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Debt, interest rates, and integration of financial markets

Peter Claeys *, Rosina Moreno, Jordi Suriñach

Universitat de Barcelona, Grup AQR IREA, Spain

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ABSTRACT

It is commonly believed that higher budget deficits raise interest rates. However, these crowding out effects of increasing public debt have usually been found to be small or non-existent. One explanation is that on globalised bond markets interest rate differentials are offset due to financial integration. This paper tests crowding out, and measures the degree of integration of government bond markets, using spatial modelling techniques. Our main finding is that the crowding out effect of public debt on domestic long term interest rates is small: a 1% increase in the debt ratio pushes up domestic rates by 2 pp at most. Financial integration implies an important spillover effect via international bond markets, but only between OECD, and in particular EU, countries. The feedback effect from these markets on long term interest rates is as important as the domestic crowding out effect of higher public debt. Emerging markets are not as well integrated into international capital markets, causing a stronger crowding out effect.

1. Introduction

A government running a deficit needs to turn to financial markets to place additional public debt. This supply of newly issued public bonds competes for financing with bonds issued by firms, and so pushes up long term interest rates. Since higher rates crowd out private investment, institutions like the IMF or OECD recommend consolidating public finances to harness economic growth. Despite being widely accepted in the economics profession as an important effect of public debt, there is surprisingly little robust empirical support for crowding out (Engen and Hubbard, 2004). A first explanation is that economic agents anticipate paying down currently high deficits with higher taxes in the future. Under Ricardian Equivalence, private saving fully offsets the effect of a higher deficit. However, there is by now a large body of empirical evidence that clearly refutes the zero impact of deficits on aggregate macroeconomic variables (Chung and Leeper, 2007). A second rationale for a lack of crowding out is capital mobility. Domestic and foreign agents diversify their holdings across borders, including also government bonds to their portfolio. Capital flows offset any interest rate differential following an increase in the domestic supply of government bonds. Under full capital mobility, domestic interest rates rise in step with global rates, and the crowding out effect is infinitesimally small. In practice, capital mobility is far from complete as foreign and domestic assets are imperfect substitutes due to incomplete information or risk aversion. Interest rate differentials persist when the spillover between markets is weak.

The typical empirical test for crowding out regresses a domestic interest rate on domestic public debt, and controls for spillover including proxy measures of capital mobility, such as aggregate capital flows or a composite measure of foreign debt or foreign interest rates. This supposes an identical transmission of fiscal policy across financial markets, and the focus usually is on a particular subset of OECD countries. However, the interactions between bond markets are much more complex in reality. The spillover works out on global financial markets via various channels, and affects more strongly countries that are more closely integrated. The spillover is contemporaneous for a large group of countries and feeds back to the domestic bond market.

In this paper, we follow standard practice in testing crowding out and explain nominal long term interest rates by public debt. But we control for the spillover by adding a spatial term that captures the degree of financial integration. This term models the contemporaneous co-movement of domestic and foreign interest rates, and so quantifies in a straightforward way the degree of integration of government bond markets. The spatial measure then allows calculating the general equilibrium effect of higher public debt on interest rates, taking into account the spillover to other markets and the feedback to the domestic bond market.

We use data for a panel of both OECD and emerging market economies over the period 1990–2005. Our main finding is that the

* Corresponding author at: Grup AQR IREA, Facultat de Economia i Empresa, Universitat de Barcelona, Avinguda Diagonal, 690, E-08034 Barcelona, Spain.
E-mail address: peter.claeys@ub.edu (P. Claeys).

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domestic crowding effect of public debt is small but significant. It adds at most 2 basis points for every percentage rise in the debt to GDP ratio. As the correlation between global bond market returns is just 0.10, there is limited spillover on international bond markets. The reason is that emerging markets are not fully integrated in global bond markets. By contrast, we find bond markets to be more strongly integrated among OECD, and especially EU, countries. The feedback effect from these markets on long term interest rates is as important as the domestic crowding out effect of higher public debt. Spillover reflects deep economic integration but also economic co-movement in major crisis moments. Various measures of cross-country linkages give broadly similar results. The findings are also robust to alternative specifications and data definitions.

The paper is structured as follows. In Section 2, we discuss a simple theoretical model for testing crowding out and measuring the effects of financial integration. We then continue in Section 3 by discussing the results of the spatial panel model, and provide several robustness checks in Section 4. The final section summarises the main results, and discusses some policy implications.

2. Financial crowding out in open economies

2.1. Financial crowding out

Firms raise capital on stock or bond markets to invest in new capital stock (K). A government running a deficit, just like a private investor, needs to turn to financial markets to finance debt (B) by giving out more bonds. We can illustrate the effects of crowding out with an aggregate (Cobb Douglas) production function (Ball and Mankiw, 1995; Elmendorf and Mankiw, 1999). This production function combines labour L and capital K to produce output Y:

$$Y = AK^{\alpha}L^{1-\alpha}. \tag{1}$$

A is the coefficient of total factor productivity and α is the elasticity of capital. Total capital income, as a share of output is equal to α, with MPK the marginal productivity of capital:

$$\alpha = MPK.K/Y. \tag{2}$$

The interest rate is determined by the marginal productivity of capital, so that

$$r = MPK = \alpha Y/K = \alpha A\left({}^{L}/_{K}\right)^{1-\alpha}. \tag{3}$$

An exogenous increase in public debt has the following effect on the interest rate

$$\partial r/\partial B = \left({}^{\partial r}/_{\partial K}\right)\left({}^{\partial K}/_{\partial B}\right) = \alpha(\alpha-1)(Y/K^2)\left({}^{\partial K}/_{\partial B}\right). \tag{4}$$

As long as public debt crowds out private bonds K on capital markets $\left({}^{\partial K}/_{\partial B}<0\right)$, interest rates rise with an increase in debt. An increase in the supply of debt B will put downward pressure on the price of government bonds. The rise in bond yields makes it more difficult for the private sector to seek finance on capital markets.

This simple model has two important implications. The first is that the size of this crowding out effect is likely not very large. We calibrate Eq. (4) on aggregate Euro Area data, assuming that the capital share in output is around $\alpha = 1/3$ and using 2008 data on the net private capital stock and general government public debt.[1] If we substitute these numbers in Eq. (4) and assume that debt fully displaces private capital $\left({}^{\partial K}/_{\partial B} = -1\right)$, we get an increase in the marginal product of private capital of just 0.15% (1.5 basis points) after a 1% rise in public debt.[2] Hence, as a benchmark, full crowding out implies rather small increases in interest rates.

A second implication of Eq. (4) is that the level of interest rates is determined by the level of the capital stock (and hence the level of public debt). A standard empirical test of financial crowding out therefore takes a very simple form: it basically explains domestic interest rates (i_t) by the level of domestic public debt B_t, and some other variables X:

$$i_t = \alpha + \beta B_t + \theta X_t + \varepsilon_t. \tag{5}$$

The coefficientβ measures the degree of crowding out. Empirical evidence is not clear cut on the size of this effect. A large number of studies employing various definitions of government debt and interest rates, different econometric approaches and various data sets to test Eq. (5) come to very different conclusions regarding the size and significance of β.[3]

The calibration of Eq. (4) helps in understanding why this is so. The 1.5 basis points are a maximum effect as we supposed no offsetting responses by the government's decision to lend on the demand for additional bonds. This is an extreme assumption, and private sector savings are likely to offset the additional supply of bonds. A first reason is that if economic agents recognise they face a higher tax burden in future periods to pay for the bond-financed deficit, they increase saving now. Under this hypothesis of Ricardian Equivalence, domestic private saving fully offsets the effect of the higher public dissaving. This implies ${}^{\partial K}/_{\partial B} = 0$ and a higher deficit does not have an impact on interest rates at all. Although many economists consider Ricardian Equivalence as a reasonable theoretical starting point, few would endorse it as a realistic description of fiscal policy. Plenty of empirical studies have examined the alternative hypothesis that fiscal policy has real economic effects. Recent evidence seems to converge on at least some expansionary effects of increased bond-financed spending (Chung and Leeper, 2007). Macroeconomic models that depart from the baseline Ricardian assumption easily find support for these real economic effects of fiscal policy. It therefore seems a reasonable assumption to reject Ricardian Equivalence.

A second reason is that financial intermediaries do not just channel the demand for bonds of the domestic private sector to match the total supply of domestic bonds but also of foreign savers. If the foreign demand for bonds offsets the additional supply, then ${}^{\partial K}/_{\partial B} > -1$, and crowding out is less than complete. In open economies that are economically integrated and do not impede trade or financial flows, capital moves to exploit interest rate differentials between markets. With full capital mobility, agents in each country completely diversify their portfolio. *Ceteris paribus*, they hold assets and bonds in their portfolio in proportion to a specific country's share in the global asset market. Under such conditions, the interest rate elasticity of the supply of savings is infinite, and even a small rise in B triggers a large inflow of foreign capital. The rise in domestic interest rates is a fraction of the crowding out effect on global interest rates, where this fraction is each country's share in global debt.

Capital mobility is usually not unlimited, and financial markets are far from being perfectly integrated across borders. Private agents have a preference for investment in domestic financial assets. This home bias is a consequence of barriers that distort information from foreign

[1] The Euro Area total net private capital stock in 2008 equals 27,203 billion euro, and a 1% increase in debt equals 6056 billion euro (ECB Statistics).

[2] This financial crowding out further curtails private spending and investment. This 'resource' crowding out of deficits results in lower private sector output in the long term. See Ball and Mankiw (1995) or Elmendorf and Mankiw (1999).

[3] See the references in the overview article by Gale and Orszag (2003) and the European Commission (2004).

financial markets.[4] Financial assets in different countries are not perfect substitutes due to exchange rate, inflation and default risk. Differences in regulation (capital controls, accounting and auditing laws, bankruptcy law, judicial enforcement, etc.) and in tax treatment across countries also push risk averse agents towards domestic assets.[5] The consequence is that the displacement of private capital by public debt is less than complete $\left(-1<\partial K/\partial B<0\right)$.

Omission of these foreign variables leads to a bias in the estimated crowding out effect, so existing empirical studies correct Eq. (5) by including among the regressors a proxy measure for the foreign demand for bonds. The typical approach in empirical tests of open economy models is to take a benchmark series, typically of a large economy like the US or Germany, or a composite measure, like the OECD, G7, or the EU. Some studies use as a proxy international capital flows (Cebula and Koch, 1994). Other studies net out international linkages by checking the direct crowding out response to a composite measure of foreign debt (Ford and Laxton, 1999; Tanzi and Lutz, 1993). Most papers test the response of domestic rates to foreign interest rates. Chinn and Frankel (2007) take the German long term rate as the benchmark in their study of US fiscal policy. Caporale and Williams (2002) or Paesani et al. (2006) reduce their sample to a few G7 economies and use in turn the interest rate from another G7 country as a benchmark. As the relations between multiple bond markets are contemporaneous, some papers construct an aggregate foreign benchmark rate. Ford and Laxton (1999) and De Haan and Knot (1995) test the response for OECD and EU countries respectively. Faini (2006) calculates an average euro area interest rate, and considers the contemporaneous effect of higher debt on interest rates at home and at EMU level in a panel.

This approach collapses all cross-section information into a single aggregate number, and restricts the transmission across financial markets to be identical or limited to a few markets only. This is a partial equilibrium approach. However, prices move contemporaneously on different financial markets, and this spillover is stronger between markets that are more closely connected. There may be several reasons why some markets are more integrated than others. International trade between two countries has a multiplier effect on their mutual financial flows, and also on the synchronisation of business cycles. This co-movement in output has further positive effects on trade and financial integration (Imbs, 2004). Close connections may also exist for less apparent reasons, as the literature on contagion suggests (Forbes and Rigobon, 2002). Foreign investors pool countries in the same group even if these do not share similar economic fundamentals. There are two important consequences of financial integration. First, a higher deficit in country A may attract more savings from a closely related country B, than a far away country C. The spillover effect on financial markets is therefore different for each country pair. Second, the change in country A affect country B, which in turn affects also country C. This change will eventually feed back to country A. If spillover is relevant, then this will affect all neighbouring markets in general equilibrium. For these reasons, the distribution of interest rates across countries may not be random, but depends on the strength of the mutual integration of the bond market. The literature on international spillover has bypassed the fact that asset markets are not equally integrated internationally (Kaminsky and Reinhart, 2000).[6] Ignoring this spatial dependence in Eq. (5) renders the parameter estimates biased, inefficient and/or inconsistent (Anselin, 1988).

A convenient way to think of these complex linkages on financial markets is with an exogenously specified weight matrix W that considers the structure and intensity of the 'closeness' of different observations. Each element w_{ij} of W represents the proximity between two observations i and j. For example, bordering regions are often believed to have closer links. A common specification for this weight matrix W is then physical contiguity, with $w_{ij}=1$ if two countries share a border, and 0 otherwise. It is straightforward to use other W's that reflect economic distance between countries such as bilateral trade or financial flows. We can include these linkages in the baseline model and rewrite Eq. (5) by introducing the term Wi_n. This regressor is the spatial lag of interest rates, and a weighted measure of interest rates in the countries with which a given country has economic links. This gives a spatial autoregressive model (6), in which we control the crowding out effect β in country n for the interaction with interest rates in all close-by financial markets, and ρ picks up the intensity of interaction:

$$i_{n,t} = \alpha_n + \beta B_{n,t} + \theta X_{n,t} + \rho W i_{n,t} + \varepsilon_{n,t}. \quad (6)$$

The spatial lag term has to be treated as an endogenous variable, and we use the ML methods developed by Elhorst (2003) to estimate Eq. (6).[7] [8]

Although the spatial model looks similar to specification (5), the crowding out effect cannot be straightforwardly be read from the parameter estimate of β, as this is not the partical derivative with respect to the change in $B_{n,t}$. The reason is the feedback effect from the linkages across financial markets. I.e., a change in B_t affects the dependent $i_{n,t}$ directly, but via the spatial lag also affects all other units and so the impact passes back to the country itself. The larger ρ, so the stronger is bond market integration, the more intense is this effect. We need to work out the spatial lag term in Eq. (6) to derive the marginal effect of each variable. We can so decompose the total general equilibrium effect of each variable into the direct contribution of the unit, and the indirect effect that feeds back to the unit via the derived effect on the other units.[9] Rather than using the coefficient estimate of the spatial lag, the estimated indirect effect can then be used as a test for the existence of spatial spillover. This indirect effect (and its significance) is a convoluted expression and can be calculated from the coefficient estimates (and standard errors) of both the crowding out effect itself and the spatial lag (Elhorst, 2010a).[10]

The spatial lag measures the correlation of market returns, and we can interpret it as the degree of integration of government bond markets. Its absolute value lies between 0 and 1 with higher values indicating stronger financial integration.[11] A higher positive value of ρ means that an increase in interest rates in country A will be followed by increases in countries that are closely connected on financial markets. Under full capital mobility, this measure would equal 1 and any interest rate differential is exploited by investors. In practice, given restrictions to capital mobility, this measure is likely to be smaller. A higher negative value of ρ means that the same increase in country A is followed by falls in closely related markets. On sovereign bond markets this can occur if there is a 'flight to quality' away from a high debt country – whose additional financing rises default risk premia – to more credible

[4] As a result, domestic savings and investment are typically highly correlated ('Feldstein–Horioka' puzzle).

[5] This home bias is particularly strong in government bond markets as governments often give tax breaks for buying public debt. Placement with their own citizens avoids in addition paying an exchange rate premium, and is also seen as a commitment not to default (Missale, 1997).

[6] An exception is Hausman and Rigobon (2000).

[7] Consistent estimation of the individual fixed effects is not possible as n grows large, due to the incidental parameter problem. Anselin et al. (2008) argue that 'since spatial models rely on the asymptotics in the cross-sectional dimension to obtain consistency and asymptotic normality of estimators, this would preclude the fixed effects model from being extended with a spatial lag'. However, Anselin et al. (2008) show that for consistent estimates of β, the demeaned spatial regressions from ML estimation like in Elhorst (2003) are appropriate. One complication with this is that the variance covariance matrix of the demeaned error term is different from the usual one. Alternative approaches to the Elhorst estimation are still a topic of ongoing research.

[8] The specification (6) is static and is the common choice in tests of crowding out of public debt. Yu et al (2008) and Lee and Yu (2010) propose estimation techniques for spatial panel models that include a lagged dependent variable.

[9] For a detailed exposition, see Lesage and Pace (2009) and Elhorst (2010b).

[10] Since we include just a spatial lag of the dependent, the feedback effect is similar for all independent variables.

[11] To that end, we row-standardize W (dividing each element of W by the sum of the elements in each row).

sovereigns. Our spatial measure is comparable to other price-based indicators of financial integration that test the law of one price on a financial asset.[12]

From the calibration of Eq. (4), we expect that higher domestic public debt has a significantly positive effect on domestic interest rates. This rise should be around 1 to 2 basis points for a 1% rise in the debt ratio. As there are a variety of factors preventing capital from freely flowing between countries, it is hard to put a precise number on the size of the spillover effect. This spillover is likely to be stronger between economies that are more closely integrated. All we can say is that the higher is capital mobility, the more foreign savings mitigate the crowding out effect.

2.2. Specification

We estimate the spatial model (6) for a panel of 50 countries, for which we have annual data on interest rates and fiscal policy covering the period 1990–2005. We use as our dependent variable a nominal long term interest rate, which is the return on long term government bonds. Although real rates are a better indicator of the borrowing cost for private investment, nominal interest rates determine the total cost of debt service in the budget. Fiscal data for many countries are available only over recent years. The debt to GDP ratios come from IMF Government Statistics, OECD, IADB or the national treasury or debt agency (Jaimovich and Panizza, 2006). As we prefer working with balanced panels over the full sample period, we had to eliminate some countries from the study. Due to variable data quality, we also decided to remove outlier observations. We first ran a simple pooled estimate and quitted the observation if the residual standard error exceeds three times the variance. These outliers are emerging markets have experienced hyperinflation caused by rapidly rising and monetised debt. Eventually, we retain 560 observations in total. This keeps in the sample mostly OECD countries as well as many emerging market economies.[13]

In more elaborate macroeconomic models than the simple loanable funds models, other factors than public debt drive the level of (long term) interest rates. These models typically assume Ricardian Equivalence – and so no inference is possible on the crowding out effect – yet the economic cycle, monetary policy, and any economic effects of fiscal policy influence the level of the interest rate (Galí et al., 2007).[14] We include in the spatial lag model (6) the short term rate, inflation and economic growth among the additional regressors $X_{n,t}$.[15] The long term rate is linked to the short term interest rate via the term structure. Under the pure expectation hypothesis, the long term rate equals the short term rate plus expected inflation. But there are several reasons why the effect need not be proportional. Price adjustment is incomplete due to real or nominal rigidities. The strength of the response of monetary policy to anticipated inflation determines the rise in short term rates. Higher inflation has also direct effects on fiscal policy. On the one hand, it influences the financing conditions of the government via its debt servicing costs. But higher inflation can also raise tax income, at least if there is no tax bracketing (the Darby–Tanzi effect). Both effects are typically too small to affect interest rates. We might therefore hypothesize that higher inflation and higher short term rates should raise long term rates. Economic growth affects private investment demand and therefore affects positively the supply of corporate bonds. The supply of public bonds usually falls since positive economic growth raises tax revenues, and in countries with high debt, alleys fears of unsustainable debt positions. The effect of growth on long term rates is therefore not clear.

The weight matrix should capture the degree of capital mobility across countries. The more exchange of capital flows between agents in different economies, the stronger is the dampening effect of capital flows on the crowding out of interest rates by public debt. Ideally, we would have data on cross-country asset positions, most notably in government bonds, but datasets on effective asset cross-holdings like the Coordinated Portfolio Investment Survey (CPIS) of the IMF do not cover many countries yet. Therefore, we proxy the degree of capital mobility by the difference in size of the bond market for each country pair. I.e. the larger are two bond markets, relative to GDP, the more international exposure two markets have. As smaller bond markets are unlikely to have the same effect on global bond markets as large ones, we scale the difference in bond market size by the sum of the two capitalization ratios. We construct the weights $w_{i,j}$ of bilateral exposure by Eq. (7), where S_i is the average capitalization of the bond market (as a ratio to GDP) in country i over the sample period:

$$w_{i,j} = 1 - \frac{|S_i - S_j|}{\left(S_i + S_j\right)} \tag{7}$$

This measure falls between 0 and 1, with higher values indicating stronger exposure. These weights are not fixed and exogenous anymore, but time-varying and possibly endogenous. On the one hand, economies that issue more debt have larger sovereign bond markets and are supposedly more exposed to international financial markets. But governments running high debt may be interested in looking for cheaper financing on international markets, for example, if domestic financial markets are too small. On the other hand, economies that are already financially integrated may have incentives to run up debt, since the financing cost of this additional debt is lower. Since there are no procedures to control for the endogeneity of $w_{i,j}$, we take a shortcut and use data on total bond market capitalization (as a ratio to GDP) that covers all domestic debt securities issued by financial institutions, corporations and government on average over the sample period, and come from the 2009 update of the database of Beck et al. (2000). We sum both private and public bonds because higher public debt increases the size of the sovereign bond market but – if there is crowding out – diminishes the size of the private market. Hence, the sum of both ratios is more stable than if we measure exposure by public debt only. To avoid the endogenous reaction of debt to financial integration, we could have used the bond capitalization ratio in the first year of the sample.[16] This would arguably be exogenous to the development of bond markets within the sample. Nonetheless, using the average exposure over the sample ensures that the measure is not influenced by a particular set of conditions in a single year. We show later that our results are robust to this specific choice.

3. Empirical results

3.1. Measuring the integration of government bond markets

Our starting point is the panel version of model (5). A priori, we would prefer to use a fixed effects estimator as we include a specific group of countries in the sample, and this draw is not random.

[12] The market for a given asset is fully integrated if all economic agents with the same relevant characteristics acting in that market face a single set of rules, have equal access and are treated equally so that assets that are close substitutes yield the same expected return (Baele et al., 2004). Several tests have been developed to test integration. Our measure is similar to tests of 'beta convergence' between different markets. Full convergence is indicated by a 'beta' measure equal to 1. Quantity based indicators assess the effects of rigidities between different markets on the demand for and supply of securities. For other tests of asset markets integration, see Claessens et al. (2001).

[13] In the Appendix A, we provide a detailed description of the dataset and its sources.

[14] These effects could cause some problems of endogeneity in Eq. (6), but these feedback effects are likely small. IV estimates are usually not considered in the literature.

[15] In the spatial econometrics literature, the bottom-up approach for searching an adequate specification prevails. Florax et al. (2003) demonstrate that the specific-to-general approach slightly outperforms the Hendry approach in the case of the estimation of linear spatial models.

[16] The results are similar to the ones reported in the paper, and are available upon request.

Table 1
Pooled, panel, and spatial panel lag model, W-matrix bond capitalization/GDP.

	Panel	Spatial lag	Decomposition		
			Total	Direct	Indirect
β	0.03	0.01	0.01	0.01	0.00
t-stat	(4.28)	(1.18)	(1.14)	(1.15)	(0.86)
ρ	-	0.08			
t-stat		(1.78)			
Gap	0.03	0.02	0.03	0.02	0.00
t-stat	(5.11)	(5.34)	(5.06)	(5.14)	(1.66)
Inflation	−0.02	−0.02	−0.02	−0.02	0.00
t-stat	(13.55)	(19.57)	(14.80)	(19.30)	(1.76)
Interest rate	0.35	0.46	0.51	0.47	0.04
t-stat	(16.85)	(24.54)	(17.81)	(24.95)	(1.78)
R^2	0.43	0.57			
Number of observations	560	560			
Hausmann test	54.61	67.13			
p-value	(0.00)	(0.00)			
LM spatial lag	13.80				
p-value	(0.00)				
LM spatial error	2.87				
p-value	(0.09)				
Robust LM spatial lag	15.01				
p-value	(0.00)				
Robust LM spatial error	4.09				
p-value	(0.04)				

Moreover, although specification (2) controls for inflation, short term interest rates and cyclical conditions, there may still be other relevant determinants of long term interest rates. In addition, as fiscal policy decisions are likely to be heterogeneous across countries, the country-specific effect is likely correlated with the explanatory variable too. The Hausmann test indicates that a fixed effects estimator is indeed preferable (Table 1). The fixed effects estimation of Eq. (5) shows a three basis points crowding out effect. Although the estimate of the crowding out effect is higher than what our calibration suggests, it is within the range of estimates found in similar studies. Country studies find similarly modest crowding out effects of higher public debt. For the US, the crowding out effect is usually estimated to be around 2 to 5 basis points (Canzoneri et al., 2002; Caporale and Williams, 2002; Engen and Hubbard, 2004; Laubach, 2009). Friedman (2005) finds that persistent rises in debt have pushed up interest rates by about 6 points per year. For EU countries, the crowding out effect is mostly slightly stronger in magnitude (Faini, 2006). In contrast, pooled regressions usually give higher crowding out effects. According to Ford and Laxton (1999) or Orr et al. (1995), interest rates rise by 7 basis points in OECD countries. Panel studies, like ours, have typically found crowding out effects of a similar magnitude. Kinoshita (2006) finds a 2 basis point rise after a rise in debt in a panel of OECD countries.[17] Baldacci and Kumar (2010) use a large sample of OECD and emerging economies and find an impact effect of debt of 5 basis points. On a similar panel, Aisen and Hauner (2008) find a crowding out of 3 basis points in long term rates.

The control variables are all very significant. Long term interest rates are very much influenced by short term rates, as we would expect from the expectations theory of the term structure. The effect is not one to one, yet the coefficient of 0.35 is in line with most previous results, suggesting that inflation gets only gradually incorporated into interest rates. Another reason is that at short horizons, monetary policy sets interest rates to stabilise inflation and output. Higher inflation eases the pressure on the budget by eroding the real value of outstanding debt. Inflation indeed has a small and negative effect. Economic growth has a positive – yet small – effect on long term rates. This suggests that the effect on private bond supply prevails over the fall in public bonds, yet the net effect is rather small.

Table 1 reports Lagrange Multiplier (LM) tests for the inclusion of a spatially lagged dependent variable or spatial error autocorrelation. These tests basically look for a spatial distribution in the residuals of the non-spatial model (Elhorst, 2010a). Under the null of no spatial dependence, the tests follow a chi-squared distribution (with one degree of freedom). We condition the test on the existence of spatial fixed effects only. A panel model without any spatial interaction effects is not appropriate. We cannot reject the hypothesis of no spatially lagged dependent variable at 5%. In contrast, there is much less significant support for the inclusion of a spatially correlated error term. The robust version of the LM test gives support for both types of specifications. Since the test gives stronger support for the former specification, and the economic model in Section 2 has a more intuitive interpretation, we confirm the choice of a spatial lag model like Eq. (6), with fixed effects.[18]

What is the effect of including the spatial links on the crowding out effect? In comparison to the non-spatial model, we find that the effect of financial integration on the co-movement of interest rates is significant yet not very large: a 1% rise in interest rates abroad raises domestic rates by just 0.08%. We may not compare the coefficient estimates in the non-spatial model with their counterparts in the spatial lag model, since there are feedback effects of higher interest rates. We therefore decompose the coefficient estimates in their direct and indirect impact. The right hand side columns of Table 1 report this decomposition. We see that the crowding out effect on long term rates is halved: a 1% increase in the debt ratio to GDP raises the long term rate by a single basis point. The size of the effect is as a consequence more in line with the calibration in Eq. (4). Crowding out is nevertheless hardly significant. Since the linkages between countries are rather small, the direct effect of debt on long term rates is more important than the indirect feedback. Crowding out is mostly affected by country-specific developments, but the comparison with the panel results shows that capital flows curb the increase in bond rates. The control for capital mobility also affects the estimates of the control variables. Since the effect of the spatial linkages is not very strong, these confirm and slightly strengthen the baseline findings. The main effect of short term rates, inflation and economic growth is direct.

Since we calculate the general equilibrium effect, the findings on spillover are slightly harder to compare to previous studies that adopt a partial equilibrium approach. The bottomline of these papers is that the size of the domestic crowding out effect is larger than the direct foreign spillover effect, in most cases always below 10 basis points. Caporale and Williams (2002) find this result for the US; and Faini (2006) reports similar results for the EU countries. Ardagna et al. (2007) report that the aggregate (world) debt stance affects domestic interest rates, but its impact is less relevant than that of domestic fiscal policy. Our results are similar. The second round effect is to push up interest rates abroad by a tiny fraction of just 0.08 ($\approx 0.08 * 1$ pp) basis points. As just about 8% of any interest rate hike feeds back domestically, the indirect consequences of debt accumulation are likewise small.

Our results show a rather low degree of integration of bond markets. There are not many studies on the integration of bond markets that measure the discrepancies in asset prices (Lucey and Steeley, 2006). Some test integration by the interest rate differential (or its standard deviation) relative to a benchmark bond (Favero et al., 2010; Paesani et al., 2006), or by the 'beta convergence' of bond yields to some common factors (Barr and Priestley, 2004; Codogno et al., 2003). The summary finding of these studies is that bond market integration is far from complete (and much less than in other market

[17] Similarly, Ardagna et al. (2007) use panel VAR techniques to look at the impact of debt on interest rates and find a moderate impact, even at long horizons, except if public finances are initially in a worse shape.

[18] The modified Hausmann test rejects a random effects spatial panel model.

Table 2
Spatial lag panel models for different country groups.

	Spatial lag	Total	Direct	Indirect
(a) OECD ($N=22, T=16$)				
β	0.00	0.01	0.00	0.00
t-stat	(0.65)	(0.66)	(0.65)	(0.66)
ρ	0.47			
t-stat	(13.76)			
Gap	0.03	0.06	0.04	0.03
t-stat	(1.72)	(1.69)	(1.71)	(1.65)
Inflation	0.15	0.28	0.16	0.12
t-stat	(3.81)	(3.61)	(3.81)	(3.21)
Interest rate	0.41	0.78	0.45	0.34
t-stat	(14.74)	(15.62)	(15.49)	(8.78)
R^2	0.93			
(b) EU15 ($N=13, T=16$)				
β	0.00	0.01	0.00	0.00
t-stat	(0.58)	(0.53)	(0.54)	(0.53)
ρ	0.61			
t-stat	(14.84)			
Gap	−0.04	−0.11	−0.05	−0.05
t-stat	(2.00)	(1.98)	(1.98)	(1.94)
Inflation	0.15	0.38	0.18	0.20
t-stat	(2.81)	(2.57)	(2.66)	(2.40)
Interest rate	0.27	0.68	0.33	0.35
t-stat	(7.33)	(10.18)	(8.33)	(8.16)
R^2	0.91			
(c) emerging markets($N=17, T=16$)				
β	0.12	0.22	0.12	0.09
t-stat	(2.69)	(2.49)	(2.77)	(1.94)
ρ	0.44			
t-stat	(5.87)			
Gap	−0.00	−0.00	−0.00	−0.00
t-stat	(0.17)	(0.17)	(0.18)	(0.15)
Inflation	0.04	0.06	0.04	0.03
t-stat	(17.11)	(7.19)	(17.76)	(3.24)
Interest rate t-stat	-	-	-	-
R^2	0.76			

segments, like money or stock markets).[19] However, even though national sovereign bond markets are only partially integrated and market idiosyncratic risk remains, they are typically not segmented as much as our results suggest. Most empirical papers find spillover to be more important.[20] The reason is the sample of countries we consider, including both OECD and emerging economies.

3.2. Global or regional linkages

Given their strong mutual relations, capital mobility between industrialised economies is rather high. Governments therefore have access to a larger market for financing new bond issues. Consequently, crowding out should be smaller, but the spillover effect stronger. Table 2 reports the coefficient estimates of the spatial lag panel model with fixed effects for the group of 22 OECD countries in the sample. The crowding out effect disappears, but the spatial lag is around 0.47, and very significant. The decomposition of the estimates shows that the crowding out effect is limited, even accounting for the large feedback effect. This feedback via financial markets results in indirect effects of the same magnitude as the direct domestic effects. The effects of the control variables are of a similar magnitude as in the full sample. The effects of economic growth on rates are positive. The decomposition of the spatial lag estimates shows that 78% of the increase in short term interest rates is translated into higher long term rates. Only inflation now has a positive significant effect on long term rates, suggesting that monetary policy is more reactive to inflation in industrialised economies, which translates in higher short term rates over the entire term structure.

Most studies in the literature on crowding out have analysed OECD countries. Our result shows that governments do not face a particularly steep increase in domestic rates since they have access to funding from abroad. Studies that do not account for these linkages on bond markets are likely overestimating the effect of public debt, and this explains the positive crowding out effects of panel studies on the same set of OECD countries. The large spillover effect is more in line with evidence in the literature on bond market integration. Our estimate is close to what the Council of Economic Advisers (1994) report argues is the offset of foreign saving on US domestic debt (around 0.40). Hence, OECD countries are more closely integrated between themselves than with other economies.

This is particularly the case for those EU countries. Economic and financial integration must have strengthened the spillover between EU countries, and even more so for those countries participating in monetary union. If different governments borrow in the same currency, free riding makes each government disregard its own intertemporal budget constraint. A variety of reasons may be invoked for the lack of credibility of the no bailout clause that prevents other governments (or the central bank) from rescuing the insolvent government. The offsetting interest rate effects do not need to materialise then, as default premia are spread out over all members of the union.[21] In the absence of agreements specifying the fiscal relations between governments, the crowding out effect depends – *ceteris paribus* – on the aggregate fiscal policy stance of all member states. Since the creation of the single currency in 1999, the government bond market has integrated quickly but this process is not complete, despite various initiatives to foster full integration of the euro area capital markets. These initiatives, such as the Financial Services Action Plan, the development of a euro area-wide secondary market trading platform, a more important corporate bond market, have been actively endorsed by the European Central Bank.

The results of the spatial tests on the subgroup of EU countries confirm the strong degree of integration.[22] We observe in panel b that crowding out is much less significant for an EU country. About 61% of an interest rate rise is transmitted to other EU countries, implying that the indirect feedback effect of interest rates rises is even larger than the direct effect at home. This number is remarkably close to the cross-border bond holdings of Euro Area residents: ECB (2007) estimates that almost 60% of total bond portfolios consists of foreign EMU holdings. These spatial linkages are also significantly stronger than between other industrialised countries. This result supports other findings of declining yield differentials on euro-denominated bonds, and the increased response of bond yields to EMU-wide factors (ECB, 2005). Higher debt does not raise interest rates significantly. Thanks to the strong degree of integration, there is no direct crowding out effect as capital flows offset the domestic increase entirely. In line with the expectations theory of the term structure, the joint effect of short term rates and inflation prompts a proportional reaction in the long term rate. But higher economic growth compresses nominal rates. Probably, in EU countries, a better economic outlook boosts tax revenues and in countries with high debt, like Italy, Greece, Belgium or Portugal permits consolidation. It may moreover be seen as reducing the risk of fiscal slippage, leading also to lower risk premia (Dai and Philippon, 2005).

[19] In different settings, other studies have found close connections between interest rates across borders (Minford and Peel, 2007). Country-specific factors seem to play a role in explaining the deviation of domestic interest rates from the evolution in worldwide interest rates (Breedon et al., 1999). One of the main reasons is a change in the fiscal policy stance, they argue.

[20] Other empirical work on international financial integration and testing the law of one price can be found in Flood and Rose (2005) or Allen and Pagano (2006).

[21] Yardstick comparisons across governments may partially undo this spillover, if the accumulation of debt by one government increases the relative creditworthiness of comparable governments.

[22] The estimates must be taken with some caution since we include only 13 EU countries, and the asymptotic distribution of the spatial panel tests requires large N.

Table 3
Spatial lag panel model with time variation.

	Spatial lag	(a) Spatial and time fixed effects			Spatial lag	(b) Crisis dummies		
		Total	Direct	Indirect		Total	Direct	Indirect
β	0.01	0.01	0.01	0.00	0.03	0.03	0.03	0.00
t-stat	(1.27)	(1.33)	(1.33)	(0.32)	(4.49)	(4.24)	(4.48)	0.58
ρ	−0.03				0.03			
t-stat	(0.48)				(0.53)			
Gap	0.02	0.02	0.02	0.00	0.03	0.03	0.03	0.00
t-stat	(5.33)	(5.19)	(5.33)	(0.41)	(5.04)	(5.15)	(5.22)	0.56
Inflation	−0.02	−0.02	−0.02	0.00	−0.02	−0.02	−0.02	0.00
t-stat	(19.19)	(13.58)	(19.29)	(0.41)	(13.79)	(12.06)	(13.93)	−0.57
Interest rate	0.45	0.44	0.45	−0.01	0.37	0.38	0.37	0.01
t-stat	(23.12)	(14.87)	(23.32)	(0.41)	(17.90)	(14.67)	(17.75)	0.57
Dummy currency					−2.56	−2.78	−2.69	−0.08
t-stat					(1.16)	(1.22)	(1.23)	-0.44
Dummy bank					6.58	6.89	6.71	0.18
t-stat					(1.73)	(1.81)	(1.83)	0.48
Dummy balance					4.16	4.31	4.19	0.12
t-stat					(1.74)	(1.80)	(1.81)	0.49
R^2	0.75				0.43			
N	560				560			

Although the spatial test indicates strong integration, there is still no full integration. For example; yield spreads on long term bonds of different EMU countries are still not completely aligned (Baele et al., 2004; Hartmann et al., 2009). Some differences in EU government bond markets remain due to differences in liquidity and the availability of derivatives markets for these assets, and a different response of national markets to global factors (ECB, 2007; Favero et al., 2010). The remaining 40% of integration could in part be due to our sample: the progress in financial integration in recent years is not easily discerned from the effects of reduced exchange rate and inflation risk in the EMU countries before 1999. Reports by the ECB (2007) argue that bond markets were quite integrated even before the start of the EMU, yet converged even more since 2000.[23]

Although OECD and EU countries are closely integrated between themselves, other economies – mainly emerging markets – are probably not fully integrated into global bond markets. Most studies on crowding out have examined OECD or EU countries, yet a growing literature is investigating the effect of fiscal policy in emerging economies.[24] Capital markets have certainly become more intertwined in the last two decades, but financial integration proceeds at a different pace for different groups of countries. Extensive cross border asset trade dominates in most advanced economies, yet emerging economies have taken only partially part in the world economy (Lane and Milesi-Ferretti, 2008). The main reason is the limited development of the financial system in these countries. Less wealthy households in these countries are more risk averse, and are less ready to diversify their portfolio outside a few safe products, let alone in international assets (Lane and Milesi-Ferretti, 2007). Having a domestic financial market is a necessary condition to participate in cross border asset trade. This is not yet the case for most emerging markets that mostly rely on external financing. This makes emerging markets more susceptible to fast changes in these external capital flows. They could be subject to contagious crises that spread from a crisis in another emerging market, but are unrelated to the economic fundamentals (and in particular the fiscal position) of the country itself. Economic crises may spread faster between emerging markets that are more exposed on financial markets, have similar macroeconomic characteristics or are prone to information asymmetries that trigger sunspot crises (Lane and Milesi-Ferretti, 2008). This implies that financial integration between emerging markets and developed economies is rather weak, but does not exclude strong linkages between emerging markets themselves. At the same time, shallow financial markets magnify the crowding out effect. Countries with high domestic savings and developed financial systems that rely on bank financing more than capital markets for funding investment may be more readily able to absorb an increase in public bond supply (IMF, 2006). Caballero and Krishnamurthy (2004) show how lack of financial depth constrains fiscal policy, since the financing of public debt absorbs all financing resources. Even though government spending is likely more productive in less advanced economies, deficits strongly displace private investment as maturing debt cannot be rolled over readily.[25]

We run the spatial lag model for a subsample of emerging markets.[26] In contrast to industrialised economies, which have been able to issue long term bonds at various time horizons, most developing economies can only get finance on capital markets at short horizons, and have financed deficits with short term bonds at a 5 years horizon at most. We therefore add to the sample those emerging markets that issue government bonds at a horizon shorter than five years, and also use a short- to medium term interest rate (of 1 to 5 years) as our dependent variable for the countries in the initial sample. Table 2 (panel c) summarises the results for the spatial lag panel. These confirm our priors. First, the degree of financial integration between emerging markets countries is rather high, and certainly higher than for the full sample. Around 44% of the change in long term interest rates abroad spills over to the domestic financial market. Second, the crowding out effect of higher public debt is significant and much larger than in industrialised economies. As the crowding out effect is large, and there is some indirect feedback effect of public debt, the total fiscal spillover effect is quite strong. These results are in line with recent evidence by Aisen and Hauner (2008) or Baldacci and Kumar (2010). Both indirectly infer on the role of capital flows as they find a significantly larger effect on interest rates in countries where deficits are mostly domestically financed, financial openness is low and financial markets are not liquid.

[23] See also Kim et al. (2006) or Allen and Pagano (2006) for more evidence on the gradual convergence of EU government bond markets.

[24] Few papers have examined the effect of budget deficits for individual emerging markets (see Aisen and Hauner (2008) for an overview).

[25] Abbas and Christensen (2010) provide evidence of positive growth effects of debt financing in emerging markets that have a more developed financial system.

[26] We do not control for possible non-linearities in this relation. Governments start paying a higher risk premium for more fiscal indiscipline, especially in emerging market economies (Zoli, 2004).

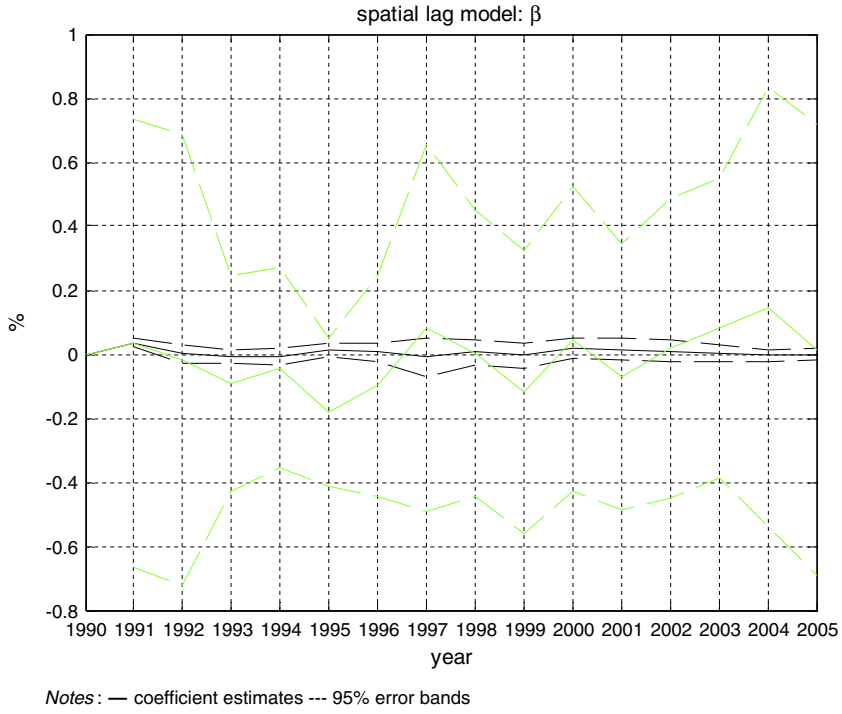

Fig. 1. Baseline model, spatial lag estimates.

3.3. Time variation in the spillover effect

Financial globalisation during the past decade is often argued to have strengthened the spillover between economies. This intensification of financial links has occurred in two different ways. On the one hand, financial integration has been a gradual process, which is stimulated by several rounds of capital account liberalisation, financial deregulation and innovation, and the introduction of the euro. This type of financial linkages is likely to dominate in industrialised economies (Lane and Milesi-Ferretti, 2008). On the other hand, economic turbulence could quickly spread in an unorderly way in emerging markets in financial or economic crises. Tranquil periods in which there is a normal degree of real and financial interdependence suddenly switch to an environment with wild co-movements during currency and financial crises (Claessens et al., 2001). We model these changes in three different ways.

First, we include time fixed effects in the spatial lag model. These year dummies capture any common shock to long term rates not explained by the evolution of the domestic control variables only. Economic shocks common to a group of countries would show up in a close synchronisation of economic variables. This would be observationally equivalent to a close correlation of interest rates. Table 3 (panel a) reports the ML estimates for this model. We indeed find that the spatial lag is small and not even significant, whereas the crowding out effect is still 1 basis point. Just a few of the time dummies are significant, but these cannot be related to any specific crisis event. The inclusion of the time effects has no particular effect on the significance of the control variables. Hence, common shocks to bond markets are an important driver of the spillover we detect.

Second, we include a set of time dummies associated with the main international economic crises in the sample period. Kaminsky (2006) classifies currency crises for 20 industrial and developing countries into a few categories. This empirical classification reflects the varieties of crises proposed by various generations of theoretical models of currency crises. We insert the dummy series for all crises in the baseline specification. We also use a dummy related to banking crises or due to balance of payment problems. Such crises have often been caused by fiscal trouble. It has usually led to turbulence on financial markets, making it harder for the government to finance new debt issues. The results in Table 3b show that during banking or balance of payment crises, long term rates rose strongly (by 658 and 416 basis points respectively). These crisis episodes seem also responsible for the spillover across markets, since the spatial lag ceases to be significant.[27] This suggests important links between countries during a crisis, either through contagion or real economic channels. The control for the crises episodes also raises the crowding out effect to 3 basis points.

Finally, we test the standard spatial lag model for explaining the variation in interest rates by fiscal variables, but now estimate it on the cross-section of 35 countries for each year.[28] Fig. 1 plots the coefficients of a ML estimation of the baseline regression over the period 1990–2005. There is little evidence of large variations in the crowding out of fiscal policy on interest rates. Baldacci and Kumar (2010) find a similarly stable crowding out effect over time for a comparable sample of countries. The measure of financial integration shows more changes over time, but there is no clear tendency. The peaks seem related to some crisis episodes, like the Asian Flu that started in 1997 in Thailand and set off a series of problems in the Asian Tigers, but spread globally. Russia defaulted in 1998 after Brazil had devalued the real a few months before. Argentina defaulted in 2001 and Turkey experienced fiscal and monetary trouble in the same year. This confirms the evidence of the model including the crisis dummies. This result corroborates similar findings in Forbes and Chinn (2004) or Lane and Milesi-Ferretti (2008) that spillover was particularly strong over the period 1996–2000 due to the crises of emerging markets.[29] After 2000, linkages on international

[27] Of course, if spatial links are predominantly determined by contagious crises across emerging economies, the annual frequency of fiscal data may not pick up the high frequency movements on financial markets due to sudden fiscal crises.

[28] Note that the efficiency of the cross-section estimates is smaller than in the panel case.

[29] Didier et al. (2006) or Mauro et al. (2006) show that the co-movement of emerging market bond spreads and returns were much stronger before 2000.

markets seem to have become systematically stronger. Contagion during crises is now much weaker, yet increasing globalisation is believed to have spurred capital mobility and increased trade flows. Deep financial and economic integration are progressing, also for emerging markets, although this process is far from complete. This result is similar to Baldacci and Kumar (2010) who argue that financial globalisation in recent years has allowed more capital to flow into sovereign bond markets, both for emerging markets and industrial countries. Kumar and Okimoto (2011) also find that long term government bond yields have become increasingly more dependent on global conditions, rather than on country specific risk factors. The consequence is a rising cross-country correlation of government bond yields. They also show that a smaller home bias has not reduced the crowding out effect in domestic credit markets.

4. Some robustness checks

So far, we have been measuring the cross-country economic linkages with bond market capitalization. We now focus on the spatial panel lag model with fixed effects for the full sample, and check if the results are robust to other definitions of the weight matrix W. We first split up the capitalization of the bond market in corporate and public bonds. The use of either market as an indicator of bilateral exposure is likely to modify the results.

Countries with a higher public debt have probably looked for a diversification of its funding sources. Therefore, the degree of integration of government bond markets is likely to be stronger than what we found using the entire bond market: Since this is also the market for which we test the effect of debt, the crowding out effect will be affected by the mobility of capital in a particular way. Large bond markets of countries like the US, Japan or Germany have a 'safe haven' status. International investors prefer keeping these risk-free and liquid bonds when other asset markets become more volatile. This 'flight to quality' effect might reduce the typical crowding out effect of additional debt issues. It may even cause interest rates to fall if investors are risk averse and prefer bonds of large liquid bond markets.

Using the size of the private bond market for measuring bilateral exposure poses similar problems. Countries with a much larger private bond market have large domestic reserves to finance an increase in public debt, hence the measure of integration is likely to be smaller. We report in Table 4 (panel a) only the crowding out effect and the spatial lag coefficient. We see that the total crowding out effect is the combination of a positive 2 basis point effect on private bonds, and a fall in the price of public bonds. The latter is the result of a liquidity effect, while the former is an estimate of the displacement of private capital that is in line with the calibration exercise. Public bond markets show strong integration, probably because investors specialise in assets of this specific class (Kaminsky and Reinhart, 2000). This shows that an increase in financing needs of one government importantly affect the financing choices of other governments. The feedback is as important as the direct impact on domestic rates. Countries with a similarly large corporate bond market are much less integrated, which is a finding comparable to other studies (Baele et al., 2004).

These results are confirmed when we try out some different measures of capital mobility. The similarity of relative bond market capitalization (as a ratio to GDP) reflects bilateral exposure, but the transmission from a large bond market to another smaller one is likely stronger than in the opposite direction.[30] Changes in fiscal policy in the large industrialised economies are likely to have a larger effect on smaller economies. For example, although the US has important economic links with Colombia, the importance of these bilateral links for the US economy is relatively tiny, given the total amount of US economic links to other countries. In contrast, for Colombia, the link with the US is much more important than any other. We would therefore expect Colombian interest rates to co-move more strongly with US rates, than *vice versa*. As we do not have complete data on bilateral bond holdings, we take a shortcut and construct an asymmetric weight matrix by taking for each pair the maximum of the bond market capitalization ratios as the bilateral weight. The results in panel b show hardly any changes with the baseline weight matrix, for total, private or public bonds.

We obtain slightly different results if we look in more detail at different categories of assets. We first use as a measure of exposure of different financial markets the relative capitalization ratio of stock markets. Although capital flows between stock markets are larger and volatile than those between bond markets, panel (c) in Table 4 shows that the spatial spillover and the crowding out effect are even weaker than in the baseline specification. Stock markets are prone to withdrawals by foreign investors in the short term.

This is not the case for foreign direct investment, which is hard to reverse, and less subject to market fluctuations. When using the relative net foreign direct investment flows between two countries, the degree of interdependence is just about 20% and the crowding out effect 2 basis points. We also have data on the overall position of a country's residents in banks of other countries. These direct holdings abroad are very different than the indirect claims via financial intermediaries, and therefore are a good indicator of the deepness of financial integration. The spatial lag panel model with this weight matrix indicates that feedback effects are responsible for two thirds of all movements in long term rates. In line with the previous results, the crowding out effect is not significant.

The database of Beck et al. (2000) provides data on all international debt issues of a country, containing any outstanding debt position that is

Table 4
Spatial lag panel model, various weight matrices.

	Weight matrix	Weight	β	ρ
			t-stat	t-stat
(a)	Total bond market capitalization/GDP	Like (7)	0.01	0.28
			(1.18)	(1.78)
	Capitalization private bonds/GDP		0.02	0.21
			(0.80)	(2.87)
	Capitalization public bonds/GDP		−0.01	0.54
			(1.18)	(12.02)
(b)	Total bond market capitalization/GDP	$\max(S_i,S_j)$	0.01	0.32
			(1.16)	(1.20)
	Capitalization private bonds/GDP		0.01	0.12
			(1.17)	(1.29)
	Capitalization public bonds/GDP		−0.01	0.53
			(1.19)	(11.31)
(c)	Stock market capitalization/GDP	Like (7)	0.01	0.06
			(0.80)	(1.68)
	Net FDI GDP		0.02	0.20
			(1.30)	(2.48)
	Total assets held in BIS-reporting banks by a country's residents		−0.01	0.65
			(0.94)	(14.33)
(d)	International debt issues/GDP	Like (7)	0.01	0.22
			(1.05)	(3.28)
	Debt net assets/GDP		0.02	0.18
			(1.31)	(2.17)
	Total net assets/GDP		0.02	0.18
			(1.31)	(2.18)
	Net external asset position/GDP		−0.01	0.12
			(1.28)	(3.74)
(e)	Gross external debt, developing countries (source: World Bank)	Like (7)	−0.04	0.04
			(1.88)	(0.31)
	Gross external debt, developing countries (source: OECD)		−0.03	−0.24
			(1.84)	(1.56)
(f)	Total trade (export and imports shares, relative to total trade)	Like (7)	0.01	0.18
			(1.28)	(2.51)
	Inverted distance matrix[a)]	Distance to capital cities	0.01	0.18
			(1.22)	(2.74)
	Distance between centroids of the country coordinates	Great circle distance	0.01	0.19
			(1.13)	(3.43)

[30] Several papers find evidence for the dominant effect of a few large economies, mostly the US (Diebold and Yilmaz, 2009; Forbes and Chinn, 2004).

not placed domestically. A specification using as spatial weights the overall debt exposure between two markets comes to a similar conclusion as the baseline model. Lane and Milesi-Ferretti (2007) provide several alternative measures of debt positions. But whether we look at a smaller group of portfolio debt and other investment, or to more macroeconomic measures, like the overall asset position or the estimated net external asset position, we obtain a similar degree of interdependence of about 20% and a crowding out effect of 2 basis points (panel d).

This result changes if we narrow down debt to the part that is externally financed. The Lane and Milesi-Ferretti (2007) database provides two measures of gross external debt, from the World Bank Global Development Finance database and the OECD. Two countries are more exposed to international finance if they have large external debt positions. Using this measure for the weight matrix gives no evidence of significant spatial linkages between markets, and results in a negative crowding out effect (panel e). How do we explain this result? In our sample, emerging markets are not integrated in international bond markets and few issued debt externally. However, there is some evidence that emerging markets have gained access to international financial markets, and are not dependent anymore on the shallow domestic financial markets for placing public debt. Baldacci and Kumar (2010) show evidence that financial globalisation has allowed more capital to flow into sovereign bond markets of emerging markets. This reduced pressure on domestic interest rates. At the same time, these emerging economies just started to integrate in world financial markets, so their integration is still limited.

Despite the importance of global financial flows, Forbes and Chinn (2004) argue that bilateral trade flows are the most important determinant of cross-country linkages in both stock and bond markets. Trade and financial openness are of course concurrent phenomena as trade directly leads to payment flows between countries (Obstfeld and Rogoff, 2001). Trade moreover creates additional financial flows as agents gain more from investing in assets from partner countries that are big importers to the home country. This diversification efficiently shares risks in both domestic and foreign markets. Given these arguments, we use a weight matrix incorporating bilateral exports and imports, which also reflect the difference in transmission from large to small economies (Glick and Rose, 1999). We therefore scale total exports and imports between country *i* and *j* by total trade of both countries.[31] In this way, the strength of the transmission depends on the size and importance of each country. Surprisingly, none of the results of the baseline model is altered very much (Table 4, panel f). The crowding out effect is as small as before, and so is the spatial effect.

Although distance is at best a proxy for the integration of countries' financial markets, gravity models can predict trade and financial flows rather well. We measure physical distance by the distance between capital cities, or the great circle distance between country centroids.[32] Panel f of Table 4 shows that the point estimates are very similar in both cases. Kelejian et al. (2006) similarly find little differences between the uses of trade or distance matrices in their analysis of financial market spillover.

5. Conclusions

There is much discussion about the effect of fiscal expansions on interest rates. A lack of response of interest rates can be justified under two different theoretical conditions. First, under Ricardian Equivalence, deficits do not affect macroeconomic variables as economic agents anticipate the paydown of higher deficits with future taxes. Second, capital flows between economically integrated economies offset any interest rate differentials that follow upon an increase in the supply of government bonds. Fiscal deficits are not necessarily financed by domestic financial resources only.

In this paper, we extend a simple empirical model for testing crowding out and apply spatial panel techniques. Spatial models impose few restrictions on the spillover, as all contemporaneous interactions on capital markets in many countries are taken into account. This co-movement of interest rates on financial markets in all nearby foreign economies is assumed not to spread symmetrically across borders. This correlation of market returns gives an easily interpretable measure of the degree of integration of government bond markets, which lies between 0 and 1. We test the effect of financial integration on crowding out for a panel of OECD and emerging economies over the period 1990–2005.

Our main finding is that the crowding out effect of public debt on domestic long term interest rates is small. A 1% increase in the debt ratio pushes up domestic rates by 2 pp at most. Financial integration implies limited spillover via financial markets. Cross border spillover is much stronger among OECD, and in particular EU, countries. Emerging markets are not fully integrated in global markets. Spillover reflects deep economic integration but also economic co-movement. Our main result is robust to various checks.

These results have some implications for fiscal policy. Persistent increases in deficits lead to large accumulated effects over time (Friedman, 2005), and in crisis periods, debt often rises by double digit numbers. The argument for coordination of fiscal policy is not convincing in case the spillover occurs on capital markets. After all, the mitigating effect of financial markets is a purely pecuniary externality and does not require international coordination. The allocation of savings to the public or private sector, whether at home or abroad, is efficient. But as financial globalisation gives access to cheap international financing, market discipline may not be sufficient to keep debt under control. In case spillover is related to contagion on financial markets (in the case of emerging economies) or to monetary union (in the case of EMU), some mechanisms might be necessary to correct the distortion on capital markets.

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Appendix A

Table A.1
Data sources, specification.

Series	Definition	Source
Long term interest rate	5 to 10 year government bond yield or corresponding (%)	IMF/IFS or central bank
Short term interest rate	Central Bank, T-bill 3 months or corresponding (%)	IMF, central bank or statistical institute
Public debt	Debt/GDP ratio (%)	-IMF General government Statistics -Ministry of Finance -Debt agency -IADB, Asian Development Bank
Surplus	Surplus/GDP ratio (%)	-IMF General government Statistics -Ministry of Finance -Statistical institute
Inflation	CPI	IMF, IFS
Output	Growth rate of real GDP	IMF, IFS

[31] All data are in USD, trade data are FOB or CIF. Spatial panel models cannot handle time varying weight matrices. We arbitrarily fix exports and imports at a base year in 2005. Two countries are 'close' if they have strong bilateral trade (relative to the other trading partners).

[32] The great circle is the shortest path between two points along the surface of a sphere.

Table A.2
Data sources, weight matrix.

Weight matrix		
Total bond market capitalization/GDP	All domestic debt securities issued (average over the year)	Beck et al. (2009)
Capitalization private bonds/GDP	Private domestic debt securities issued by financial institutions and corporations as a share of GDP (average over the year)	Beck et al. (2009)
Capitalization public bonds/GDP	Public domestic debt securities issued by government as a share of GDP (average over the year)	Beck et al. (2009)
Stock market capitalization/GDP	Value of listed shares to GDP (average over the year)	Beck et al. (2009)
Total assets held in BIS-reporting banks by a country's residents	(BIS)	Lane and Milesi-Ferretti (2007)
Net FDI/GDP	FDI assets − liabilities, as a share of GDP	Lane and Milesi-Ferretti (2007)
International debt issues/GDP	Outstanding amount of international debt securities	Lane and Milesi-Ferretti (2007)
Debt net assets/GDP	Portfolio debt and other investment	Lane and Milesi-Ferretti (2007)
Total net assets/GDP	Assets − liabilities	Lane and Milesi-Ferretti (2007)
Net external asset position/GDP	Estimate of the net external asset position based on adjusted cumulative current account	Lane and Milesi-Ferretti (2007)
Gross external debt	(World Bank, Global Development Finance)	Lane and Milesi-Ferretti (2007)
Gross external debt	(OECD)	Lane and Milesi-Ferretti (2007)
Total trade	Export CIF + import FOB	IMF DOTS
GDP per capita	US $ PPP	Penn World Tables
Distance	Latitude/longitude	Rose (2001)

Table A.3
Countries in sample.

EU	OECD	Emerging markets	Other
Austria	EU countries	Argentina	Belize
Belgium	Australia	Peru	Costa Rica
Denmark	Canada	Colombia	El Salvador
Finland	Japan	Mexico	Jamaica
France	United States	Pakistan	Singapore
Germany	New Zealand	Thailand	Saudi Arabia
Ireland	Korea	Philippines	
Italy	Switzerland	Malaysia	
Luxembourg	Norway	Indonesia	
Netherlands	Israel	China	
Portugal		India	
Spain		Bulgaria	
United Kingdom		Hungary	
		Poland	
		Morocco	
		South Africa	
		Turkey	

References

Abbas, A., Christensen, E., 2010. The role of domestic debt markets in economic growth: an empirical investigation for low-income countries and emerging markets. IMF Staff Papers 57 (1), 209–255.

Aisen, A., Hauner, D., 2008. Budget Deficits and Interest Rates: A Fresh Perspective: IMF working paper, 42.

Allen, F., Pagano, M., 2006. Special issue on capital markets and financial integration: preface. Review of Finance 10 (1), v-vi.

Anselin, L., 1988. Lagrange multiplier test diagnostics for spatial dependence and spatial heterogeneity. Geographical Analysis 20, 1–17.

Anselin, L., Le Gallo, J., Jayet, H., 2008. Spatial panel econometrics. In: Matyas, L., Sevestre, P. (Eds.), The econometrics of panel data. : Fundamentals and Recent Developments in Theory and Practice, 3. Kluwer, Dordrecht, pp. 627–662.

Ardagna, S., Caselli, F., Lane, T., 2007. Fiscal discipline and the cost of public debt service: some estimates for OECD countries. Journal of Macroeconomics 7 (1).

Baele, L., Ferrando, A., Hordahl, P., Krylova, E., Monnet, C., 2004. Measuring European financial integration. Oxford Review of Economic Policy 20 (4), 509–530.

Baldacci, E., Kumar, M., 2010. Fiscal deficits, public debt, and sovereign bond yields: IMF working paper, 184.

Ball, L., Mankiw, G., 1995. What do budget deficits do? Proceedings, Federal Reserve Bank of Kansas City, pp. 95–149.

Barr, D., Priestley, D., 2004. Expected returns, risk and the integration of international bond markets. Journal of International Money and Finance 23 (1), 71–97.

Beck, T., Demirgüç-Kunt, A., Levine, R., 2000. A new database on financial development and structure. World Bank Economic Review 14, 597–605.

Breedon, F., Henry, B., Williams, G., 1999. Long term real interest rates: evidence on the global capital market. Oxford Review of Economic Policy 15 (2), 128–142.

Caballero, R., Krishnamurthy, A., 2004. Fiscal policy and financial depth: NBER working paper, 10532.

Canzoneri, M., Cumby, R., Diba, B., 2002. Should the ECB and the Federal Reserve be concerned about fiscal policy? Rethinking Stabilization Policy. Federal Reserve Bank of Kansas City, Kansas City, pp. 333–389.

Caporale, G., Williams, G., 2002. Long term nominal interest rates and domestic fundamentals. Review of Financial Economics 11, 119–130.

Cebula, R., Koch, J., 1994. Federal budget deficits, interest rates, and international capital flows: a further note. Quarterly Review of Economics and Finance 34 (1), 117–120.

Chinn, M., Frankel, J., 2007. Debt and interest rates: the US and the Euro Area: E-conomics Discussion Paper, 11.

Chung, H., Leeper, E., 2007. What has financed government debt? : NBER working paper, 13425.

Claessens, S., Dornbusch, R., Park, Y., 2001. International financial contagion: how it spreads and how it can be stopped. In: Claessens, S., Forbes, K. (Eds.), International Financial Contagion. Kluwer, Boston, pp. 3–18.

Codogno, L., Favero, C., Missale, A., 2003. Yield spreads on EMU government bonds. Economic Policy 37, 503–527.

Council of Economic Advisers, 1994. Economic Report of the President. U.S. Government Printing Office, Washington, D.C.

Dai, Q., Philippon, T., 2005. Fiscal policy and the term structure of interest rates: NBER working paper, 11574.

De Haan, J., Knot, K., 1995. Fiscal policy and interest rates in the European Community. European Journal of Political Economy 11 (1), 171–187.

Didier, T., Mauro, P., Schmukler, S., 2006. Vanishing financial contagion. IMF Policy Discussion Paper 1.

Diebold, F., Yilmaz, K., 2009. Measuring financial asset return and volatility spillovers, with application to global equity markets. Economic Journal 119 (534), 158–171.

ECB, 2005. Financial integration in Europe, Bulletin.

ECB, 2007. Financial integration in Europe, Bulletin.

Elhorst, J., 2003. Specification and estimation of spatial panel data models. International Regional Science Review 26 (3), 244–268.

Elhorst, J., 2010a. Spatial panel data models. In: Fischer, M., Getis, A. (Eds.), Handbook of Applied Spatial Analysis. Springer, Berlin, pp. 377–407.

Elhorst, J., 2010b. Applied spatial econometrics: raising the bar. Spatial Economic Analysis 5, 9–28.

Elmendorf, D., Mankiw, G., 1999. Government debt. In: Taylor, J., Woodford, M. (Eds.), Handbook of Macroeconomics. Elsevier Science, Amsterdam. Chapter 25.

Engen, E., Hubbard, R., 2004. Federal government debt and interest rates. NBER Macroeconomics Annual. NBER, Cambridge, Massachusetts, pp. 83–138.

European Commission, 2004. Public Finances in EMU, European Economy: DG for Economic and Financial Affairs, 3.

Faini, R., 2006. Fiscal policy and interest rates in Europe. Economic Policy 21 (47), 443–489.

Favero, C., Pagano, M., Von Thadden, E., 2010. How does liquidity affect government bond yields? Journal of Financial and Quantitative Analysis 45, 107–134.

Flood, R., Rose, A., 2005. Financial integration: a new methodology and an illustration. Journal of the European Economic Association 3 (6), 1349–1359.

Florax, R., Folmer, H., Rey, S., 2003. Specification searches in spatial econometrics: the relevance of Hendry's methodology. Regional Science and Urban Economics 33, 557–579.

Forbes, K., Chinn, M., 2004. A decomposition of global linkages in financial markets over time. Review of Economics and Statistics 86 (3), 705–722.

Forbes, K., Rigobon, R., 2002. No contagion, only interdependence: measuring stock market co-movement. Journal of Finance 57 (5), 2223–2261.

Ford, R., Laxton, D., 1999. World public debt and real interest rates. Oxford Review of Economic Policy 15 (2), 77–94.

Friedman, B., 2005. Deficit and debt in the short and long run: NBER working paper, 11630.

Hartmann, M., Manganelli, S., Monnet, C., 2009. Capital markets and financial integration in Europe. In: Balling, M., et al. (Ed.), Competition and Profitability in European Financial Services. Taylor and Francis, London.
Gale, W., Orszag, P., 2003. The economic effects of long-term fiscal discipline. Urban-Brookings Tax Policy Center Discussion Paper 60.
Galí, J., López-Salido, J., Vallés, J., 2007. Understanding the effects of government spending on consumption. Journal of the European Economic Association 5 (1), 227–270.
Glick, R., Rose, A., 1999. Contagion and trade why are currency crises regional? Journal of International Money and Finance 18, 603–617.
Hausman, R., Rigobon, R., 2000. Financial contagion in emerging markets. In: Fernandez-Arias, E., Hausman, R. (Eds.), Wanted: World Financial Stability. Inter-American Development Bank, Washington, DC.
Imbs, J., 2004. Trade, finance, specialization, and synchronization. Review of Economics and Statistics 86 (3), 723–734.
IMF, 2006. Annual Report 2006. IMF, Washington DC.
Jaimovich, D., Panizza, U., 2006. Public debt around the world: a new dataset of central government debt: IADB working paper, 561.
Kaminsky, G., Reinhart, C., 2000. On crises, contagion and confusion. Journal of International Economics 51, 145–168.
Kaminsky, G., 2006. Currency crises: are they all the same? Journal of International Money and Finance 25, 503–527.
Kelejian, H., Tavlas, G., Hondroyiannis, G., 2006. A spatial modelling approach to contagion among emerging economies. Open Economies Review 17 (4–5), 423–441.
Kim, S., Moshirian, F., Wu, E., 2006. Evolution of international stock and bond market integration: influence of the EMU. Journal of Banking and Finance 30 (5), 1507–1534.
Kinoshita, N., 2006. Government debt and long term interest rates: IMF working paper, 63.
Kumar, M., Okimoto, T., 2011. Dynamics of international integration of government securities' markets. Journal of Banking and Finance 35 (1), 142–154.
Lane, P., Milesi-Ferretti, G., 2007. The external wealth of nations mark II: revised and extended estimates of foreign assets and liabilities 1970–2004. Journal of International Economics 73 (2), 223–250.
Lane, P., Milesi-Ferretti, G., 2008. The drivers of financial globalization. American Economic Review 98 (2), 327–332.
Laubach, T., 2009. New evidence on the interest rate effects of budget deficits and debt. Journal of the European Economic Association 7 (4), 858–885.
Lee, L., Yu, J., 2010. A spatial dynamic panel data model with both time and individual fixed effects. Econometric Theory 26, 564–597.
Lesage, J., Pace, R., 2009. Introduction to Spatial Econometrics. Taylor and Francis, Boca Raton.
Lucey, B., Steeley, B., 2006. Measuring and assessing the effects and extent of international bond market integration. International Financial Markets, Institutions and Money 16, 1–3.
Mauro, P., Nathan, S., Yishay, Y. (Eds.), 2006. Emerging Markets and Financial Globalization. Oxford University Press, Oxford.
Minford, P., Peel, D., 2007. On the equality of real interest rates across borders in integrated capital markets. Open Economics Review 18 (1), 119–125.
Missale, A., 1997. Managing the public debt: the optimal taxation approach. Journal of Economic Surveys 11 (3), 235–265.
Obstfeld, M., Rogoff, K., 2001. The six major puzzles in international macroeconomics: is there a common cause? NBER Macroeconomics Annual 15, 339–390.
Orr, A., Edey, M., Kennedy, M., 1995. Real long term interest rates: the evidence form pooled-time-series. OECD Economic Studies 25, 75–107.
Paesani, P., Strauch, R., Kremer, M., 2006. Public debt and long term interest rates: the case of Germany, Italy and the USA: ECB working paper, 656.
Rose, A., 2001. Currency unions and trade. Economic Policy 16 (33), 449–461.
Tanzi, V., Lutz, M., 1993. Interest rates and government debt: are the linkages global rather than national? In: Verbon, H., Van Winden, F. (Eds.), The Political Economy of Government Debt. Elsevier Science, Amsterdam, pp. 233–253.
Yu, J., de Jong, R., Lee, L., 2008. Quasi-maximum likelihood estimators for spatial dynamic panel data with fixed effects when both n and T are large. Journal of Econometrics 146, 118–134.
Zoli, E., 2004. How does fiscal policy affect monetary policy in emerging market countries? : BIS working papers, 174.