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Transmission of Fiscal Spillovers on Interest Rates in EMU

*Lena MALEŠEVIĆ PEROVIĆ**

Abstract

In this paper we investigate the relationship between fiscal imbalances and long-term interest rates and assess various transmission channels of fiscal spillovers in EMU during 2002 – 2015. Our results support the importance of bilateral trade, informational and geographical channel of transmission, with spillovers accounting for more than 50 percent of the overall effect. Our findings suggest that if the share of public debt in GDP in all countries increases by 1 percentage point, the long-term interest rates of a given country will, on average, increase by 2.56 – 5.98 basis points, 1.9 – 3.61 basis points of which can be attributed to indirect effects.

Keywords: *public debt, long-term interest rates, EMU, spatial panel analysis, spillover effects*

JEL Classification: C21, E43, E62, F42, F45, H60, O52

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Introduction

The existence of spillovers, whereby fiscal policy measures in one country produce effects in other countries, is often used as a justification for fiscal policy coordination. One of the main worries in this respect is the impact of fiscal imbalances on long-term interest rates. This issue is especially relevant in monetary unions where monetary policy and exchange rate are shared and the level of integration is high. In such a situation, debt accumulation of one government may lead to a change in devaluation and/or default risk for another government within the union, and consequently increase its bond yields (Alcidi, Maattanen and Thiron, 2015). Chari and Kehoe (2004) argue that fiscal authority in a member state of a monetary union has an incentive to increase its own debt, knowing

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that the supra-national monetary authority will, in response, increase inflation rate thus inflating away member state's nominal debt. In this case the cost of inflation brought upon other member states is ignored. This time-inconsistency problem in monetary policy leads to free-rider problem in fiscal policy, and results in sub-optimal (too high) debt levels in member states. It might be argued, though, that the effects of debt spillovers in Economic and Monetary Union (EMU) should be controlled through no-bail out clause (Article 125 of the Treaty on the Functioning of the European Union). Moreover, Stability and Growth Pact specifies upper numerical limits on debts and deficits. However, to the extent that the bail-out clause in not fully credible, there is scope for the existence of government debt spillovers among countries. As noted by Landon and Smith (2007), in this case financial markets do not price individual countries' risk of government debt properly, which results in a situation whereby fiscal irresponsibility of individual countries leads to higher interest rates in all countries within a monetary union. Namely, if lenders expect that member states will be supported by financial funds of the whole union, the yields on individual members' debt will depend on the debt of the union as a whole. In the literature this is known as informational channel of spillovers, as opposed to real channel of spillovers (for a more detailed discussion of these channels please refer to Debarsy et al., 2018, and references thereof). These real linkages arise from trade and financial relationships between countries. Excessive debt in one member state may negatively influence output and prices within that state, but also in other states through decreased trade and financial flows, as well as tax revenues. In this way it might be more difficult for these other member states to meet their debt obligations (Landon and Smith, 2007). Additionally, geographical vicinity might also be a transmission channel of fiscal spillovers. If two countries are closely linked, then the pool of funds available to each government is larger and exceeds the funds in domestic credit market only. In this case significant spillovers to and from these countries are to be expected. As noted by Claeys, Moreno and Surinach (2012), a country running a deficit is more likely to find funding in a country considered to be "close". This closeness can be geographical or economic (via, say, financial integration, similarity of economic fundamentals etc.). Indeed, Kaminsky and Reinhart (2000) find that spillovers are more regional than global.

Given the possibility of significant externalities created by debt accumulation, the main goal of this study is to investigate the existence and magnitude as well as transmission channels of government debt spillovers in EMU. Within this, we concentrate on real, informational and geographical channel of fiscal transmissions. This is very important from policy makers' point of view, since the adequate policy may vary depending on the nature of these spillovers. In

addition to exploring an issue which is timely and relatively under-investigated, the contribution of present study lies in our econometric approach. Firstly, as will become evident from the literature review below, most papers on the topic use a benchmark country or a measure of the "world" interest rate to assess spillovers, which is quite restrictive. Our approach, on the other hand, applies spatial panel analysis whereby spillovers are modelled via spatial weights matrix. Our approach, therefore, pertains to a very small literature that explicitly tests for the existence of fiscal spillovers via spatial matrices. Conversely, we differ from this specific literature in terms of the analysed period and country selection (we focus on EMU), and the fact that we also account for the impact of financial integration. More importantly, even though we follow the general approach of Debarsy at al. (2018) in testing the real and informational transmission channel, we use a much wider range of indicators (we create ten, as opposed to Debarsy et al.'s (2018) four, interaction matrices - for more details please see Section III) to assess informational channel of transmission, and in addition we test geographical channel.

Our results indicate that all of the analysed transmission channels are relevant. Moreover, we find that were the share of public debt in GDP of a country to increase by 1 percentage point, its long-term interest rates would increase by 1.35 – 2.4 basis points. Furthermore, if the share of public debt in GDP in all countries increases by 1 percentage point, the long-term interest rates of a given country will, on average, increase by 2.56 – 5.98 basis points.

The rest of this paper is organised as follows. Section 1 reviews related empirical literature, section 2 introduces methodological approach adopted in the paper and presents the data, section 3 gives the results of our empirical investigation, while the last section concludes.

1. Empirical Estimations of Fiscal Spillovers – Literature Review

It should be emphasised at this point that the term sometimes used with regards to international fiscal transmission mechanisms is contagion. As noted by Kohonen (2012), contagion refers to transmission of financial distress between countries, whereby turmoil in one country causes turmoil in another country. This term differs from terms such as interdependence, interconnectedness or spillovers. The latter refers to relationships between variables in different countries during normal times, while the former refers to a change in these linkages connected to crises. In our approach we adopt this distinction and alienate ourselves from the vast literature on contagion. In addition, as noted by Dell'Erba, Baldacci and Poghosyan (2013), the issue of contagion is typically investigated through the use of high-frequency data (monthly or daily). In our analysis, we

make use of low-frequency – annual – data, which enables us to smooth out temporary fluctuations typically associated with contagion. As noted by Giannone, Lenza and Reichlin (2009), while the use of annual data might result in the loss of some short-term dynamics, it is more reliable for establishing robust facts on real economic activity. Additionally, annual data is used by majority of other papers on the topic (see, for example Faini, 2006; Ardagna, Caselli and Lane, 2007; Alper and Forni, 2011; Landon and Smith, 2007; Claeys, Moreno and Surinach, 2012; Dell'Erba, Baldacci and Poghosyan, 2013). Therefore, the main goal of our paper is to investigate the co-movement between fiscal imbalances and government bond yields of different economies, and to shed light on the underlying channels of transmission.

Although the results from Global Vector Autoregression (GVAR) papers cannot be directly compared to spatial panel results in terms of estimated coefficients, both strands of literature come to similar conclusions in terms of the importance of spillover effects. More precisely, within the GVAR literature, Caporale and Girardi (2013) find that foreign factors explain larger percentage of variability in long-term interest rates in EMU countries than domestic factors, and that, overall, euro-denominated government yields are strongly interrelated within the EMU. Nickel and Vansteenkiste (2013) conclude that fiscal shocks have significant domestic and international spillover effects on financial variables. Echevarria-Icaza and Sosvilla-Rivero (2017) find that, within the euro area, spillover effects from other member countries into the domestic economy are substantial. Moreover, Belke and Osowski (2016) find that there are spillover effects of fiscal policy shocks originating in Germany and France, and these are stronger on EMU than on non-EMU countries.

In panel literature government bond yields for each country are typically regressed on a set of domestic explanatory variables, and then this specification is augmented with foreign explanatory variables. Statistically significant coefficients on foreign variables are interpreted as a sign of spillovers. Faini (2006), for example, investigates whether domestic fiscal policy affects primarily domestic interest rates or euro area interest rates in EMU in the period 1979 – 2002. He assesses these spillovers by estimating a system of 10 regressions – one for each of the 9 countries in the sample, and one for EMU as a whole. A comparison between coefficients estimates on EMU variables and individual country variables enables him to draw conclusions about the size of these spillovers. He finds that the impact of both, government deficit and debt, is more pronounced at the euro zone level than at the national level, suggesting significant spillovers of fiscal policy effects over the euro area as a whole. At the country level these effects are practically non-existent. Ardagna, Caselli and Lane (2007), analyse

16 OECD countries during 1960 – 2002. They create "world" explanatory variables, by using average values across OECD countries as a proxy, and add them as extra right-hand-side variables. They conclude that fiscal imbalances produce the most significant effect in home country; however "world" fiscal policy also matters for interest rates. This finding is read as the evidence in favour of spillovers among OECD countries. Similarly, Alper and Forni (2011) create measures of "global" public debt, short-term interest rate, growth and inflation and use these to broaden their baseline specification. They find significant spillover effects from global debt on emerging economies' interest rates. Furthermore, they find spillovers from US long-term interest rates on other countries interest rates. Landon and Smith (2007) adopt a comparable approach in their investigation of the impact of government debt on interest rates within a monetary union, using the data for Canadian provinces over the period 1983 – 2005. They estimate spillovers by including federal government debt to GDP as well as aggregate debt to GDP of the provinces as explanatory variables. They find the former to be statistically significant, and the latter not. This is explained through the fact that monetary accommodation, as a channel of transmission, is available only to the federal government, while the other provinces are not perceived as a source of bail-out funds in the case of need.

The problem with assessing spillovers in the manner described above is that a researcher typically chooses only one country as a benchmark; alternatively, a measure of world or regional interest rate is created and used. Both approaches are rather restrictive, as it would be much better to account for the level of interest rates in various foreign countries. This would, then again, lead to too many regressors, and the number of parameters to be estimated larger than the number of observations. Spatial econometrics approach which we apply, on the other hand, allows us to assess the impact of foreign variables on domestic interest rates quite elegantly. These complex linkages are, in this approach, captured through the exogenously specified spatial weights matrix, whose structure reflects the intensity of the 'closeness' of different observations (Claeys, Moreno and Surinach, 2012). Moreover, estimation of direct and indirect effects allows differentiating between those factors which are internal versus those which are external, respectively. Our approach is, in this respect, similar to Claeys, Moreno and Surinach (2012), Dell'Erba, Baldacci and Poghosyan (2013) and Debarsy et al. (2018), who explicitly test for the existence of spillovers. Claeys, Moreno and Surinach (2012) analyse 50 OECD and emerging economies over 1990 – 2005. They use spatial autoregressive model, whereby spatial weights matrix captures the degree of capital mobility across countries. They proxy this mobility through difference in the size of bond market for each country pair. A larger spatial rho is taken to

imply stronger bond market integration. They conclude that cross border spillovers are stronger among the OECD members, and especially the EU, than among the emerging markets. Dell'Erba, Baldacci and Poghosyan (2013) explore spillovers between 24 emerging economies during 1995 – 2010. They find that the main transmission channels are business cycle synchronization, trade and geographical proximity. Financial links and institutional similarities are also significant *albeit* to a lesser extent. It should be emphasised, though, that they investigate the impact of external, not government debt on interest rate spreads. Debarsy et al. (2018) investigate 21 emerging and 20 advanced economies over the period 2008Q1 – 2012Q4. They find that spillovers spread primarily from advanced economies towards emerging economies, while the opposite is not the case, i.e. it is less pronounced. As for transmission channels, they find all channels to be important. Precisely, they test real economic links, approximated via contribution of bilateral trade to country's GDP, and informational channels, captured through debt-to-GDP, and deficit-to-GDP ratio, as well as government stability index and socio-economic index.

2. Data and Methodology

Spillovers in empirical literature can be assessed either via spatial indirect effects (spatial panel models) or impulse responses (Global Vector Autoregression (GVAR) models). In both cases spillover effects are a function of shocks, coefficient estimates and weights matrix specification; however, spatial models use maximum likelihood (ML), instrumental variables (IV) or generalised method of moments (GMM), as opposed to OLS used by GVARs. These two approaches differ in several other aspects as well. Firstly, spatial models typically focus on a single equation with clear distinction between dependent and independent variables, whereas GVAR models focus on simultaneous equation systems, whereby different types of variables are treated the same i.e. as dependent variables. As for panel dimension, N is large and T smaller in spatial models, while GVARs focus on time dimension, with T larger than N. In spatial models, slope coefficients are homogeneous across units for each explanatory variable, whereas in GVAR coefficients are unit specific. Spatially lagged variable is endogenous in spatial model and weakly exogenous in GVAR. Weight matrix is usually the same for all variables in spatial model. It typically contains many zero off--diagonal elements, or elements that converge to zero as the distance increases. In GVAR, on the other hand, weight matrices can be time variant and potentially different for each variable. There are hardly any zero off-diagonal elements in these matrices. This difference with respect to the sparsity of density (in terms

of number of zero elements) of the matrix as well as the speed of convergence dictates the choice of the estimation method. Finally, cross-sectional dependence is related to a limited number of neighbours with relatively large weights in spatial model and to a large number of neighbours with evenly distributed weights in GVARs (Elhorst, Gross and Tereanu, 2018).

Having said all of the above our choice of spatial panel model arises from the fact that in our sample N is larger than T; we investigate an impact of various variables on a specific dependent variable (long-term interest rates) while the assumption of homogeneous slope coefficients is justified by the fact that we investigate similar i.e. EMU countries. Furthermore, weak exogeneity restrictions and country-specific VAR estimations imposed by GVAR approach are not suitable for our empirical analysis, given that the countries in our sample are strongly interconnected. In contrast, we model this contemporaneous interdependence via quasi-maximum likelihood estimation, thus accounting for the endogeneity problem.

We analyse a set of 19 EMU members: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain. Originally, we intended to use the longest period available - from the creation of EMU in 1999 to 2017; however, data availability issues (primarily regarding long-term interest rates) rendered this impossible, forcing us to narrow the period down to 2002 – 2015. Not all of the listed countries were EMU members from the beginning; therefore, we control for this via the use of dummy variable (EMU dummy). Tables 1 and 2 give the list and descriptive statistics of all the variables, respectively.

T a b l e 1

Definitions and Sources of the Variables

Name	Definition	Source
Long-term interest rate (%)	Yield on 10-year government bonds.	Economist Intelligence Unit
Public debt (% GDP)	Total debt (both local and foreign currency) owed by government to domestic residents, foreign nationals and multilateral institutions such as the IMF, expressed as a percentage of GDP.	Economist Intelligence Unit
Inflation (CPI, %)	Percentage change in consumer price index in local currency (period average), over previous year.	Economist Intelligence Unit
GDP growth (%)	Percentage change in real GDP, over previous year.	Economist Intelligence Unit
EMU dummy	Dummy variable that takes the value of 1 if a certain country was an EMU member in a certain year and 0 otherwise.	Author's construction
IIPGDP (%)	International investment position as reported by the IMF's Balance of Payments Statistics and International Financial Statistics (share of GDP)	Author's calculations Lane and Milesi-Ferretti (2017)

Note: All the data is annual.

Source: Author's calculations and sources listed in the table.

T a b l e 2
Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Long-term interest rate (%)	266	4.31	2.29	0.37	22.50
Public debt (% GDP)	266	61.94	36.36	3.66	179.14
Inflation (CPI, %)	266	2.26	2.06	–2.08	15.41
GDP growth (%)	266	1.98	4.18	–14.81	25.49
EMU dummy	266	0.78	0.41	0	1
IIPGDP (%)	266	–30.61	50.86	–243.44	82.81

Source: Author's calculations.

T a b l e 3
Test for Global Cross-sectional Dependence in Variables

Variable	Global CD	Local CD
Long-term interest rate (%)	23.160***	13.143***
Public debt (% GDP)	37.300***	13.298***
Inflation (CPI, %)	30.050***	12.077***
GDP growth (%)	31.610***	9.207***
IIPGDP (%)	4.490***	3.404***

Source: Author's calculations.

As can be observed from Table 3, Pesaran's (2004) global cross-sectional dependence (Global CD) test suggests the rejection of cross-sectional independence. Moreover, Pesaran and Tosetti's (2011) local CD test suggests the existence of spatial dependence, thus implying that the cross-sectional correlation can be treated as spatial correlation. Application of spatial econometric techniques is, therefore, justifiable; hence we apply a general SAR model of the type:

$$y_{it} = \alpha + \rho \sum_{j=1}^{n} w_{ij} y_{jt} + x_{it}\beta + \gamma_t + u_{it} \tag{1}$$

where

y_{it} – the dependent variable (long-term interest rates),

x_{it} – a set of independent variables,

w_{ij} – a spatial weights matrix,

μ_i – the individual fixed or random effect,

γ_t – the time effect,

ϵ_{it} – a normally distributed error term.

A key component of this model is the spatial lag coefficient (spatial rho), ρ, which, if found to be significant, would confirm the existence of spillovers among countries. Model given in (1), thus, enables us to test whether interest rates and debt accumulated by a government in one EMU member country influence, not only long-term interest rates in the domestic economy (direct effect), but also interest rates in other member countries (indirect effect). We apply fixed

effects model. Namely, Hausman test (unreported, but available upon request) suggested that fixed effects are preferred to random effects. This makes more sense from an economic point of view also, since we do not want to draw conclusions outside our sample, and fixed effects should be used in this situation. More precisely, as all of the EMU member countries are included, sample practically becomes population. It should also be emphasised at this point that in spatial autoregressive models, the functional form of autocorrelation is assumed to be linear, and as such is subject to caveats of approximating non-linear phenomena using linear methods (Elhorst, Gross and Tereanu, 2018).

Spatial weights matrix, w_{ij}, generally measures proximity between two countries. This proximity is usually understood in geographical terms; however it can also be approximated by economic links. This matrix pays a key role in our empirical estimation, since we will change its definition to assess the transmission channels of fiscal spillovers. Specific issues with its construction will be discussed later in the text.

The dependent variable, 10-year government bond yield, used in this paper, is the one used in the convergence criteria of the EMU for long-term interest rates. It should be noted at this point that a sizeable literature (see, for example, Akitoby and Stratmann, 2008; Alexopolou, Bunda and Ferrando, 2009; Ebner, 2009; Favero, 2013; Cihak and Mitra, 2009; Nickel, Rother and Rulke, 2009; Dumičić and Ridzak, 2011, Csonto and Ivaschenko, 2013 and Lau-Hansen, 2015) uses interest rate spreads, not levels, as the dependent variable; the spreads being defined as the difference between the bond yield of a particular country and the yield of a German government bond. In our opinion, however, the use of interest rate level instead of a spread is more justified given the fact that it is a policy variable i.e. a Maastricht criteria requirement.

The set of control variables we use comprises of public debt, inflation and GDP growth, whereby we are mostly interested in the effects of public debt on long-term interest rates. In theory, the relationship between public debt and long-term interest rates is positive. There are several transmission channels of this impact. Firstly, interest rates might increase as a result of (compensation for) a fear of government debt default. Furthermore, investors also require compensation for their willingness to hold government debt, which leads to an increase in interest rates. Moreover, interest rates rise proportionally to expected inflation because of the fear of debt monetization, and finally, an increase in government debt can crowd-out private investment, thus leading to higher interest rates. The influence of GDP growth on long-term interest rates can be either positive or negative. Namely, economic growth, on the one hand, increases the supply of corporate bonds (through private investment), and, on the other hand, decreases

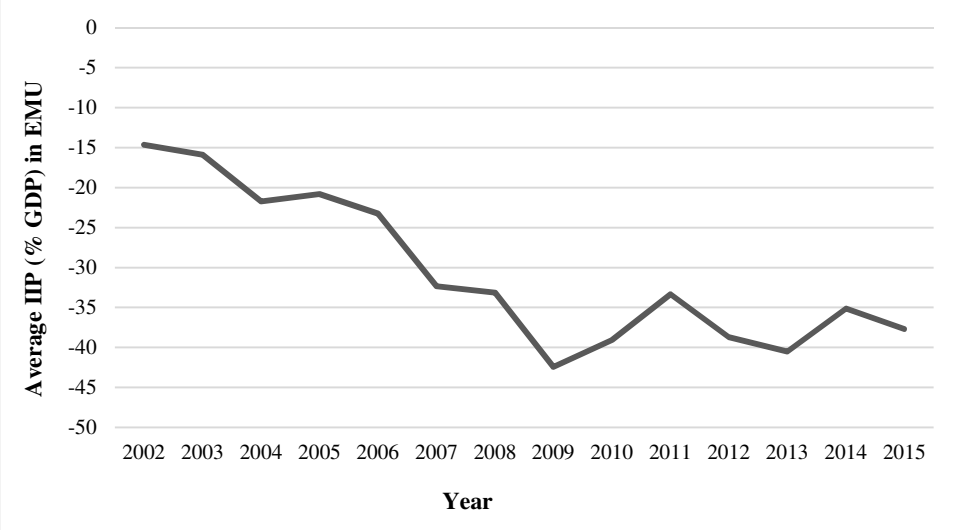
the supply of public bonds (by increasing tax revenues and raising fears of unsustainable debt positions). This can result in either higher or lower bond yields, depending on which effect prevails. As for inflation, we would *a priori* expect it to raise long-term rates, since, according to pure expectation theory; the long-term rate equals the short-term rate plus expected inflation.

This sort of regression sometimes also includes primary balance and short--term interest rates as control variables. We restrain from incorporating them for the following reasons. Firstly, as Engen and Hubbard (2004) note, primary balance should not be among the set of explanatory variables for explaining the level of long-term government bond yields, since it is the *level* of government debt that influences the *level* of interest rates, and the *change* in government debt, i.e. primary balance, that influences the *change* in interest rates.[1] Additionally, primary balance will be accounted for in the spatial weights matrix (please refer to equation (3)). Secondly, a measure of short term interest rates typically used is money market interest rate, which is, for the majority of countries in our sample the same – 3 month Euribor rate. There is, therefore, not enough variation in this variable.

In addition to the set of core control variables we also include EMU dummy (to control for EMU membership) and a measure of financial integration. Namely, Faini (2006) observes that the degree of financial integration is a key variable that affects the influence of fiscal policy on interest rates. Following the approach suggested by Lane and Milesi-Ferretti (2003), and using the data from Lane and Milesi-Ferretti (2017), we approximate the degree of financial integration through International Investment Position (IIP), which summarizes total holdings by domestic residents of financial claims on the rest of the world, and nonresidents' claims on the domestic economy. We use the share of this measure in GDP (IIPGDP), so that all of our variables are expressed as percentages. Figure 1 plots the evolution of average IPIGDP in the period 1999 – 2015 for EMU countries. As can be seen, this indicator has been constantly negative meaning that liabilities exceeded assets, i.e. that EMU members were, on average, net borrowers of financial funds. Taken in absolute terms, there has been a visible increase in this indicator, suggesting increased activity in international financial markets i.e. higher level of financial integration.

[1] In spite of the argument provided above, to the extent that primary deficits (also due to their serially correlated nature) offer information about the future evolution of public debt, they are often included in the model. For these reasons, we also add it to our regression, as a robustness check. The results are given in Table 9 in the Appendix. Our overall conclusions remain unaltered by this inclusion and the variable Primary balance is found to have statistically mostly insignificant effect. Due to space preservation reasons we have used only one macroeconomic variable in w_{ij} as given in (3) for informational channel. For macroeconomic variable, we have used Unemployment, and for Institutional variable GE, as these two were found to be the most statistically significant in Tables 5 and 6.

F i g u r e 1
Evolution of International Investment Position in EMU, 2002 – 2015



Source: Author's calculations Lane and Milesi-Ferretti (2017).

As indicated above, the main goal of this paper is to test the real, informational and geographical channel of fiscal transmissions among the EMU. In order to do so we make use of spatial weights matrix, and construct it in such a way that enables testing of each of these channels. It should be stressed that we are already controlling for financial integration, so that that these matrices enable us to test the transmission channels beyond financial integration. Admittedly, it might have been better to construct a matrix which accounts for financial transmission channel directly. This turned out to be impossible due to: inexistence of bilateral data on financial integration and, additionally, most of statistical data on bilateral financial transactions of any type is available only for some countries. Therefore, following the approach by Debarsy et al. (2018) we test the real transmission channel via the following matrix:

$$w_{ij} = \frac{M_{ij} + X_{ij}}{GDP_i + GDP_j} \tag{2}$$

where

M_{ij} and X_{ij} – bilateral total imports and exports, respectively,

GDP – nominal gross domestic product.

All the data is for 2015 and taken from World Integrated Trade Solutions (WITS) database using World Standard Trade International Classification (STIC revision 2). Matrix given in (2) enables us to assess the intensity of the overall

trade between each pair of countries. Similarly, and again following the approach by Debarsy et al. (2018), we test the informational transmission channel via the following matrix:

$$w_{ij} = \frac{1}{\left|A_i - A_j\right| + 1} \tag{3}$$

where

A_i – a certain indicator in country *i*,

A_j – that same indicator in country *j*.

We depart from Debarsy et al. (2018) here and use a wide range of macroeconomic as well as institutional quality indicators. Among the macroeconomic variables we include: General government net lending/borrowing (percent of GDP), General government primary net lending/borrowing (percent of GDP), Current account balance (percent of GDP) and unemployment rate. All the data is taken from World Economic Outlook (WEO) for year 2015. Additionally, we use different quality of institutions indicators: Control of Corruption, Government Effectiveness, Political Stability and Absence of Violence/Terrorism, Regulatory Quality, Rule of Law and Voice and Accountability. All the data is taken from World Governance Indicators (WGI) for year 2015. In this way we account for the similarity (in terms of macroeconomic and institutional characteristics) between each pair of countries, thus capturing the idea that investors treat all countries with similar macroeconomic fundamentals/quality of institutions as equal, because of incomplete information. In such a situation a negative shock in one country leads investors to pull-out from another country (the so-called "wake up call") with similar macroeconomic/institutional conditions due to information spillovers, i.e. expectations that the same situation will happen in this country (Hernandez and Valdes, 2001). Finally, we argue that geographical vicinity also plays a role as a transmission channel. Once again, we create a matrix, this time given as inverse distance squared spatial weights matrix:

$$w_{ij} = \begin{cases} \frac{1}{d_{ij}^2} if\ i \neq j \\ 0 if\ i = j \end{cases} \tag{4}$$

where

d_{ij} – stands for the distance between observations (countries) *i* and *j*.

Matrix given in (4) exhibits distance decay effect i.e. the value of the function decreases with growing distance, thus giving more weight to nearby countries. All of the above matrices given in (2) – (4) are row standardised.

3. Results

LeSage and Page (2009) observe that many studies erroneously use point estimates of spatial regressions, in order to infer whether spatial spillovers exist. They, on the other hand, suggest partial derivative interpretation of the impact from changes to the variables in a model. In this way a change in a particular explanatory variable within one country influences not only the dependent variable in that country but also the dependent variable in other countries. These effects are called direct and indirect effects, respectively. In our case, the direct effect measures the influence of changes in exogenous variable within one country on its own long-term interest rates, while the indirect effect measures the impact of changes in exogenous variable within one country on the dependent variable of all other countries. Tables 4 – 7 give direct and indirect effects for the model given in (1), and differ only in terms of the used spatial weights matrix (as presented in equations (2) – (4)). We start by testing the bilateral trade channel of transmission. The results are given in Table 4.

T a b l e 4
Results with Bilateral Trade Matrix

Spatial weights matrix	**w_{ij} as given in (2)**
Dependent variable	**Long-term interest rate (%)**
Spatial Rho	0.465***
	(0.0636)
Direct effects	
Public debt (% GDP)	0.0240***
	(0.00627)
Inflation (CPI, %)	0.163***
	(0.0582)
GDP growth (%)	–0.166***
	(0.0278)
EMU dummy	–2.057***
	(0.359)
IIPGDP (%)	–0.00722*
	(0.00375)
Indirect effects	
Public debt (% GDP)	0.0204**
	(0.00851)
Inflation (CPI, %)	0.133***
	(0.0514)
GDP growth (%)	–0.137***
	(0.0333)
EMU dummy	–1.718***
	(0.541)
IIPGDP (%)	–0.00585*
	(0.00320)
N	266
r2	0.430

Note: Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Author's calculations.

All of the results in Table 4 are statistically significant at conventional levels of significance. Direct and indirect effects are similar in size, i.e. approximately 46 percent of the overall effect can be attributed to spillover (indirect) effects. More precisely, a one percentage point increase in the stock of public debt is found to be associated with an increase in long-term interest rates of 4.44[2] basis points, 2.4 of which can be attributed to direct and 2.04 basis points to indirect effects. Inflation also influences interest rates positively, while the influence of GDP growth, EMU dummy and International investment position is negative. A positive sign on inflation suggest that if inflation in all countries increases by 1 percentage point, the long-term interest rates of a given country will increase by 29.6 basis points; 13.3 of which can be attributed to indirect effects. The theory is inconclusive regarding the expected sign on GDP growth. Our results suggest that a one percentage point increase in the rate of GDP growth leads to a decrease in long-term interest rates of 30.3 basis points; 16.6 directly, and 13.7 indirectly. The negative sign on EMU dummy, suggests that with the accession of a country to the EMU, long-term interest rates fall. Correspondingly, the negative sign on IIPGDP suggests that increased financial integration lowers long-term interest rates, which is in line with the convergence of long-term interest rates which has been taking place over the past quarter of a century. To keep the analysis simple, from now on we consider only the impact of public debt (in GDP) on long-term interest rates.

Spatial rho is also statistically significant thus confirming the importance of spatial effects. Specifically, a positive value of spatial rho suggests that an increase in interest rates in one country will be followed by increases in interest rates in other countries. Given the construction of our spatial weights matrix, these results confirm the existence of bilateral trade as an important channel of transmission between EMU countries. Higher intensity trade between each pair of countries, therefore, leads to larger fiscal spillovers among them. Namely, debt accumulation in one country may negatively influence its own output, but also output in other countries via decreased demand and consequently trade. In this case it might be more difficult for these other countries to service their debt.

Furthermore, as indicated previously, investors, in a situation of imperfect information, treat those countries with similar macroeconomic conditions as equal. Informational channels are, as noted by Debarsy et al. (2018), based precisely on these beliefs about countries' similarities. To capture these channels, we adopt a dual approach. Firstly, we use annual macroeconomic data such as: budget balance to GDP ratio (DEF), primary budget balance to GDP ratio (PRIMDEF),

[2] This is the so-called total effect, which is calculated as the sum of direct and indirect effects. We did not report total effects in Tables 4 – 7 for space preservation reasons; rather we refer to them in the text.

current account balance to GDP ratio (CA) and unemployment rate (UNEMP). For each of these variables we construct a separate interaction matrix as given in (3). Each of these matrices accounts for macroeconomic similarities between countries, captured by a chosen indicator. The results are given in Table 5.

T a b l e 5
Results with Informational Channel – Macroeconomic Variables

Spatial weights matrix	w_{ij} **as given in (3)**			
Macroeconomic variable in w_{ij}	**DEF**	**PRIMDEF**	**CADEF**	**UNEMP**
Dependent variable	**Long-term interest rate (%)**			
Spatial Rho	0.478*** (0.0807)	0.455*** (0.0807)	0.455*** (0.0801)	0.533*** (0.0762)
Direct effects				
Public debt (% GDP)	0.0136** (0.00595)	0.0135** (0.00597)	0.0123** (0.00593)	0.0166*** (0.00597)
Inflation (CPI, %)	0.153** (0.0595)	0.156*** (0.0597)	0.157*** (0.0596)	0.156*** (0.0583)
GDP growth (%)	–0.201*** (0.0271)	–0.203*** (0.0271)	–0.206*** (0.0270)	–0.198*** (0.0266)
EMU dummy	–2.195*** (0.365)	–2.215*** (0.365)	–2.237*** (0.366)	–2.164*** (0.363)
IIPGDP (%)	–0.0159*** (0.00364)	–0.0157*** (0.00364)	–0.0164*** (0.00365)	–0.0157*** (0.00361)
Indirect effects				
Public debt (% GDP)	0.0133* (0.00804)	0.0121* (0.00735)	0.0110 (0.00691)	0.0199* (0.0106)
Inflation (CPI, %)	0.141** (0.0620)	0.131** (0.0570)	0.132** (0.0570)	0.177** (0.0756)
GDP growth (%)	–0.190*** (0.0634)	–0.175*** (0.0584)	–0.177*** (0.0592)	–0.229*** (0.0736)
EMU dummy	–2.104** (0.854)	–1.940** (0.787)	–1.950** (0.790)	–2.537** (0.994)
IIPGDP (%)	–0.0152** (0.00634)	–0.0137** (0.00568)	–0.0143** (0.00591)	–0.0184** (0.00742)
N	266	266	266	266
r2	0.441	0.445	0.435	0.423

Note: Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: Author's calculations.

The results in Table 5 again indicate that spillovers are significant, and account for more than 45 percent of the overall effect. Spillover effects (indirect effects) are found to be insignificant only in the case where current account balance is used as a signal of similarities between countries. The other results are rather similar, and suggest that a one percentage point increase in public debt leads to an increase in long-term interest rates of 2.6 – 3.6 basis points; 1.2 – 1.9 of which can be attributed to spillover effects. These results, thus, point towards the importance of informational channel of transmission between EMU countries, whereby investors treat equally those countries with similar budget balances and/or unemployment rates.

To further capture similarities between countries we also account for institutional similarities. For this we use Worldwide Governance Indicators (WGI), which report six dimensions of governance: Voice and Accountability (VA), Political Stability and Absence of Violence (PV), Government Effectiveness (GE), Regulatory Quality (RQ), Rule of Law (RL) and Control of Corruption (CC). The first two indicators, as noted by Kaufmann, Kraay and Mastruzzi (2010), capture the process by which governments are selected, monitored, and replaced; the second two indicators refer to the capacity of the government to effectively formulate and implement sound policies; while the last two capture the respect of citizens and the state for the institutions that govern economic and social interactions among them. As before, for each of these indicators we construct a separate interaction matrix (using expression given in (3)), which captures institutional similarities between countries. These results are given in Table 6.

T a b l e 6

Results with Informational Channel – Institutional Variables

Spatial weights matrix	**w_{ij} as given in (3)**					
Macroeconomic variable in w_{ij}	**VA**	**PV**	**GE**	**RQ**	**RL**	**CC**
Dependent variable	**Long-term interest rate (%)**					
Spatial Rho	0.532*** (0.0793)	0.515*** (0.0807)	0.540*** (0.0784)	0.546*** (0.0780)	0.538*** (0.0781)	0.539*** (0.0777)
Direct effects						
Public debt (% GDP)	0.0166*** (0.00601)	0.0167*** (0.00605)	0.0179*** (0.00605)	0.0173*** (0.00601)	0.0174*** (0.00602)	0.0171*** (0.00600)
Inflation (CPI, %)	0.152*** (0.0589)	0.155*** (0.0591)	0.154*** (0.0587)	0.151*** (0.0586)	0.155*** (0.0586)	0.153*** (0.0586)
GDP growth (%)	–0.198*** (0.0267)	–0.199*** (0.0269)	–0.196*** (0.0267)	–0.196*** (0.0267)	–0.197*** (0.0267)	–0.197*** (0.0267)
EMU dummy	–2.194*** (0.365)	–2.131*** (0.364)	–2.189*** (0.364)	–2.186*** (0.364)	–2.223*** (0.365)	–2.227*** (0.365)
IIPGDP (%)	–0.0152*** (0.00362)	–0.0152*** (0.00363)	–0.0149*** (0.00362)	–0.0149*** (0.00362)	–0.0150*** (0.00362)	–0.0151*** (0.00361)
Indirect effects						
Public debt (% GDP)	0.0200* (0.0110)	0.0190* (0.0105)	0.0223* (0.0119)	0.0220* (0.0118)	0.0214* (0.0114)	0.0212* (0.0114)
Inflation (CPI, %)	0.173** (0.0764)	0.165** (0.0722)	0.181** (0.0788)	0.182** (0.0802)	0.180** (0.0782)	0.179** (0.0783)
GDP growth (%)	–0.231*** (0.0780)	–0.217*** (0.0727)	–0.235*** (0.0784)	–0.241*** (0.0805)	–0.234*** (0.0780)	–0.236*** (0.0782)
EMU dummy	–2.598** (1.062)	–2.361** (0.959)	–2.670** (1.082)	–2.728** (1.108)	–2.687** (1.089)	–2.706** (1.094)
IIPGDP (%)	–0.0179** (0.00745)	–0.0169** (0.00702)	–0.0182** (0.00753)	–0.0186** (0.00771)	–0.0181** (0.00748)	–0.0183** (0.00753)
N	266	266	266	266	266	266
r2	0.424	0.426	0.417	0.418	0.423	0.424

Note: Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Author's calculations.

Spillover effects are now even more pronounced than when we included macroeconomic similarities, and account for 51.5 – 54.6 percent of the overall effect. Taken together, the results in Table 6 suggest that a one percentage point increase in public debt leads to an increase in long-term interest rates of 3.6 – 4 basis points; of which 1.9 – 2.23 basis points can be attributed to spillover effects. Although the differences are small, the results indicate that those indicators that refer to the capacity of the government to effectively formulate and implement sound policies are those that reveal most information to investors. More precisely, spillover effects are more pronounced when our spatial weights matrix is created from indicators GE and RQ. GE refers to perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies, while RQ captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development (Kaufmann, Kraay and Mastruzzi, 2010). Overall, informational channel turned out to be significant in explaining spillovers between EMU countries. Fiscal irresponsibility of an individual country is, therefore, strongly felt in other countries within a monetary union, which are perceived by investors to be similar, in macroeconomic or institutional terms, with the first country.

Table 7, finally, looks at geographical distances as an important transmission channel of spillovers. Spillover effects now account for almost 60% of the overall effect. In this case a one percentage point increase in public debt leads to an increase in long-term interest rates of 5.98 basis points; 3.61 of which can be attributed to spillover effects. This significance of neighbourhood effects of fiscal spillovers points towards the importance of formulating regional policies, which would be specifically tailored for smaller groups of neighbouring countries.

Finally, given that it could be argued that fiscal spillovers in the euro were different before and during/in the aftermath of the financial crisis, we additionally include dummy variable Crisis into our model to account for the crisis of 2007 – 2008. The results are given in Table 8 in the Appendix[3]. Our overall conclusions remain unaltered by this inclusion and the variable Crisis is found to have statistically insignificant effect.

Overall, our findings of the importance of geographical and bilateral trade channel is in line with the findings of Dell'Erba, Baldacci and Poghosyan (2013) who also find geographical proximity, as well as trade to be important channel

[3] Due to space preservation reasons we have used only one macroeconomic variable in w_{ij} as given in (3) for informational channel. For macroeconomic variable, we have used Unemployment, and for Institutional variable GE, as these two were found to be the most statistically significant in Tables 5 and 6.

of fiscal transmission. Debarsy et al. (2018) also find trade channel to be significant, while they do not test geographical channel. As for the informational channel, our results are comparable to those of Debarsy et al. (2018) in the sense that we also find that institutional similarities are a relevant channel of spillover transmission.

However, unlike Debarsy et al. (2018) who find that this channel is of utmost importance, our results suggest that geographical proximity is more important than institutional similarities. Moreover, Debarsy et al. (2018) use socioeconomic similarity index to test informational channel, which reflects the pressures at work in the society that could constrain government action, while we, on the other hand, use Worldwide Governance Indicators. We find that spillover effects are more pronounced when our spatial weights matrix is created from similarity of those indicators that refer to government effectiveness and regulatory quality. As in Debarsy et al. (2018), we find this to be more important than macroeconomic similarity channel.

T a b l e 7
Results with Geographic Matrices

Spatial weights matrix	**w_{ij} as given in (4)**
Dependent variable	**Long-term interest rate (%)**
Spatial Rho	0.599***
	(0.0722)
Direct effects	
Public debt (% GDP)	0.0237***
	(0.00622)
Inflation (CPI, %)	0.144**
	(0.0582)
GDP growth (%)	–0.173***
	(0.0268)
EMU dummy	–2.012***
	(0.362)
IIPGDP (%)	–0.0123***
	(0.00361)
Indirect effects	
Public debt (% GDP)	0.0361**
	(0.0172)
Inflation (CPI, %)	0.208**
	(0.0931)
GDP growth (%)	–0.255***
	(0.0794)
EMU dummy	–2.999***
	(1.161)
IIPGDP (%)	–0.0182**
	(0.00768)
N	266
r2	0.396

Note: Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Author's calculations.

Conclusions

The main goal of this paper is to investigate the impact of fiscal imbalances (primarily public debt) on long-term interest rates within the EMU, and to shed light on the underlying channels of transmission. Within this we focus on three channels: real, informational and geographical. Our results suggest that fiscal spillovers are significant and tend to be larger for countries which are geographically close to each other, those who trade more, and those which are perceived to be similar either in terms of macroeconomic conditions or the quality of their institutions.

Firstly, all of the analysed transmission channels (modelled by an interaction matrix) are found to be relevant. Moreover, spatial rho, which captures spatial interactions between countries, is also consistently found to be significant. This finding suggests that interdependencies between countries should be taken into account in the analyses of long-term interest rates; alternatively misspecification issues arise. Furthermore, irrespective of the transmission channel under consideration, all of the explanatory variables in the model are statistically significant, without sign changes – these results are in line with common findings of previous studies, and confirm the robustness of our model. It should also be stressed that all these channels work beyond financial integration, which is, as a separate variable, found to be significant.

The size of indirect effects of public debt, our main variable of interest, suggests that spillovers are mostly pronounced when inverse distance matrix is included in the model, i.e. that geographical spillovers play the most significant role, and that they fade away with increased distance. Bilateral trade channel is also confirmed to be important in transmitting the impact of public debt among EMU countries. As for the informational channel, it seems that institutional quality similarities are somewhat more important for investors than macroeconomic similarities, when comparing countries and their risk of default. Within this, the capacity of the government to effectively formulate and implement sound policies seems to be giving the strongest signal to investors.

Taken together (Tables 4 – 7) our findings indicate that if the share of public debt in GDP of a country increases by 1 percentage point, its long-term interest rates will immediately increase by 1.35 – 2.4 basis points. This is in line with the findings of Claeys, Moreno and Surinach (2012) who find that a 1% increase in the debt ratio pushes up domestic rates by 2 percentage points, Debarsy et al. (2018) who find the resulting increase in sovereign risk to be 2.5 basis points, and Dell'Erba, Baldacci and Poghosyan (2013) who find the resulting increase in spreads to be 1 – 3 basis points.

On the other hand, if the share of public debt in GDP increases by 1 percentage point in a certain country there will, on average, be a cumulative increase of 1.9 – 3.61 basis points in long-term interest rates of all the other EMU countries. Put differently, if the share of public debt in GDP increases by 1 percentage point in all EMU countries but one, long-term interest rates in that one country will increase by 1.9 – 3.61 basis points (even though its public debt did not increase). Debarsy et al.'s results (2018) differ somewhat. They find this impact to be larger, i.e. the find a cumulative increase of 5 basis points. It should be emphasised, though, that their sample includes 21 emerging and 20 advanced economies, as opposed to our 19 EMU countries.

Finally, taken together our findings suggest that if the share of public debt in GDP in all countries increases by 1 percentage point, the long-term interest rates of a given country will, on average, increase by 2.56 – 5.98[4] basis points.

In terms of policy recommendations, our findings suggest the following. Fiscal policies of individual countries are a matter of common concern, which calls for a better policy coordination at the euro area level. Namely, costs of fiscal irresponsibility (higher levels of public debt) of an individual country incurred by other members (in terms of their long-term interest rates) are significant and should not be ignored. These fiscal spillovers take place through trade, informational and geographical channel. More precisely, higher intensity trade between countries leads to larger spillovers among them, so that with increased integration and openness of countries this issue can be expected to become even more significant in the future. Furthermore, when comparing countries and their risk of default, investors rely mostly on the similarity of those indicators that refer to government effectiveness and regulatory quality. This stresses the importance of formulating and implementing sound and credible policies by the governments of the EMU. Finally, geographical vicinity also serves as a significant transmission channel. The importance of these neighbourhood effects calls for formulation of regional policies, aimed at groups of neighbouring countries.

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[4] These numbers are not directly visible from Table 4 – 7 – they are the minimum and maximum of total effects (sum of direct and indirect effects from Tables 4 – 7).

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Appendix

Table 8
Results with Variable Crisis

	(1)	(2)	(3)	(4)
Spatial weights matrix	w_{ij} **as given in (2)**	w_{ij} **as given in (3)**	w_{ij} **as given in (3)**	w_{ij} **as given in (4)**
Macroeconomic variable in w_{ij}		**UNEMP**	**GE**	
Dependent variable	**Long-term interest rate (%)**			
Spatial rho	0.472*** (0.0635)	0.535*** (0.0761)	0.544*** (0.0782)	0.602*** (0.0720)
Direct effects				
Public debt (% GDP)	0.0260*** (0.00752)	0.0178** (0.00715)	0.0194*** (0.00726)	0.0251*** (0.00747)
Inflation (CPI, %)	0.139** (0.0564)	0.139** (0.0567)	0.134** (0.0570)	0.125** (0.0564)
GDP growth (%)	–0.166*** (0.0249)	–0.198*** (0.0236)	–0.196*** (0.0237)	–0.174*** (0.0238)
EMU dummy	–2.081*** (0.359)	–2.187*** (0.363)	–2.213*** (0.364)	–2.034*** (0.362)
IIPGDP (%)	–0.00668 (0.00416)	–0.0156*** (0.00390)	–0.0147*** (0.00392)	–0.0121*** (0.00392)
Crisis	0.331 (0.308)	0.213 (0.309)	0.260 (0.310)	0.254 (0.308)
Indirect effects				
Public debt (% GDP)	0.0221** (0.0104)	0.0209 (0.0128)	0.0240* (0.0146)	0.0378* (0.0203)
Inflation (CPI, %)	0.111** (0.0483)	0.152** (0.0706)	0.152** (0.0738)	0.174** (0.0872)
GDP growth (%)	–0.135*** (0.0312)	–0.222*** (0.0668)	–0.230*** (0.0718)	–0.248*** (0.0726)
EMU dummy	–1.720*** (0.532)	–2.485*** (0.916)	–2.636*** (1.010)	–2.956*** (1.094)
IIPGDP (%)	–0.00519 (0.00327)	–0.0176** (0.00688)	–0.0173** (0.00707)	–0.0172** (0.00728)
Crisis	0.288 (0.294)	0.262 (0.402)	0.334 (0.438)	0.397 (0.525)
N	266	266	266	266
R^2	0.413	0.420	0.410	0.388

Note: Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Author's calculations.

T a b l e 9
Results with Variable Primary Balance

	(1)	(2)	(3)	(4)
Spatial weights matrix	w_{ij} **as given in (2)**	w_{ij} **as given in (3)**	w_{ij} **as given in (3)**	w_{ij} **as given in (4)**
Macroeconomic variable in w_{ij}		**UNEMP**	**GE**	
Dependent variable	**Long-term interest rate (%)**			
Spatial rho	0.468*** (0.0634)	0.559*** (0.0753)	0.563*** (0.0774)	0.614*** (0.0713)
Direct effects				
Public debt (% GDP)	0.0247*** (0.00734)	0.0188*** (0.00706)	0.0200*** (0.00716)	0.0255*** (0.00738)
Inflation (CPI, %)	0.154*** (0.0536)	0.140*** (0.0541)	0.139** (0.0543)	0.131** (0.0538)
GDP growth (%)	–0.177*** (0.0268)	–0.219*** (0.0255)	–0.215*** (0.0256)	–0.191*** (0.0257)
EMU dummy	–2.102*** (0.360)	–2.241*** (0.364)	–2.263*** (0.366)	–2.076*** (0.363)
IIPGDP (%)	–0.00802** (0.00406)	–0.0168*** (0.00384)	–0.0160*** (0.00385)	–0.0133*** (0.00384)
Crisis	0.0332 (0.0348)	0.0664* (0.0360)	0.0623* (0.0360)	0.0565 (0.0356)
Indirect effects				
Public debt (% GDP)	0.0208** (0.00998)	0.0244 (0.0149)	0.0267 (0.0165)	0.0403* (0.0222)
Inflation (CPI, %)	0.122*** (0.0473)	0.168** (0.0762)	0.171** (0.0791)	0.192** (0.0904)
GDP growth (%)	–0.143*** (0.0355)	–0.271*** (0.0907)	–0.274*** (0.0947)	–0.288*** (0.0936)
EMU dummy	–1.717*** (0.540)	–2.806*** (1.086)	–2.915** (1.169)	–3.171*** (1.226)
IIPGDP (%)	–0.00624* (0.00324)	–0.0209** (0.00856)	–0.0204** (0.00864)	–0.0200** (0.00853)
Crisis	0.0284 (0.0323)	0.0875 (0.0658)	0.0846 (0.0673)	0.0908 (0.0749)
N	266	266	266	266
R^2	0.422	0.407	0.400	0.380

Note: Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Author's calculations.