We have limited the data period to 2011 since the most important data series has been reported until 2011. The data on Turkey have been collected from various sources. The data on inflation rate (CPI 1996 = 100), interest rate (long-term), burden of net public debt (percentage of GDP) and GDP have been collected from the database of the Central Bank of Turkey (CBT). Budget deficit is calculated in percentages by dividing the difference between budget incomes and budget expenses by GDP. The data on incomes and expenses are reported monthly on the CBT database. Annual data from the 2000–2010 period are available on the web page of the Ministry of Development. For the post-2006 period, the quarterly arithmetic mean has been obtained from the monthly data by calculating three-month data. The 2000–2006 quarterly data have been collected via the 'proc expand' command in SAS Package. Annual data from the the 2000–2010 period have been collected via the cubic spline interpolation method.

Descriptive statistics summarising the variables' changes in the relevant periods is one of the frequently consulted methods in analysing time series. Thus, the descriptive statistics (mean, variance and minimum and maximum values) of the variables are calculated by the authors and summarised country-by-country in Table 1. The discussion of the data in Table 1 within the framework of the MCC will be useful in order to obtain a pre-understanding of the research. In this sense, the European Council (EC) scheduled a calendar for the formation of the EMU in the Maastricht Treaty of 7 February 1992. In the Copenhagen Summit held on 2 June 1993, the EC determined the criteria for full membership. The criteria include three groups: political, economic and adoption of community legislation. The difference between the average of the annual inflation rates of the three countries with the lowest inflation and the inflation rate of a relevant candidate country must be under 1.5. The total of a candidate country's public debt (gross consolidated debt stock) must be less than 60% of its GDP. A candidate country's budget deficit–GDP ratio must remain under 3%. As of the 12-month period, there must be more than two points between the long-term interest rates being charged in any candidate country and the interest rates of the three countries with the best performances in price stability. A candidate country's currency must undergo no devaluation across another candidate's currency within the last two years. Candidate countries' currencies must be stable enough across the member states'

Table 1. Descriptive statistics for variables (annual 2000–2012).

Variable	Statistic	Germany	Austria	Belgium	Finland	France	Cyprus	The Nether-lands	Ireland	Spain	Italy	Luxembourg	Malta	Portugal	Slovakia	Slovenia	Turkey	Greece
Budget deficit	Mean	−2.22	−2.03	−1.34	2.72	−3.73	−3.40	−1.62	−4.49	−2.60	−3.33	1.67	−4.56	−5.12	−5.23	−3.17	−6.24	−7.42
	Variance	3.54	2.31	4.04	9.41	3.84	9.46	6.17	106.98	23.57	1.56	6.64	3.98	6.04	10.89	4.09	46.20	11.69
	Minimum[a]	1.1	0	0.4	7	−1.5	3.5	2	4.7	2.4	−0.8	6.1	−2.3	−3.1	−1.8	0	0.8	−3.7
	Maximum[b]	−4.20	−4.50	−5.50	−2.50	−7.50	−6.60	−5.60	−30.90	−11.20	−5.40	−1.10	−9.20	−10.20	−12.30	−6.40	−23.90	−15.60
Inflation	Mean	1.73	2.06	2.24	1.96	1.93	2.57	2.23	2.14	2.81	2.38	2.76	2.49	2.58	4.07	3.96	17.17	3.19
	Variance	0.51	0.70	1.18	1.23	0.50	1.22	1.52	4.07	1.23	0.55	1.11	0.87	1.82	6.21	5.57	292.07	1.12
	Minimum	0.19	0.40	−0.01	0.14	0.10	0.17	0.93	−1.65	−0.24	0.74	0.01	0.69	−0.90	0.70	0.86	6.25	1.04
	Maximum	2.79	3.55	4.49	3.92	3.16	4.37	5.11	4.78	4.13	3.55	4.09	4.69	4.41	8.43	8.56	56.84	4.70
Net public debt burden	Mean	68.05	66.11	96.03	42.35	67.57	63.27	54.32	45.63	50.57	108.90	9.83	64.85	70.38	39.05	29.48	53.63	114.98
	Variance	57.07	13.22	53.44	20.62	95.02	43.16	39.47	756.60	99.43	38.92	28.03	27.51	288.60	54.89	51.16	195.73	527.33
	Minimum	59.10	60.20	84.00	33.90	56.90	48.90	45.30	24.60	36.30	103.30	6.10	54.90	50.70	27.90	22.00	39.90	97.40
	Maximum	82.50	72.40	107.80	49.00	86.00	71.10	65.50	106.40	69.30	120.70	19.20	71.70	108.10	50.30	46.90	77.90	170.60
Interest rate	Mean	3.718	4.045	4.202	3.931	3.984	5.352	3.903	5.108	4.554	4.642	3.750	4.792	5.444	4.977	4.687	28.980	7.271
	Variance	1.059	0.740	0.526	0.943	0.633	1.158	0.882	2.489	0.564	0.414	1.206	0.393	5.205	1.613	0.734	239.440	31.423
	Minimum	1.500	2.370	3.000	1.890	2.540	4.130	1.930	3.330	3.390	3.560	1.820	4.130	3.440	3.520	3.810	12.080	3.590
	Maximum	5.260	5.560	5.590	5.480	5.390	7.620	5.400	9.600	5.580	5.580	5.520	6.190	10.550	8.040	6.400	63.710	22.500

Note: Base year for inflation date is 1996 = 100.
[a]Minimum budget deficit or surplus.
[b]Maximum budget deficit.

currencies. Candidate countries must comply with normal fluctuation margins (±2.25%) proposed by the exchange mechanism in the European Monetary System.

The average inflation rate of the three countries (Germany, 1.73%; Finland, 1.93%; and France, 1.96%) is 1.87%. Based on the three countries' 1.5% excess in terms of the average inflation rate, the violation limit of the criterion for inflation rate has been determined as 3.37%. Thus, Slovakia and Slovenia have exceeded the average 3.37% limit in the analysed period. However, Turkey's inflation rate is 17.7% on an average value basis in the analysed period. Turkey has never met this criterion.

In the period analysed in terms of public debt, the countries with <60% average value are Finland (42.25%), The Netherlands (54.32%), Ireland (46.63%), Spain (50.57%), Slovakia (39.05%), Slovenia (29.48%) and Luxembourg (9.83%). Furthermore, Turkey's score of public debt is 53.63% on an average basis. On the average scale, this shows that Turkey has managed to meet the criterion for public debt, but has sometimes fallen short of maintaining this performance throughout the analysed period. It must be borne in mind that the increase in Turkey's performance in meeting this criterion has noticeably approximated to the minimum value of 39.90% in recent years.

The countries with a <3% criterion for public budget deficit are Germany (–2.22%), Austria (–2.03%), Belgium (–1.34%), The Netherlands (1.62%) and Spain (–2.60%). Finland with 2.72% and Luxembourg with 1.67% budget surplus have showed good performances. The other EMU countries have failed to meet the criterion for budget deficit on an average value scale in the relevant period. In terms of budget deficit, Turkey with –6.24% has failed to meet the criterion on average value. However, it has complied with the 0.8% budget surplus criterion to a certain degree on a minimum value. Turkey's performance in budget deficit has remained under the 3% criterion, pointing to a positive improvement.

For the criterion of interest rate, the three countries that have revealed the best performances in price stability are Germany (1.73%), France (1.93%) and Finland (1.96%). Regarding these countries' average interest rates (Germany with 3.71%, France with 3.98% and Finland with 3.93%), we can assert that the average annual interest rate is 3.87% for the three countries. Greece's annual interest rate is two points beyond the criterion. Thus, it is the only country to violate the MCC. Turkey has never complied with the criterion.

4. Econometric methods and empirical results

In line with the objectives of the study, we have processed the quarterly data with time series econometric techniques and panel data analysis. We have tested the stationarity of time series by different stationary tests. Later, we have conducted cointegration tests for testing the long-term dependency in the variables. Finally, we have used vector autoregression (VAR) models/VECMs (for time series) and fully modified ordinary least square estimation methods (for panel data) in order to identify whether the factors affect the dependent variables significantly.

4.1. Time series unit root test, cointegration test and results

Cointegration and other multivariate time series analyses demand that stationarity of series be tested. We have used Augmented Dickey–Fuller and Phillips–Perron unit root tests in this study. The null hypothesis of the two tests is that series are non-stationary; in other words, series include unit roots. The unit root test results have showed budget deficit data

Table 2. Johansen cointegration test results.

Country	Trace test	Eigenvalue test
Austria	1 cointegration	2 cointegrations
Belgium	No cointegration	No cointegration
Germany	No cointegration	1 cointegration
Ireland	2 cointegrations	2 cointegrations
Spain	1 cointegration	No cointegration
France	1 cointegration	No cointegration
Italy	2 cointegrations	1 cointegration
Luxembourg	1 cointegration	1 cointegration
The Netherlands	1 cointegration	1 cointegration
Portugal	3 cointegrations	1 cointegration
Finland	1 cointegration	1 cointegration
Greece	5 cointegrations	1 cointegration
Slovenia	1 cointegration	1 cointegration
Cyprus	No cointegration	No cointegration
Malta	1 cointegration	1 cointegration
Slovakia	No cointegration	No cointegration
Turkey	2 cointegrations	1 cointegration

Note: H_0 (null hypothesis): no cointegration found. H_1: cointegration found.

are stationary for some countries, whereas all other variables are non-stationary for all countries. We have reported no results in this paper. However, we may provide them on request.

After testing the stationarity of series, the next step is to test if there is cointegration in series. Two or more individually integrated series will be cointegrated if the linear combination of the series is stationary. Statistical tests overestimate the relationship between the series when time series are integrated. The estimators are questionable for the presence of spurious regressions. The spurious regression problem can be removed by changing the data. However, this may lead to the loss of long-run information in the data. Time series can be modelled through cointegration without losing the long-run information content.

We have used Johansen cointegration tests for determining if there is cointegration (i.e., long-term correlation) in the variables. Furthermore, we have used trace and maximum eigenvalue test statistics for testing cointegration. Table 2 shows the Johansen cointegration test results.

The results show that the null hypothesis that there is no cointegration has been rejected for all countries except Belgium, Cyprus and Slovakia, revealing the presence of long-term correlation between the variables. The results show that the VAR model should be used for the countries with no cointegration and VECM should be used for those with cointegration.

4.2. VAR model/VECM X_{t} model results

We have used the VAR model in order to examine the linear dynamic interdependencies in the variables. The VAR model in matrix format is as follows:

$$X_t = A_0 + \sum_{i}^{k} A_i X_{t-i} + \varepsilon_t \tag{1}$$

Here, (nXn) is the matrix of the variables. A_0(nX1) is the constant term matrix. A_i(nXn) is the matrix of coefficients and ε_t(nX1) is the matrix of error terms. The variables must be stationary in the VAR model. If series are non-stationary and any cointegration has been

found, VECM, an advanced analysis incorporating lagged values of error terms into the model, will be conducted. To decide whether to use the VAR model or VECM, a test should be conducted for cointegration between series.

Table 3 shows the results of VAR models/VECMs. According to the results, budget deficit has statistically positive effects on interest rates in Austria, Ireland, Spain and Portugal. However, it affects Greece, Italy and Slovakia negatively. Budget deficit has a significantly positive effect on inflation in Spain, Cyprus, Luxembourg, The Netherlands and Slovakia, as well as on the burden of net public debt in Germany, Greece, Ireland, Malta and Slovenia. These relationships shed light particularly on the crises in Greece and Ireland. The countries with negative effects are Belgium, Spain, Italy and Cyprus. Here, we can suggest that Italy has encountered a result that is contrary to expectations. Budget deficit has a significantly positive effect on exchange rates in Ireland and France.

Interest rate is positively affected by budget deficit in Greece, Malta and Slovenia. The effect of interest rate is significantly positive on the burden of net public debt in Greece. Inflation has a significantly positive effect on budget deficit in Austria, Ireland, France, Italy, Cyprus, The Netherlands, Slovenia and Slovakia. However, it has a negative effect in Germany and Spain.

Inflation has a significantly positive effect on the burden of net public debt in Austria and it is less effective in Spain, France, Italy, Malta and Portugal. The burden of net public debt has a significantly positive effect on budget deficit in Italy and Turkey and it has less of an effect in Malta and The Netherlands. Exchange rate has a negative effect on budget deficit in Italy and The Netherlands. Exchange rate has a positive effect on the burden of net public debt in Greece and Turkey. However, it has a negative effect in Germany, Finland, Luxembourg and The Netherlands.

4.3. Panel Data Analysis Results

We have used the following empirical model for examining whether budget deficit, inflation, interest rate and exchange rate have any explanatory effects on net public debt burden in the EMU countries and Turkey.

$$Ln\,NPD_{it} = \alpha_{0i} + \alpha_{1i} BD_{it} + \alpha_2 Ln\,INF_{it} + \alpha_{3i}\,Ln\,INTR_{it} + \alpha_{4i}\,Ln\,ER_{it} + \varepsilon_{it} \qquad (2)$$

Here, i shows the countries, t time period and Ln natural logarithm. We have used series in the logarithm form for removing possible estimation problems such as heteroscedasticity and non-stationarity so that we can interpret the coefficients in the elasticity form. The budget deficit results have been incorporated into the model without the budget deficit logarithm due to its negative values. The coefficient of the budget deficit should be interpreted carefully since a negative coefficient means that an increase in budget deficit will increase the burden of net public debt. The coefficients of the other variables directly present the coefficient of elasticity.

The dollar–euro rate has been assigned as the independent variable for the countries that joined the Union in 1999 and 2001. However, we have formed another model excluding the exchange rate independent variable for analysing Turkey and other countries that joined the Union after 2001. We have used panel cointegration tests for analysing the long-term correlations between the burden of net public debt and the factors that may affect this

Table 3. VAR model/VECM results.

Variables	AUT	BEL	GER	IRL	GRE	ESP	FRA	FIN	ITA	CYP	LUX	MLT	NED	POR	SLO	SVK	TR
BD→BD	(–) 1	(–,+) 1,2	NO	(–) 2	(–) 2	NO	NO	(–) 2	(+) 1,2	NO	(+) 1,2	NO	NO	NO	NO	(+) 2	(–) 1
BD →IR	(+) 2	NO	NO	(+) 1	(–) 1,2	(+) 1	NO	NO	(–) 2	NO	NO	NO	NO	(+) 1	(–) 1,2	NO	NO
BD→INF	(–) 1	NO	(–) 2	NO	NO	(+) 1	(–) 1	(–) 1,2	(–) 2	(+) 1	(+) 1	NO	(+) 2	NO	(–) 1,2	(–,+) 1,2	NO
BD→NDB	NO	(–) 2	(+) 1,2	(+) 1	(+) 2	(–) 2	NO	NO	(–) 2	(–) 1	NO	(+) 1	NO	NO	(+) 1	NO	NO
BD→ER	NO	NO	NO	(+) 1	NO	NO	(+) 1	NO	NO	–	NO	–	NO	NO	–	–	NO
IR→ BD	NO	NO	NO	NO	(+) 2	NO	NO	NO	NO	NO	NO	(+) 1	NO	NO	(+) 1	NO	(–) 2
IR→IR	(–) 2	(+) 1	(–) 2	(+,–) 1,2	(–) 1,2	NO	(–) 2	(–) 2	NO	(+,–) 1,2	(+) 1	(+,–) 1,2	(+,–) 1,2	NO	(+,–) 1,2	(+) 1	NO
IR→INF	(+,–)1,2	NO	NO	NO	(–) 2	NO	(–) 2	(–) 2	(+) 1	NO	NO	NO	NO	(+) 1	NO	NO	NO
IR→NDB	NO	NO	(–) 2	(–) 2	(+) 2	NO	NO	(–) 1	(+) 2	NO	NO	NO	NO	NO	NO	NO	(–) 1
IR→ER	NO	NO	NO	NO	NO	NO	NO	NO	NO	–	NO	–	(+) 1	NO	–	–	NO
INF→BD	(+) 2	NO	(–) 2	(+) 2	NO	(–) 2	(+) 1,2	NO	(+) 2	(+,–) 1,2	NO	NO	(+) 2	NO	(+) 1,2	(+,–) 1,2	(+) 2
INF→IR	NO	NO	NO	NO	(+) 1	NO	NO	NO	(+) 2	(+,–) 1,2	NO	NO	(–) 1	NO	(–) 1	NO	NO
INF→INF	NO	(+) 1	NO	NO	(–,+) 1,2	NO	NO	NO	(–,+) 1,2	(+) 1,2	NO	NO NO	(–) 1	NO	NO	(+,–) 1,2	NO
INF→NDB	(+) 1	NO	NO	NO	NO	(–) 2	(–) 2	NO	(–) 1,2	(–,+) 1,2	NO	(–) 1	NO	NO	(–) 1,2	NO	NO
INF→ER	NO	NO	NO	NO	NO	NO	NO	NO	NO	–	(–) 2	–	(–) 1	NO	–	–	NO
NDB→BD	NO	NO	NO	NO	NO	NO	NO	NO	(+,–) 1,2	NO	NO	(–) 1	(–) 2	NO	NO	NO	NO
NDB→IR	(+) 1	NO	NO	(–) 2	(–) 1,2	NO	NO	NO	NO	NO	NO	(–) 1	NO	NO	NO	NO	NO
NDB→INF	(–) 1,2	NO	NO	(–) 2	NO	NO	NO	(–) 1	(+) 1	NO	(–) 1	NO	NO	(–) 1	NO	NO	NO
NDB→NDB	NO	(+) 1	(–) 1	NO	(+) 2	(–) 2	NO	NO	NO	(+) 1	NO	NO	NO	NO	NO	(+) 1	(–)2
NDB→ER	NO	NO	NO	(–) 1,2	NO	NO	NO	NO	NO	–	NO	–	NO	NO	–	–	NO
ER→BD	NO	NO	NO	NO	NO	NO	NO	NO	(–) 2	–	NO	–	(–) 2	NO	–	–	NO
ER→IR	(+) 1	NO	NO	NO	(–) 1,2	NO	NO	NO	NO	–	NO	–	(+) 1	NO	–	–	NO
ER→ INF	(–) 2	(+) 1	NO	NO	NO	(+) 1	NO	NO	(+) 1	–	NO	–	NO	NO	–	–	NO
ER→NDB	NO	NO	(–) 2	NO	(+) 2	NO	NO	(–) 1	NO	–	(–) 1	–	(–) 1	NO	–	–	NO
ER→ER	(+,1) 1,2	(+,–) 1,2	(+,–) 1,2	(–) 2	(+) 1	(+,–) 1,2	(+,–) 1,2	(+,–) 1,2	(+) 1	–	(+) 1	–	(+) 1	(+,–) 1,2	–	–	NO

Note: BD = budget deficit, IR = interest rate, INF = inflation, NDB = net debt burden, ER = exchange rate.
Countries: AUT = Austria, BEL = Belgium, GER = Germany, IRL = Ireland, GRE = Greece, ESP = Spain, FRA = France, ITA = Italy, CYP = Cyprus, LUX = Luxembourg, MLT = Malta, NED = The Netherlands, POR = Portugal, SLO = Slovenia, SVK = Slovakia, FIN = Finland, TR = Turkey.
*Error term is statistically significant.
(+,–) 1,2 shows first and second lags of the relevant variable are statistically significant and signs are '+' and '–', respectively.

Table 4. Panel unit root test results.

Statistic	Test value[a]	*p*-value	Test value[b]	*p*-value
Interest				
Levin, Lin & Chu t	5.831	1.000	3.369	0.999
Breitung t-stat	8.228	1.000	5.178	1.000
Im, Pesaran & Shin W-stat	5.914	1.000	4.282	1.000
Hadri Z[c]	7.800	0.000	9.264	0.000
Inflation				
Levin, Lin & Chu t	–3.094	0.001	–5.051	0.001
Breitung t-stat	1.071	0.858	3.459	0.999
Im, Pesaran & Shin W-stat	–3.851	0.001	–4.938	0.000
Hadri Z[c]	17.081	0.000	11.992	0.000
Budget deficit				
Levin, Lin & Chu t	–23.173	0.001	–12.014	0.000
Breitung t-stat	–10.114	0.001	–8.207	0.000
Im, Pesaran & Shin W-stat	–22.788	0.001	–20.538	0.000
Hadri Z[c]	9.152	0.000	–9.588	0.000
Net public debt burden				
Levin, Lin & Chu t	2.653	0.996	3.790	0.999
Breitung t-stat	7.716	1.000	7.882	1.000
Im, Pesaran & Shin W-stat	4.024	1.000	5.620	1.000
Hadri Z[c]	10.228	0.000	11.209	0.000
Exchange (dollar/euro)				
Levin, Lin & Chu t	1.393	0.918	–	–
Breitung t-stat	–1.118	0.132	–	–
Im, Pesaran & Shin W-stat	1.982	0.976	–	–
Hadri Z[c]	13.812	0.000	–	–

Note: Null hypothesis: except Hadri Z test, series includes unit root (non-stationary) and 5% critical value is –2,564.
[a]The results of 12 states that joined the Union before 2001.
[b]The results that are obtained by excluding a total of 17 exchange rate variables including Turkey and the countries that joined the Union after 2001.
[c]Null hypothesis of Hadri Z test: series is stationary.

variable. As indicated in the time series analysis, one should check the stationarity of the series before conducting the cointegration test.

The panel unit root tests of Breitung (2000), Levin, Lin and Chu (2002), Im, Pesaran, and Shin (2003) and Hadri (2000) have been used for examining the stationarity of series. Table 4 shows the unit root test results. We have found that the budget deficit variable is non-stationary in the Hadri test only and used two different tests for determining the non-stationarity of the inflation variable. By determining that all variables are non-stationary, we have tested whether there is cointegration between the variables.

We have used the test developed by Pedroni (1999) for determining the presence of panel cointegration. For testing cointegration in the panel, Pedroni (1999) developed seven cointegration statistics that are asymptotically standard normal distributions. Four statistics are based on the within-dimension approach that pools the autoregressive coefficient across different members for the unit root tests on the estimated residuals. The next three statistics are based on the between-dimension approach that averages the individually estimated coefficients for each member in the panel.

Table 5 shows the panel cointegration test results. The findings support the view that the net public debt burden is cointegrated with budget deficit, interest rate, exchange rate and inflation in 12 countries that joined the Union before 2001 and in the group including all member states. The presence of cointegration also implies that the short-run deviations from the steady-state equilibrium in the estimated model are corrected in time.

Table 5. Panel cointegration tests results.

Statistic	Test value[a]	*p*-value	Test value[b]	*p*-value
Within-dimension				
Panel v-stat	4.005	0.000	15.722	0.000
Panel rho-stat	−11.774	0.000	−17.298	0.000
Panel pp-stat	−18.334	0.000	−26.202	0.000
Panel adf-stat	13.812	0.000	−9.713	0.000
Between-dimension				
Group rho-stat	−12.760	0.000	−13.404	0.000
Group pp-stat	−24.285	0.000	−27.181	0.000
Group adf-stat	−14.181	0.000	−9.790	0.000

Note: The critical value for panel v-stat is 1.96 at the 1% significance level. The critical value for the others is −1.96. Null hypothesis: there is no cointegration. All statistics are significant at the 1% significance level and the null hypothesis that there is no cointegration is rejected.

[a]The results of 12 states that joined the Union before 2001

[b]The results obtained by excluding a total of 17 exchange rate variables including Turkey and the countries that joined the Union after 2001.

The presence of cointegration in the variables raises the question of the extent to which the explanatory variables influence the net burden of public debt in the long run. To estimate the long-run cointegration parameters, panel ordinary least squares (OLS), panel dynamic OLS (DOLS) and panel fully modified OLS (FMOLS) have been used in the literature. Kao and Chiang (2000)'s Monte Carlo experiments have showed that panel DOLS outperforms both panel OLS and panel FMOLS estimators. A recent Monte Carlo study by Wagner and Hlouskova (2010) has indicated the panel DOLS estimator outperforms both single- and system-equation panel cointegration methods. Thus, we estimate the panel cointegration parameters by the group mean panel DOLS estimator developed by Pedroni (2001), since it is flexible in examining cross-country heterogeneity in the panel as well as in providing the mean value of the panel cointegration coefficient.

We have used panel DOLS (Pedroni, 2001) for finding the coefficients of the long-term cointegration. The following model is for estimating the coefficients:

$$y_{it} = \gamma_i + x'_{it}\beta_i + \sum_{k=-p_i}^{p_i} \psi_{ik} \Delta x_{it-k} + \varepsilon_{it} \tag{3}$$

Here, y and x show the matrix of the dependent and independent variables (*LnINF, LnIR, BA* and *LnER*), respectively. Δ is the first difference operator and p_i is the length of lead-lag.

Table 6 shows the results obtained for the countries that joined the Union before 2001 and all member states after 2001. According to *t*-value statistics, the results have revealed that budget deficit, inflation and interest rate have explanatory effects on the burden of net public debt. In assessing the negative coefficient, an increase in budget deficit will raise the burden of public debt since the budget deficit values are negative. We suggest that an increase in inflation may lead to a decrease in the burden of net public debt, whereas an increase in interest rate will raise the burden of net public debt. The coefficients of the variables saving budget deficit present the coefficient of elasticity. As for inflation, for example, a 1% increase in inflation may lead to a 0.040% decrease in burden of net public debt. Based on the explanation of public debt burden above, we may assume that a one-unit increase in budget deficit may lead to a 0.4% unit increase for the coefficient of budget deficit.

Table 6. Panel cointegration estimation results.

	Coefficients[a]	*t*-value	Coefficients[b]	*t*-value
BD	−0.004*	−5.299	−0.004*	−3.543
LnINF	−0.040*	−2.773	−1.266*	−5.259
LnINTR	0.538*	12.182	0.476*	11.505
LnER	−0.297	−0.354	–	–

Note: * and ** show that the coefficients are statistically significant at 1% and 5% significance levels, respectively. Burden of net public debt is the dependent variable.
[a]The results of 12 states that joined the Union before 2001.
[b]The results that obtained by excluding a total of 17 exchange rate variables including Turkey and the countries that joined the Union after 2001.

5. Conclusion

Using the 2000 Q1–2011 Q4 period quarterly data, we have aimed to achieve two goals: first, we have used VAR models/VECMs to test the EMU states and Turkey for the presence of relationships between budget deficit, inflation, interest rate, burden of net public debt and exchange rate. Second, we have used panel data for testing the presence of any explanatory effects of inflation, interest rate, exchange rate and budget deficit on the burden of net public debt.

The VAR model/VECM results show that budget deficit has a positive effect on interest rate in Austria, Ireland and Portugal. Budget deficit has a positive effect on inflation in Spain, Cyprus, Luxembourg, The Netherlands and Slovakia, whereas it has a negative effect in Austria, Germany, France, Finland, Italy and Slovenia. Furthermore, it has a positive impact on burden of net public debt in Germany, Greece, Ireland, Malta and Slovenia. However, it has a negative effect in Belgium, Spain, Italy and Cyprus.

Interest rate has a negative effect on budget deficit in Turkey and a positive effect in Greece, Malta and Slovenia. It has a positive effect on the burden of net public debt in Greece and Italy and a negative effect in Germany, Ireland and Finland.

Inflation has a positive effect on budget deficit in Austria, Ireland, France, Italy, Cyprus, The Netherlands, Slovakia and Slovenia. It is a positive effect on the burden of net public debt in Austria and a negative effect in France, Italy, Malta and Portugal.

The burden of net public debt has an increasing effect on budget deficit in Italy and Turkey and a decreasing effect in Malta and The Netherlands. It has a positive effect on interest rate in Austria only and a negative effect in Ireland, Greece and Malta. The burden of net public debt has a positive effect on inflation in Italy only and a negative effect in Austria, Ireland, Finland, Luxembourg, Portugal and Turkey.

The results of the present study have some implications for the explanation of the European Debt Crisis. In Greece and Ireland, budget deficit has an increasing effect on the burden of net public debt. However, it is contrary to our expectations that budget deficit has a decreasing effect in Spain and Italy. Furthermore, interest rate has a positive effect on the burden of net public debt in Greece and Italy as expected. Contrary to the monetarist approach, which assumes that public debt increases interest rates, Ireland has showed an unexpected result. Surprisingly, the burden of net public debt has a decreasing effect on interest rates in Greece and Ireland. Inflation has a decreasing effect on the burden of net public debt in Spain, France, Italy and Portugal, as expected. Furthermore, the burden of net public debt has an increasing effect on inflation in Italy, as expected, whereas its decreasing effects in Ireland and Portugal are contrary to expectations.

The panel cointegration test results have showed that changes in interest rate, budget deficit and inflation have increasing effects on the burden of net public debt. We have found that increases in budget deficit and interest rates have positive effects on the burden of net public debt, while an increase in inflation has a decreasing effect on the burden of net public debt. These results show that the effects of budget deficit, inflation and interest rates on the burden of net public debt have lived up to our expectations.

It is still unquestionable that the European Debt Crisis can be attributed completely to the above-mentioned variables. However, these variables have important roles in obstructing debt sustainability and transforming it into a crisis. For a healthier assessment, it is important to determine whether countries' expenditures are in productive fields (such as investments in infrastructure) or in non-productive fields (such as security spending or pensions) in a debt crisis. The determination of the effects of economic and political stability is also important. Furthermore, the sufficient use of income taxes is also critical in financing budget deficits. Future studies may deal with the question from this perspective for more informative results.

However, the countries with a positive correlation between public debts and budget deficits may prefer structural reforms instead of borrowing for financing budget deficits by taxation. They may divert public expenses from non-productive to productive areas so that they can comply with budget discipline. The most striking result is the fact that the countries that have suffered from the Debt Crisis have violated the budget deficit criterion. By leading to an unsustainable debt level, this violation has culminated in a debt crisis. Thus, the ECB's rule-based individual management in monetary policy should be taken as a successful example for designing a similar discipline in fiscal policy. Furthermore, we expect that these results may help policy-makers to determine economic and fiscal policies.

Disclosure statement

No potential conflict of interest was reported by the authors.

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