Fiscal discipline and foreign direct investment: Do investors care about public debt and government deficits?[◇]

Benedikt Heid[1,*] and Laura Márquez-Ramos[2]

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Abstract

High levels of budget deficits and public debt were a key concern for policy makers in countries affected by the recent public debt crisis. Reductions of budget deficits and the level of public debt were seen as crucial to improve economic conditions and to increase investment, both domestic and from abroad. We analyze the *direct* impact of fiscal discipline on bilateral stocks of foreign direct investment (FDI) by estimating a gravity model of FDI in a panel of countries for the years 2001 to 2012. We find that FDI stocks are not correlated with neither the budget balance nor the public debt-to-GDP ratio of origin and destination countries. This holds for worldwide FDI into European Union (EU) countries and for FDI between EU countries. We also analyze the *indirect* effect of fiscal discipline on FDI. To do so, we study the interdependence between EU FDI stocks over time using a spatial econometric origin-destination model. We document that FDI stocks are correlated between EU countries with similar levels of fiscal discipline. We find that the FDI interdependencies due to the fiscal discipline channel remain quite stable before and during the financial and public debt crises.

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[1]Heid, University of Adelaide and CESifo. [2]Márquez-Ramos, University of Adelaide and Universitat Jaume I, acknowledges the support by Universitat Jaume I (P1-1B2013-06) and Generalitat Valenciana (PROMETEOII/2014/053). *Address: School of Economics, University of Adelaide, 10 Pulteney St, 5005 SA, Australia. Phone: +61 88313 4930. Email: benedikt.heid@adelaide.edu.au. ◇We thank participants at the IFABS 2016 Barcelona Conference for useful comments and suggestions. We also thank James P. LeSage for cordially sharing his code with us and Felix Stips for excellent research assistance with the FDI data. All remaining errors are our own.

1 Introduction

During the recent financial and subsequent public debt crisis, austerity policies in favor of fiscal discipline put peripheral countries in the European Union (EU) under pressure. The goal of these measures is to lower the public debt burden of these countries by readjusting public spending in order to achieve a balanced budget in the long-run. Whether low levels of public debt and the according austerity measures have a positive effect for the long-run growth of economies is still a hotly debated topic (see Reinhart and Rogoff, 2010 as well as the ensuing debate about the validity of their findings, e.g., Herndon et al., 2014 and Panizza and Presbitero, 2014; for the Eurozone, see, e.g., Checherita-Westphal and Rother, 2012). While the relationship between public debt and growth is hotly debated, there hardly exists any evidence on the effect of fiscal discipline on FDI.

We analyze the role of national public debt and budget balance levels on bilateral foreign direct investment (FDI). We aim to answer whether international investors care about countries' commitment to fiscal discipline (*direct* effect). We also investigate whether awareness of fiscal discipline and its impact on FDI varies over time. Additionally, we analyze whether the interdependencies or co-movements of FDI across countries are influenced by fiscal discipline (*indirect* effect) and whether they have been accentuated during the financial and public debt crises. Therefore, we focus on the time-varying effect of both a *direct* and an *indirect* effect of fiscal discipline on FDI activity.

But why should investors be aware about fiscal discipline at national level? The theoretical relationship between FDI and fiscal discipline is not clear. Lower growth prospects are bad news for market-seeking FDI, as lower growth means a smaller potential market. At the same time, FDI might be motivated by cost advantages such as lower wage costs. Then, FDI might actually increase with higher levels of debt, as wages may fall during an economic downturn, and hence make a country more attractive for foreign investors. This type of real devaluation was heavily discussed as one way to improve economic conditions and increase the attractiveness for domestic and

foreign investment in the GIIPS countries (Greece, Ireland, Italy, Portugal and Spain) as the option of devaluing their currency is not available to them as they are members of the Eurozone.

In the long-run, higher levels of debt imply a larger amount of government spending on interest payments. Debt tends to increase during economic downturns when the pressure on government spending is especially high due to a decline in tax revenue. To balance this, governments may well be forced to increase taxes. Such a tax spike lowers firm profits and eventually lowers the return for foreign investors from investing in a debt-ridden country. Therefore, foreign investors may decide to invest in countries committed to fiscal discipline.

To the best of our knowledge, we are the first to consider both the *direct* and the *indirect* impact of fiscal discipline on bilateral FDI stocks. We measure fiscal discipline as the level of the budget balance (short-run fiscal discipline) and the level of public debt (long-run fiscal discipline). Empirically, there is some evidence that foreign investors indirectly care about public debt levels in potential destination markets (see Alamá-Sabater et al., 2016b).[1] In addition, higher debt in the destination country may not only deter foreign investment in the destination country itself (*direct* effect) but may also lead to domestic capital leaving the country, as domestic investors try to evade the rise in taxes, a phenomenon dubbed "capital flight", see Eaton (1987) and Eaton and Fernandez (1995).

A complimentary line of research to ours is that by Fuentes and Saravia (2010) and Stoddard and Noy (2015) who study the impact of extreme events like sovereign default and financial crises on FDI. We contribute to this branch of the literature by studying the impact of fiscal discipline on FDI, i.e., the impact of indicators of potential crises or macroeconomic problems in the near future before the uncertainty is resolved.

[1]Specifically, these authors find that FDI inflows within the EU in 2007 are correlated across countries that have similar debt levels. If two destination countries of FDI violate the Maastricht criterion of a public debt-to-GDP ratio of more than 60 percent, their FDI inflows are correlated. The same holds for inflows into countries which are below the 60 percent threshold. However, they neither investigate the *direct* effect of public debt on FDI nor consider the budget balance nor the potential time-variation in these effects.

The remainder of the paper is structured as follows: Section 2 analyzes the *direct* effect of fiscal discipline on bilateral FDI stocks using a panel gravity framework. Section 3 introduces a spatial econometric framework for modeling the interdependence of bilateral FDI stocks across countries due to two main channels, geographic proximity and fiscal discipline, to analyze the *indirect* effect of fiscal discipline on bilateral FDI stocks. Section 4 concludes.

2 The *direct* effect of fiscal discipline on bilateral FDI stocks

We follow the literature and analyze the determinants of bilateral FDI stocks using a gravity equation.[2] This framework takes into account the fact that FDI depends on origin and destination characteristics as well as on bilateral variables such as geographical distance, common border, common language and colonial ties. We introduce fiscal discipline variables together with the rest of theoretically justified regressors to analyze whether public debt and budget balance levels might impact FDI.

2.1 Panel gravity model for FDI stocks

We estimate the following panel gravity model for FDI stocks:

$$\begin{aligned}\ln FDI_{odt} &= \beta_1 \ln GDP_{ot} + \beta_2 \ln GDP_{dt} + \beta_3 \ln POP_{ot} + \beta_4 \ln POP_{dt} + \\ &+\beta_5 \ln DIST_{od} + \beta_6 CONTIG_{od} + \beta_7 COMLANG_{od} \\ &+\beta_8 COLONY_{od} + \beta_9 EU_{ot} + \beta_{10} EU_{dt} \\ &+\beta_{11} EURO_{ot} + \beta_{12} EURO_{dt} + \\ &+\beta_{13} FISCAL_{ot} + \beta_{14} FISCAL_{dt} + \mu_o + \eta_d + \delta_t + \varepsilon_{odt}. \quad (1)\end{aligned}$$

FDI_{odt} are bilateral FDI stocks from origin country o invested in destination country d in year t, GDP_{ot} and GDP_{dt} are the GDPs in the origin and

[2] See Anderson (2011) and Blonigen and Piger (2014) for recent literature reviews on modeling bilateral FDI.

destination country in year t, and POP_{ot} and POP_{dt} measure the population in the origin and destination country in year t. Both GDP and population measure the respective investment potentials and market sizes of o and d. $DIST_{od}$ measures the distance between the two countries o and d, $CONTIG_{od}$ is an indicator variable which is 1 when o and d share a common border, $COMLANG_{od}$ is an indicator variable which is 1 when at least 9% of the population speak the same language in both o and d, $COLONY_{od}$ is an indicator variable which is 1 if both o and d ever had a colonial relationship. These four variables, i.e., $DIST_{od}$, $CONTIG_{od}$, $COMLANG_{od}$ and $COLONY_{od}$, are time-invariant and are included in gravity models of FDI to proxy for information costs: increasing distance means higher information costs among countries, while common border, language and colonial ties mean lower information costs (see Portes and Rey, 2005 and Márquez-Ramos, 2011). EU_{ot} is a dummy variable that equals 1 when o is a member of the EU in year t, and similarly for EU_{dt}; and $EURO_{ot}$ is a dummy variable equal to 1 if o is a member of the Eurozone in year t, and similarly for $EURO_{dt}$. The importance of both the EU and the Eurozone for FDI has been documented by de Sousa and Lochard (2011). Finally, we include a measure of fiscal discipline of the origin and destination country in year t, $FISCAL_{ot}$ and $FISCAL_{dt}$.

We use two measures of fiscal discipline to differentiate between short-run and long-run fiscal discipline: for short-run fiscal discipline, we use $BUDGET_{ot}$ and $BUDGET_{dt}$ that measure the budget balance of the central government of the origin o and destination country d in year t as a percentage share of GDP. For example, if $BUDGET_{ot} = 1.2$, origin country o's budget surplus is 1.2% of GDP, whereas if $BUDGET_{dt} = -4.5$, destination country d's budget deficit is 4.5%. For long-term fiscal discipline, we use $DEBT_{ot}$ and $DEBT_{dt}$, which measure the level of public debt as a percentage share of GDP. Hence if $DEBT_{ot} = 72$, origin country's level of public debt is 72% of its GDP.

Finally, we should mention here the importance of including fixed effects in our regression to avoid a potential endogeneity bias in our variables of interest. If there exist relevant omitted variables that are correlated with

fiscal discipline but included in the error term ε_{odt} of Equation (1), our estimated coefficients would be biased. In the literature of gravity equations for bilateral trade flows, Anderson and van Wincoop (2003) have shown the importance of what they call "multilateral resistance terms". These terms measure the relative trade costs between all countries, in a similar way to the multilateral attractiveness described in the FDI literature.[3] In the trade literature, these terms are typically controlled for by origin and destination country dummies (see Head and Mayer, 2014). We reason by analogy and also include μ_o and μ_d, i.e., origin- and destination fixed effects. Theoretically, these dummies should be time-varying to control for changes in the attractiveness of other destinations over time. We refrain from including origin and destination dummies that vary for every year in the data set as this would prevent us from identifying our regressors of interest, i.e., our measures of $FISCAL_{ot}$ and $FISCAL_{dt}$, but include instead δ_t, i.e., year fixed effects.[4] It should also be noted that the analogy between trade and FDI is only imperfect: as Anderson (2011) points out, taking into account that firms may, at least to some extent, diversify their risk by investing in several countries and recognizing that the returns on investments are endogenous in general equilibrium are still unresolved problems. Opposite to modeling trade flows, no clear consensus has been reached for modeling bilateral FDI, stocks or flows.[5] We therefore estimate variants of Equation (1) using several sets of fixed effects and a variety of estimators commonly used in the gravity literature to address several potential econometric issues which we will describe while discussing our results.

2.2 Data

We use an unbalanced panel data set on bilateral stocks of FDI from UNCTAD's bilateral FDI statistics. It contains information about 157 origin

[3]Head and Ries (2008) and de Sousa and Lochard (2011) point out that FDI into a particular country depends on the relative attractiveness of FDI in all other countries.

[4]Given the fact that we only use a rather short panel, we think that the time change in the attractiveness of destinations may be less of an issue.

[5]Besides in Anderson (2011), this perception of the literature can also be found in Blonigen and Piger (2014).

countries and 189 destination countries of FDI stocks. We use data on FDI stocks because they have several advantages over FDI flow data: they contain less negative or zero values which cannot be used in typical log-linear FDI regressions, see, e.g., de Sousa and Lochard (2011). They are also less volatile than FDI flow data, see Bénassy-Quéré et al. (2007). As in Alamá-Sabater et al. (2016a), Badinger and Egger (2013) and Barthel et al. (2010), we use both data on inward and outward FDI stocks (so-called "mirror statistics") to fill up missing values.

Contiguity, common language, colonial relationship as well as distance are taken from the Centre d'études prospectives et d'informations internationales (CEPII). Income and population data are from the World Development Indicators (WDI).

Our data on public debt levels and the budget balance as a percentage of GDP are also from the WDI. However, we use data from Eurostat for EU member states as the WDI data have many missing observations for these countries.

We provide summary statistics for our data set in Table A.1 in the Appendix.

2.3 Results

2.3.1 World-wide sample

We present our results for our (world-wide) sample in Table 1. The first five columns consider the results using our measure of long-term fiscal discipline, i.e., the impact of the debt-to-GDP ratio on bilateral FDI stocks. Columns (6) to (10) consider our measure of short-term fiscal discipline, i.e., the budget balance as a percentage of GDP.

Column (1) presents the results of a benchmark specification which is estimated via pooled Ordinary Least Squares (OLS) and does not include origin and destination country fixed effects (FEs). We find that FDI stocks significantly increase with GDP, and this occurs in both origin and destination countries. An increase in origin and destination population decreases FDI stocks *ceteris paribus*. This means that holding GDP constant, an increase in

population translates into lower GDP per capita. Hence, the richer a country becomes, the less it invests abroad when controlling for its overall size with the GDP variable. The typical measures of trade or information costs (see Portes and Rey, 2005) are all significant and have the expected sign: FDI stocks decrease with distance and increase when the origin and destination country share a common border, a common language or a common colonial history. Interestingly, Eurozone countries invest more than non-Eurozone EU member states. At the same time, Eurozone countries receive less foreign investments. The EU as a destination does not attract significantly more FDI when simultaneously controlling for Eurozone membership. Finally, with regards our regressors of interest, we find that the public debt-to-GDP ratio does not have an (economically) significant impact on FDI stocks.

In column (2), we include origin- and destination fixed effects to control for the relative attractiveness of other destinations as specified in Equation (1). The elasticities of FDI with respect to both origin and destination GDP decrease considerably compared with column (1). Origin population turns insignificant and the negative destination population elasticity becomes even larger in absolute size. Compared to column (1), distance exerts an even larger dampening effect on FDI stocks. While the effect of a common border or a common colonial history remain rather similar, the effect of a common language is reduced considerably. In column (2), EU member countries significantly invest more and receive more FDI than non-EU countries. The Eurozone effect remains similar to results in column (1): Eurozone members invest more abroad but receive less FDI. As found in the previous specification, our regressors of interest are not significant.

Head and Ries (2008) point out that traditional log-linear FDI gravity regressions may suffer from a bias if FDI data are heteroscedastic. In addition, log-linearization drops all zero FDI stock observations. This is tantamount to throwing away data which may otherwise help with identification of the coefficients of interest. In the literature on bilateral trade flow gravity models, Santos Silva and Tenreyro (2006) provide a simple solution to these problems. Instead of estimating the log-linear Equation (1), one can estimate it in levels, i.e., using FDI_{odt} as the dependent variable and estimate the coefficients via

poisson pseudo maximum likelihood (PPML). The elegance of this approach lies in the fact that even though FDI data are not poisson distributed, one can still obtain consistent parameter estimates as long as the FDI equation is well-specified, i.e., it does not suffer from endogeneity bias, e.g., due to omitted relevant regressors. Hence, in terms of assumptions, PPML does not imply stricter assumptions than a standard linear regression but avoids the inconsistency of the estimated parameters due to the heteroscedasticity. In terms of interpretation, the estimated coefficients can be compared to OLS coefficients and can be interpreted in exactly the same way as the coefficients of Equation (1).[6]

We present results from the poisson estimator in column (3) but otherwise use the same specification as in column (2), i.e., including origin- and destination fixed effects. GDP results remain broadly similar, but the elasticity of FDI stocks with respect to origin population now increases to more than 3 percent, while destination population turns insignificant. The same happens for common language as well as for both EU dummies. Eurozone countries have significantly higher outward FDI, but do not receive significantly more FDI than the rest of the world. Our regressors of interest, i.e., the debt level of both origin and destination countries remain insignificant.

When specifying a gravity model for bilateral FDI, de Sousa and Lochard (2011) use bilateral fixed effects to control for time-invariant country-pair specific transaction costs affecting FDI. This approach may also control for potential endogeneity of the EU and Eurozone dummies.[7] We therefore use a linear panel estimator in column (4). Note that including bilateral fixed effects implicitly controls for time-invariant origin and destination country effects. Also, time-invariant country-pair specific variables, i.e., distance, common border, common language and common colonial ties, cannot be separately identified. Interestingly, results remain rather similar to those of

[6]Using PPML to include zero FDI stocks is complementary to approaches that model the potential censoring and the selection bias of positive FDI stocks. Examples in the literature are Kristjánsdóttir (2010) who uses a Tobit model and Davies and Kristjánsdóttir (2010) who use a Heckman estimator.

[7]Bilateral fixed effects are commonly used to control for the endogeneity bias of regional trade agreements in bilateral trade flow gravity equations, see Baier and Bergstrand (2007).

column (2) and our measure of long-run fiscal discipline does not exert a significant effect on FDI stocks.

Finally, concerning the same variable, we report results from a panel poisson estimator which also controls for bilateral fixed effects in column (5). Results stay broadly the same and public debt does not affect FDI stocks in a significant way.

Probably our measure of long-run fiscal discipline does not completely capture investors' behavior. Investors may also consider the budget balance-to-GDP ratio as a measure of fiscal discipline. For example, Eichler and Maltritz (2013) find that short-run fiscal imbalances may indicate long-run country risks. We therefore use the budget balance expressed as a share of GDP as a measure of short-run fiscal discipline in columns (6) to (10) and reestimate the same set of models as in columns (1) to (5).

Comparing each column using budget balance with its counterpart using public debt as the regressor of interest, we find very similar results. In the interest of brevity, we abstain from commenting on the other control variables. In column (6), the pooled OLS specification without origin and destination country dummies, we find partial evidence (significance level of 10 percent) for an impact of fiscal discipline on FDI stocks: when the budget balance of a destination country increases by one percentage point, FDI stocks increase by one percent *ceteris paribus*. Similarly, if the budget balance of an origin country increases by one percentage point, the country invests one percent more abroad *ceteris paribus*. The size of the effects remains quite stable across all specifications and even gains in significance when including origin- and destination fixed effects in the log-linear model (column (7)) or country-pair fixed effects (column (9)). However, for the pooled poisson model (column (8)), the effect loses its significance. Finally, when controlling for bilateral FEs using the panel poisson estimator (column (10)), the budget balance in the origin country is significant at 10 percent, but not so in the destination country.

To sum up, we find partial evidence against the "capital flight" hypothesis by Eaton (1987) when using the budget balance as an indicator of fiscal discipline: An increase in the budget balance actually *in*creases FDI. There

is also some evidence for a negative impact of a worsening budget balance on inward FDI stocks. Interestingly, according to our results, the level of public debt does not exert a significant impact on FDI activity.

2.3.2 EU subsamples

It may be that, given our sample period from 2001 to 2012, fiscal discipline is more of a concern in EU member countries, and less so in other parts of the world. It may well be that our world-wide regression sample masks this impact for investments in EU member countries. In addition, investors may exhibit a time-varying level of complacency or awareness for fiscal discipline, i.e., fiscal discipline might have become more important during the recent financial and public debt crises.

Especially given the fact that EU member countries are required to stick to the Maastricht criteria of having a public debt-to-GDP ratio of less than 60 percent and a budget deficit which may not exceed 3 percent, it may be that investors are primed to care more about fiscal discipline when investing in EU countries.[8]

In Figures 1 and 2, we illustrate that EU countries can be easily discriminated by their compliance regarding fiscal rules. These figures show the evolution for both the budget balance as a share of the GDP and the debt-to-GDP ratios by distinguishing the trends of the average of EU countries, the group of countries known as GIIPS, as well as the Central and Eastern European countries (CEECs), together with Malta and Cyprus, that accessed the EU in 2004 and 2007. Figure 1 shows that GIIPS countries have consistently been above the average level of debt-to-GDP of the EU. Additionally, there is a steep increase beginning in 2007 in this group of countries. Regarding the public deficit, Figure 2 shows that it is also in the group of GIIPS where the public deficit increased to a higher extent after the financial crisis and it is only from 2010 onwards that this ratio decreases.

[8]Note that both the Maastricht convergence criteria for becoming a member of the Eurozone as well as the rules of the Stability and Growth Pact for the whole EU imply exactly the same thresholds for public debt and budget deficit. However, the debt and budget deficit criteria are commonly known as the "Maastricht criteria". We therefore refer to them by this name.

Figure 1: Evolution of the debt-to-GDP ratio in the EU members

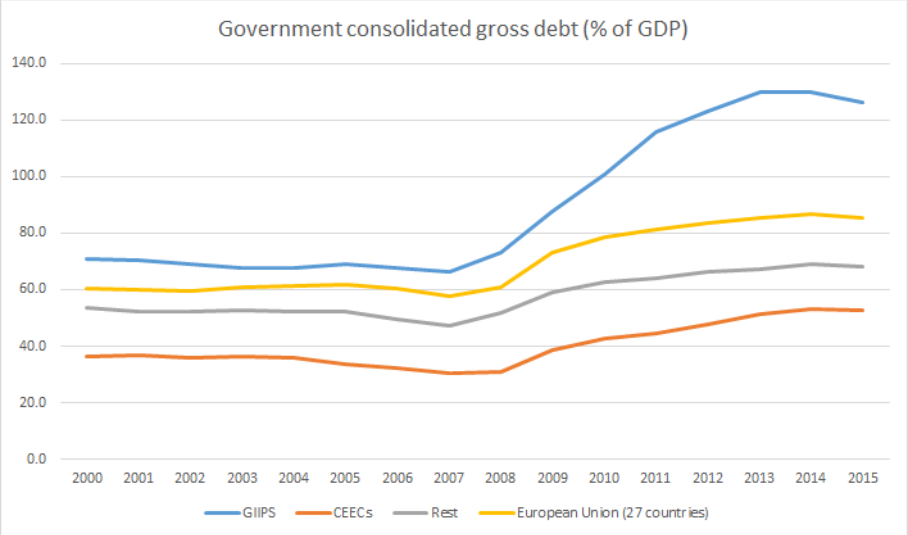
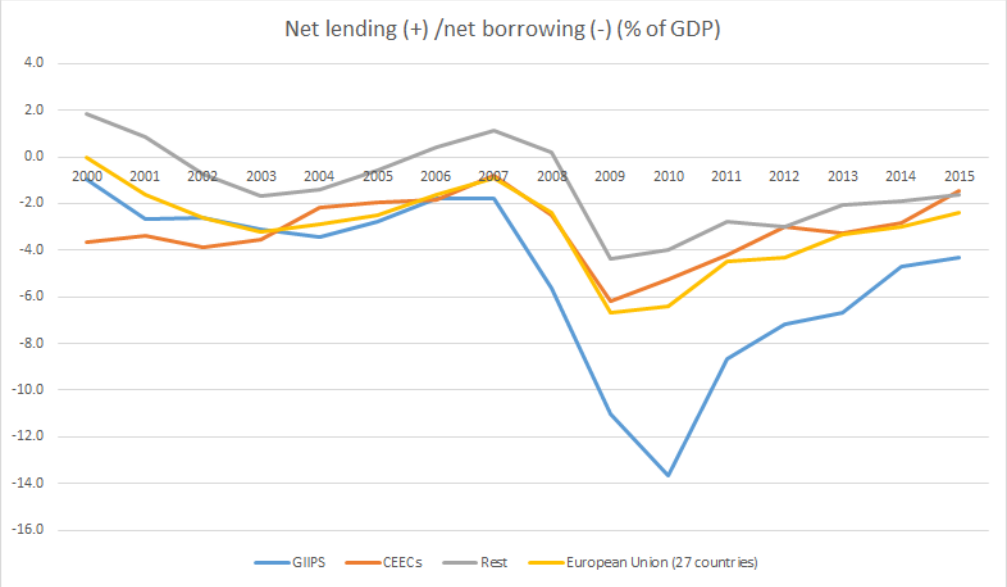


Figure 2: Evolution of the budget balance in the EU members



Therefore, in Table 2, we estimate our model only for investments into the EU member countries. In addition, we now allow the effect of our measures of fiscal discipline to vary over time. In order to save space, we only report results from using the poisson specifications including origin- and destination- as well as time fixed effects, i.e., the specifications from columns (3) and (8) in Table 1. These specifications maximize the number of observations as we can consider zero FDI stocks due to the poisson estimator. In addition, these are the most conservative estimates in Table 1 in the sense that we do not find any significant result for our two measures of fiscal discipline.

Table 2 shows the according time-varying coefficients both for origin and destination country of investments of six different measures of fiscal discipline. To save space, we omit the estimated coefficients of the other control variables but results are broadly similar to those reported in Table 1.

In column (1) we interact the level of public debt as a share of GDP with year dummies. As can be seen, we do no find any significant effect, neither for public debt in the origin nor in the destination country. In column (2), we create a dummy variable which equals one if the level of public debt in an origin (or destination) country violates the 60 percent threshold of the Maastricht criteria in a particular year, and zero otherwise. Again, we do not find any significant effect. Finally, we calculate the level of debt violation, i.e., we create a variable equal to zero if the country complies with the Maastricht debt criterion in a given year, but which is equal to the level of public debt if this particular country violates the criterion. Again, we do not find any significant effect.

The last three columns of Table 2 construct similar time-varying interaction terms using the budget balance level ("budget level"), whether a country violates the 3 percent budget deficit criterion ("budget violation"), and by how much this particular country violates the deficit criterion ("budget violation level"). For the level of the budget balance, we do not find any significant coefficient. Interestingly, we find a significant and negative effect on bilateral FDI stocks when the origin country of FDI violates the deficit criterion in 2005 and 2006, but not during the crisis period. In these two years, violating the deficit criterion decreases investments from this country by roughly 21

percent. Finally, when using the level of the violation of the budget deficit criterion, we still find a significant negative impact on FDI from the origin country into EU countries. In addition to the effect for 2005 and 2006 found in column (1), we find a significant impact in 2001.

To sum up, investors from over the world do not seem to care much about fiscal discipline or the compliance with Maastricht criteria. Although there is some evidence of significant effects before the crisis, there is none during the crisis period.

So, if investors across the world do not care about financial discipline when investing into the EU, do European investors care? We investigate the answer to this question in Table 3 where we restrict our estimated model to only intra-EU bilateral FDI stocks. Table 3 uses the same variables and it is organized in the same way as Table 2. Results can be quickly summarized: With the exception of a significant negative impact of the level of budget violation in origin countries of FDI in 2001, we do not find any evidence for a time-varying significant impact of fiscal discipline of FDI within the EU. Given the large amount of estimated coefficients for our regressors of interest (144 per table), the only 6 significant coefficients in Tables 2 and 3 do not lead us to any stronger conclusions.

As a first robustness test, we also experimented with the empirical strategy for bilateral FDI gravity models proposed by Head and Ries (2008) in unreported regressions. Still, neither the debt nor deficit level seem to have a robust and significant impact on bilateral FDI stocks. As a second robustness test, we experimented by adding an interaction term between the variables indicating budget and debt criterion violation in the destination countries, and similarly for the origin countries. This interaction term identifies all countries that have a high level of debt as well as a large budget deficit, i.e., the country violates the two Maastricht criteria at the same time. We did not find any robust relationship between FDI and this interaction term.

To sum up, we do not find any robust evidence for a *direct* impact of fiscal discipline on bilateral FDI stocks.

Table 1: Bilateral FDI stock panel regressions 2001-2012—world sample

	(1) OLS $\ln(FDI)_{ijt}$	(2) OLS $\ln(FDI)_{ijt}$	(3) poisson FDI_{ijt}	(4) panel $\ln(FDI)_{ijt}$	(5) poisson panel FDI_{ijt}	(6) OLS $\ln(FDI)_{ijt}$	(7) OLS $\ln(FDI)_{ijt}$	(8) poisson FDI_{ijt}	(9) panel $\ln(FDI)_{ijt}$	(10) poisson panel FDI_{ijt}
	debt as a percentage of GDP					budget balance as a percentage of GDP				
$\ln(GDP)_{ot}$	1.51***	0.67***	0.75***	0.73***	0.56***	1.26***	0.42***	0.55***	0.40***	0.52***
	(0.02)	(0.16)	(0.25)	(0.14)	(0.21)	(0.02)	(0.09)	(0.17)	(0.09)	(0.12)
$\ln(GDP)_{dt}$	0.86***	0.50***	0.99***	0.79***	1.03***	0.72***	0.43***	1.10***	0.70***	1.08***
	(0.02)	(0.15)	(0.19)	(0.12)	(0.16)	(0.01)	(0.08)	(0.12)	(0.07)	(0.10)
$\ln(POP)_{ot}$	-1.01***	0.58	3.15***	1.25*	2.79***	-0.82***	0.10	3.56***	0.71*	2.72***
	(0.02)	(0.53)	(0.80)	(0.70)	(0.77)	(0.02)	(0.38)	(0.71)	(0.40)	(0.73)
$\ln(POP)_{dt}$	-0.21***	-1.65***	-0.54	-1.29**	0.06	-0.12***	-0.28	-0.38	-1.08***	-0.28
	(0.02)	(0.60)	(0.73)	(0.60)	(0.88)	(0.02)	(0.41)	(0.57)	(0.41)	(0.69)
$\ln(DIST)_{od}$	-0.70***	-1.44***	-0.92***			-0.67***	-1.29***	-0.79***		
	(0.02)	(0.03)	(0.04)			(0.02)	(0.02)	(0.03)		
$CONTIG_{od}$	0.45***	0.32***	0.17***			0.81***	0.54***	0.19***		
	(0.07)	(0.06)	(0.05)			(0.06)	(0.05)	(0.05)		
$COMLANG_{od}$	1.51***	0.34***	0.02			1.19***	0.47***	0.11*		
	(0.07)	(0.07)	(0.07)			(0.04)	(0.05)	(0.06)		
$COLONY_{od}$	0.77***	0.95***	0.38***			1.08***	1.10***	0.46***		
	(0.08)	(0.07)	(0.06)			(0.06)	(0.06)	(0.05)		
EU_{ot}	-0.14***	0.38***	0.43	0.38***	0.52***	-0.10**	0.30***	0.45	0.32***	0.51***
	(0.05)	(0.12)	(0.34)	(0.11)	(0.18)	(0.04)	(0.11)	(0.32)	(0.09)	(0.16)
EU_{dt}	0.04	0.22**	0.12	0.20***	0.14*	0.17***	0.27***	0.09	0.26***	0.10
	(0.05)	(0.09)	(0.10)	(0.07)	(0.08)	(0.04)	(0.07)	(0.09)	(0.06)	(0.07)
$EURO_{ot}$	0.49***	0.25**	1.42***	0.36***	0.42***	0.47***	0.21*	1.26***	0.32***	0.43***
	(0.05)	(0.12)	(0.33)	(0.11)	(0.12)	(0.04)	(0.12)	(0.32)	(0.10)	(0.10)
$EURO_{dt}$	-0.39***	-0.23**	0.10	-0.21**	0.11	-0.19***	-0.30***	0.09	-0.20***	0.11
	(0.05)	(0.09)	(0.10)	(0.08)	(0.08)	(0.04)	(0.09)	(0.10)	(0.08)	(0.08)
$DEBT_{ot}$	-0.00	0.00	-0.00	0.00	-0.00					
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)					
$DEBT_{dt}$	0.00*	-0.00	-0.00	-0.00	-0.00					
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)					
$BUDGETBALANCE_{ot}$						0.01*	0.01***	0.01	0.01***	0.01*
						(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
$BUDGETBALANCE_{dt}$						0.01*	0.01	0.00	0.01*	0.00
						(0.00)	(0.01)	(0.01)	(0.00)	(0.01)
origin- & destination FEs	NO	YES	YES	YES†	YES†	NO	YES	YES	YES†	YES†
country-pair FEs	NO	NO	NO	YES	YES	NO	NO	NO	YES	YES
N	12,386	12,386	15,985	12,386	15,201	22,206	22,206	30,568	22,206	29,298
R^2	0.57	0.75	0.82	0.38		0.53	0.70	0.82	0.35	
number of country pairs				2,143	1,990				3,701	3,560

All columns include year FEs (not reported), robust standard errors in parentheses, †country pair FEs implicitly control for origin- and destination FEs, *** p<0.01, ** p<0.05, * p<0.1.

Table 2: Bilateral FDI stock panel regressions 2001-2012—investments into the European Union from all countries

time-varying regressor defined as...		debt as a percentage of GDP			budget balance as a percentage of GDP		
		debt level	debt violation	debt violation level	budget level	budget violation	budget violation level
origin	2001	-0.00	-0.09	0.00	0.01	-0.32	-0.27**
		(0.00)	(0.18)	(0.01)	(0.03)	(0.22)	(0.11)
origin	2002	-0.00	-0.13	0.00	0.02	-0.21	-0.15
		(0.00)	(0.17)	(0.01)	(0.03)	(0.16)	(0.13)
origin	2003	-0.00	-0.14	-0.00	0.02	-0.01	-0.03
		(0.00)	(0.14)	(0.01)	(0.03)	(0.12)	(0.05)
origin	2004	-0.00	-0.14	-0.01	0.03	-0.11	-0.07
		(0.00)	(0.13)	(0.01)	(0.02)	(0.13)	(0.05)
origin	2005	-0.00	-0.10	-0.00	0.02	-0.21*	-0.14**
		(0.00)	(0.12)	(0.01)	(0.02)	(0.11)	(0.06)
origin	2006	-0.00	-0.07	0.00	0.02	-0.21*	-0.16*
		(0.00)	(0.11)	(0.01)	(0.01)	(0.11)	(0.08)
origin	2007	0.00	0.02	0.01	0.02	-0.18	-0.11
		(0.00)	(0.12)	(0.01)	(0.02)	(0.14)	(0.09)
origin	2008	-0.00	-0.01	0.00	0.02	-0.13	-0.06
		(0.00)	(0.12)	(0.01)	(0.01)	(0.12)	(0.05)
origin	2009	-0.00	-0.01	0.00	0.02	-0.13	-0.02
		(0.00)	(0.12)	(0.01)	(0.01)	(0.11)	(0.02)
origin	2010	-0.00	0.01	0.00	0.01	-0.11	-0.00
		(0.00)	(0.12)	(0.00)	(0.01)	(0.10)	(0.01)
origin	2011	0.00	0.01	0.00	0.01	-0.05	-0.02
		(0.00)	(0.13)	(0.00)	(0.01)	(0.11)	(0.03)
origin	2012	0.00	0.10	0.00	0.01	0.02	-0.02
		(0.00)	(0.13)	(0.00)	(0.02)	(0.11)	(0.03)
destination	2001	-0.01	-0.13	0.00	0.04	-0.03	-0.01
		(0.00)	(0.14)	(0.00)	(0.04)	(0.13)	(0.07)
destination	2002	-0.00	-0.03	-0.00	0.02	0.11	0.02
		(0.00)	(0.13)	(0.01)	(0.06)	(0.12)	(0.08)
destination	2003	-0.00	-0.10	-0.00	0.04	-0.02	0.00
		(0.00)	(0.13)	(0.01)	(0.04)	(0.12)	(0.05)
destination	2004	-0.00	-0.01	0.00	0.03	-0.18	-0.04
		(0.00)	(0.12)	(0.01)	(0.03)	(0.11)	(0.03)
destination	2005	-0.00	-0.04	0.00	0.02	-0.10	-0.04
		(0.00)	(0.10)	(0.01)	(0.02)	(0.10)	(0.03)
destination	2006	-0.00	-0.04	0.00	0.01	-0.04	-0.02
		(0.00)	(0.10)	(0.01)	(0.02)	(0.10)	(0.03)
destination	2007	0.00	0.03	0.01	0.00	-0.08	-0.03
		(0.00)	(0.11)	(0.01)	(0.02)	(0.10)	(0.05)
destination	2008	0.00	0.05	0.01	0.02	-0.03	-0.04
		(0.00)	(0.12)	(0.01)	(0.02)	(0.12)	(0.04)
destination	2009	0.00	0.03	0.00	0.01	-0.07	-0.00
		(0.00)	(0.12)	(0.01)	(0.01)	(0.11)	(0.02)
destination	2010	0.00	0.06	0.00	0.00	-0.06	-0.00
		(0.00)	(0.11)	(0.00)	(0.01)	(0.13)	(0.01)
destination	2011	0.00	0.01	0.00	0.00	-0.02	-0.00
		(0.00)	(0.12)	(0.00)	(0.02)	(0.10)	(0.03)
destination	2012	0.00	-0.00	0.00	-0.01	-0.11	0.02
		(0.00)	(0.12)	(0.00)	(0.02)	(0.11)	(0.03)

All regressions are estimated with FDI_{od} as dependent variable using PPML including year FEs, origin and destination FEs and standard gravity regressors (not reported) as used in Table 1. Coefficients from interaction term between a year indicator and the according debt and budget balance variable as indicated by the column headings and as explained in the main text. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Bilateral FDI stock panel regressions 2001-2012—investments into the European Union from European Union countries

time-varying regressor defined as...		debt as a percentage of GDP			budget balance as a percentage of GDP		
		debt level	debt violation	debt violation level	budget level	budget violation	budget violation level
origin	2001	-0.00	-0.22	-0.00	0.01	0.06	-0.19*
		(0.00)	(0.16)	(0.01)	(0.03)	(0.18)	(0.10)
origin	2002	-0.00	-0.02	-0.00	0.01	-0.03	0.00
		(0.00)	(0.13)	(0.01)	(0.03)	(0.10)	(0.07)
origin	2003	-0.00	0.02	-0.01	0.01	0.02	0.00
		(0.00)	(0.11)	(0.01)	(0.03)	(0.10)	(0.05)
origin	2004	-0.00	-0.01	-0.01	0.02	-0.01	-0.05
		(0.00)	(0.11)	(0.01)	(0.02)	(0.10)	(0.04)
origin	2005	-0.00	-0.02	-0.01	0.01	-0.04	-0.06
		(0.00)	(0.11)	(0.01)	(0.02)	(0.10)	(0.05)
origin	2006	-0.00	0.04	-0.00	0.01	-0.02	-0.04
		(0.00)	(0.10)	(0.01)	(0.02)	(0.09)	(0.06)
origin	2007	-0.00	0.10	0.00	0.01	-0.05	-0.02
		(0.00)	(0.10)	(0.01)	(0.02)	(0.10)	(0.09)
origin	2008	-0.00	0.07	0.00	0.01	0.04	-0.01
		(0.00)	(0.11)	(0.01)	(0.02)	(0.10)	(0.04)
origin	2009	-0.00	0.04	0.00	0.01	-0.02	-0.01
		(0.00)	(0.11)	(0.00)	(0.01)	(0.10)	(0.01)
origin	2010	-0.00	0.02	-0.00	0.01	0.01	-0.01
		(0.00)	(0.11)	(0.00)	(0.01)	(0.10)	(0.01)
origin	2011	-0.00	0.11	0.00	0.00	0.09	-0.02
		(0.00)	(0.12)	(0.00)	(0.01)	(0.10)	(0.02)
origin	2012	0.00	0.18	0.00	-0.00	0.13	-0.02
		(0.00)	(0.12)	(0.00)	(0.01)	(0.10)	(0.02)
destination	2001	-0.00	0.03	0.00	0.00	-0.13	-0.02
		(0.00)	(0.12)	(0.00)	(0.02)	(0.11)	(0.06)
destination	2002	-0.00	0.01	0.00	-0.02	0.17	0.06
		(0.00)	(0.10)	(0.00)	(0.02)	(0.10)	(0.04)
destination	2003	-0.00	-0.01	0.00	0.00	0.02	0.02
		(0.00)	(0.10)	(0.00)	(0.02)	(0.10)	(0.04)
destination	2004	0.00	0.04	0.00	0.00	-0.10	-0.01
		(0.00)	(0.09)	(0.00)	(0.02)	(0.10)	(0.03)
destination	2005	-0.00	0.00	0.00	-0.00	-0.06	-0.01
		(0.00)	(0.09)	(0.00)	(0.01)	(0.10)	(0.04)
destination	2006	-0.00	0.01	0.00	-0.01	-0.02	0.00
		(0.00)	(0.08)	(0.00)	(0.01)	(0.09)	(0.03)
destination	2007	0.00	0.07	0.01	-0.00	-0.11	-0.03
		(0.00)	(0.08)	(0.01)	(0.01)	(0.09)	(0.05)
destination	2008	0.00	0.07	0.00	-0.01	-0.01	-0.00
		(0.00)	(0.10)	(0.01)	(0.01)	(0.10)	(0.03)
destination	2009	-0.00	-0.04	0.00	0.00	-0.09	-0.01
		(0.00)	(0.10)	(0.01)	(0.01)	(0.10)	(0.01)
destination	2010	-0.00	-0.06	0.00	0.00	-0.16	-0.00
		(0.00)	(0.11)	(0.00)	(0.01)	(0.11)	(0.01)
destination	2011	0.00	-0.05	0.00	-0.01	-0.06	0.01
		(0.00)	(0.11)	(0.00)	(0.01)	(0.10)	(0.02)
destination	2012	0.00	-0.03	0.00	-0.01	-0.10	0.01
		(0.00)	(0.10)	(0.00)	(0.01)	(0.10)	(0.02)

All regressions are estimated with FDI_{od} as dependent variable using PPML including year FEs, origin and destination FEs and standard gravity regressors (not reported) as used in Table 1. Coefficients from interaction term between a year indicator and the according debt and budget balance variable as indicated by the column headings and as explained in the main text. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

3 The *indirect* effect of fiscal discipline on FDI stocks

It seems as if neither short-run nor long-run fiscal discipline affects bilateral FDI stocks across countries, neither for the whole world sample nor for investments into EU countries from across the world, nor for investments within EU countries. This is surprising given the several theoretical mechanisms that imply a correlation as well as the prominence public debt and budget deficit concerns play in the policy arena.

At the same time, it seems that unobserved factors which drive FDI indeed are correlated across EU27 countries who are Maastricht debt or deficit compliers/non-compliers (see Alamá-Sabater et al., 2016b). This implies that the level of debt or deficit may not influence decisions of investors directly but indirectly: European investors do seem to group countries into the Maastricht complier/non-complier groups in the sense that when they observe a signal to change their investment behavior in one country, they take this as a signal to also change their investment behavior in similar markets, i.e., markets with similar fiscal discipline. We call this the *indirect* effect of fiscal discipline on FDI.

3.1 Spatial econometric origin-destination model for FDI stocks: intuition

Alamá-Sabater et al. (2016b) use a spatial econometric model to document that FDI is correlated across countries which share a common border (geography channel) as well as between countries with similar public debt levels (public debt channel).[9] Specifically, they include spatial lags of the dependent

[9]The interdependence of FDI between host countries using spatial econometrics has also been analysed by Baltagi et al. (2007), Blonigen et al. (2007), Baltagi et al. (2008), Chou et al. (2011), Blanco (2012), Leibrecht and Riedl (2014) and Alamá-Sabater et al. (2016a). In all these studies, interdependence between FDI host or source countries is analyzed considering geographic proximity, not fiscal discipline. In the finance literature, spatial econometrics has been barely applied. Two notable exceptions are Asgharian et al. (2013) and Tam (2014) who rely on a spatial approach to analyze how different linkages between countries affect stock market co-movements.

variable to document the geographic cross-country correlation and the correlation between Maastricht compliers and between Maastricht non-compliers. They interpret their findings as evidence that investors do group countries into the two groups of Maastricht compliers versus non-compliers in terms of the public debt criterion.

Two natural questions arise from their analysis: 1.) Does this type of interdependence also exist between countries that violate the other heavily discussed Maastricht criterion, namely having a budget deficit larger than 3 percent? And, 2.) has this interdependence of FDI increased during the financial and public debt crises?

To investigate whether this type of spatial dependence has increased during the recent financial crises, we estimate a spatial econometric origin-destination (OD) model for every year in our sample and plot the estimated parameters of the included spatial lags. This framework uses several spatial lags of the dependent variable to take into account the effect of both observed and unobserved factors that are correlated across both complying and non-complying countries.

As spatial econometric OD models rely on "square" data sets, i.e., one needs bilateral FDI stocks between all N countries within the sample, i.e., N^2 observations (including the investments of countries in themselves), we focus on the EU27 member countries where we observe FDI stocks across the whole sample period.

One could expect that while geographical FDI interdependencies were more important in the pre-crisis period, the channel of fiscal discipline has increased in importance for FDI interdependencies in the crisis period.[10] Therefore, we hypothesize that before the financial crisis, geographical proximity was a more important channel than fiscal discipline to (indirectly) determine investments across EU members. However, after the crisis, fiscal discipline might have increased in importance as a channel of FDI interdependencies.

Alamá-Sabater et al. (2016b) construct a spatial weight matrix that in-

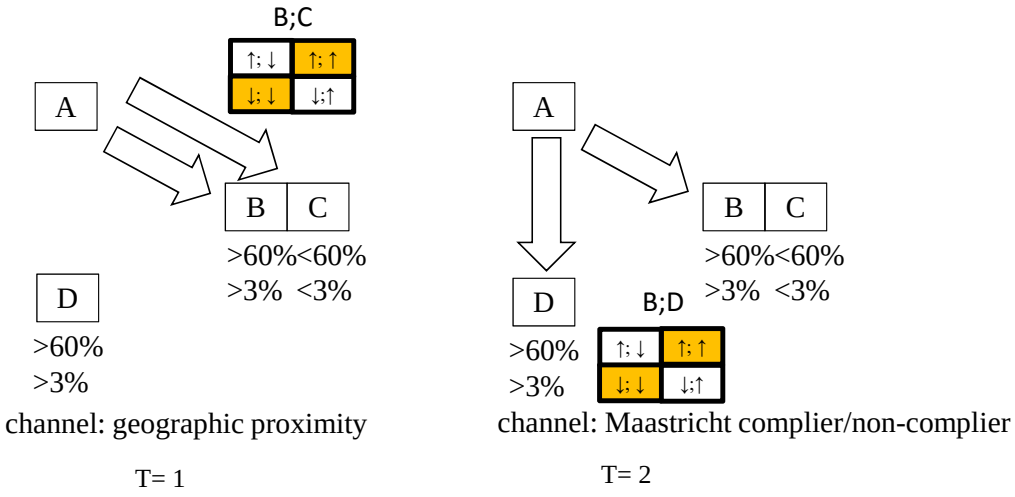
[10]Note that Cronin et al. (2016) analyze co-movements in European sovereign bond markets and highlight the importance of distinguishing between periods. Blasques et al. (2016) find that European sovereign credit default swap spreads changes exhibit a strong, time-varying degree of spatial dependence.

dicates whether two countries o and d are both Maastricht compliers or non-compliers in terms of the public debt criterion for a cross-section of countries. We therefore construct a similar weighting matrix. However, we want to go beyond their approach and also consider another weighting matrix that takes into account whether two countries are both Maastricht compliers or non-compliers in terms of the *budget deficit* criterion. In addition, we also want to consider origin-dependence, i.e., the potential interdependence of *outward* FDI, and allow for correlation between FDI stocks *from* countries with similar debt (or deficit) characteristics. As explained above, Eaton (1987) may rationalize effects centering on the origin countries of FDI. Also, origin- interdependencies have been shown to be important for geographically close countries, see Blonigen et al. (2005). Finally, as explained above, we want to study whether this dependence is time-varying.

Before we explain the formal model, we will introduce a simple example to illustrate the potential dynamics of the indirect effect of both geography and fiscal discipline on FDI stocks across destination countries, so-called destination-based dependence of FDI, i.e., interdependence between investments into neighbors of FDI destination countries (see Figure 3). Consider an investor from country A that invests in country B. B shares a common border with C but not with D. B and D both have public debt-to-GDP ratios above 60 percent and deficit-to-GDP ratios above 3 percent and thus are in violation of the Maastricht convergence criteria, while C is below these levels. According to our expectations, if a negative shock occurs in country B which leads the investor from A to reduce her investments in B in the pre-crisis period (T=1), this will lead the investor to reduce her investments in the contiguous country C but not in D, as only geography matters. However, in the crisis period (T=2), fiscal discipline becomes a relevant channel for FDI interdependencies, and she will reduce her investments in D but not in C, as she considers B and D to share characteristics that are important for her investment returns.

Second, let us consider so-called origin-based dependence of FDI (see Figure 4), i.e., interdependence between investments from neighbors of FDI origin countries. Specifically, let us again consider investments into country

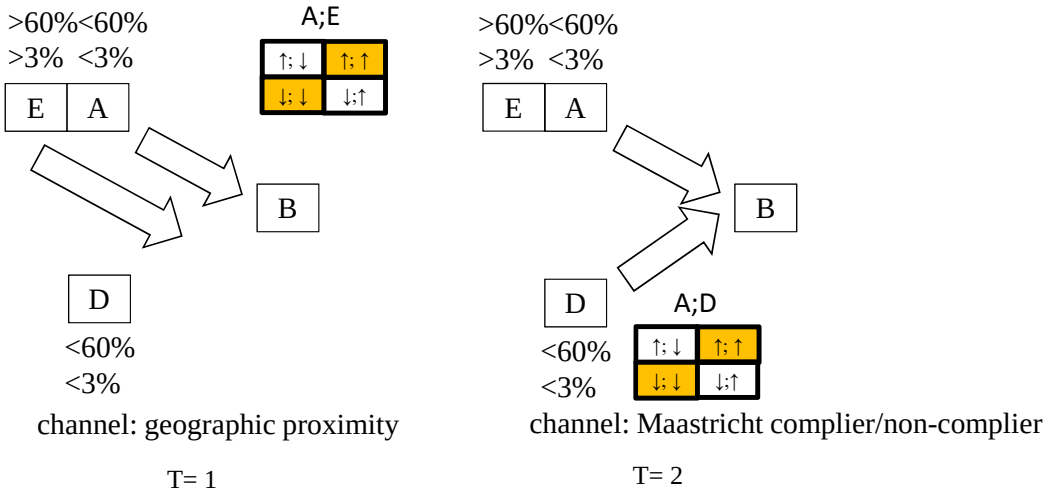
Figure 3: Illustration of the two channels for interdependence between FDI destination countries



B. A shares a common border with E but not with D. However, D presents similar fiscal discipline as A. According to our expectations, if a positive shock in country A leads the investor from A to increase her investments in B, investments from the contiguous country E might also increase. This channel would be the predominant one in the pre-crisis period (T=1). In the crisis period (T=2), we expect that investors in countries with similar fiscal discipline increase their investments in B when investments from A to B increase.

Orange cells in the two figures represent the expected outcome. According to Figure 3, in the pre-crisis period (T=1), an increase (decrease) of investments from A to B correlates with the increase (decrease) of investments from A to the geographical neighbor C. In the crisis period (T=2), an increase (decrease) of investments from A to B correlates with the increase (decrease) of investments from A to the country with similar Maastricht compliance (D). Similarly, according to Figure 4, in the pre-crisis period (T=1), an increase (decrease) of investments from A to B correlates with the increase (decrease) of investments from E (the geographical neighbor of A) to B. In the crisis period (T=2), an increase (decrease) of investments from A to B correlates with the increase (decrease) of investments from D (the country with similar

Figure 4: Illustration of the two channels for interdependence between FDI origin countries



Maastricht compliance than A) to B.

3.2 Spatial econometric origin-destination model for FDI stocks: the formal model

Let us now translate these different channels of interdependence between FDI stocks into our formal spatial econometric OD model. For this, we have to first define the used spatial weighting matrices that indicate the different channels.

We will use three neighborhood definitions: 1.) one based on sharing a common border (geographic proximity channel), 2.) one that defines countries to be neighbors when they exhibit similar short-run fiscal discipline (Maastricht compliers/non-compliers in terms of the budget balance, i.e., deficit lower/higher than 3 percent) and 3.) one that defines countries to be neighbors when they exhibit similar long-run fiscal discipline (Maastricht compliers/non-compliers in terms of the debt criterion, i.e., debt-to-GDP ratio lower/higher than 60 percent). Note that whereas the geographic neighborhood criterion is time-invariant, the fiscal discipline measures do vary over time.

Following LeSage and Pace (2008), we construct three amplified weighting matrices that measure the correlation between FDI stocks between neighboring origin countries (origin-based dependence), the correlation between FDI stocks between neighboring destination countries (destination-based dependence) and between neighbors of both origin and destination countries (OD based dependence).[11] We specify the spatial weighting matrices $\mathbf{W}_d$ (destination-based dependence), $\mathbf{W}_o$ (origin-based dependence) and $\mathbf{W}_w$ (OD-based dependence) for the geography criterion. To construct these matrices, we need a spatial contiguity matrix $\tilde{\mathbf{W}}$ with dimensions $n \times n$, where n is the number of countries. We define its typical entry in row i and column j, $\tilde{w}_{ij}$, as follows:

$$\tilde{w}_{ij} = \begin{cases} 1 & \text{if } i \text{ and } j \text{ share a common border} \\ 0 & \text{if } i \text{ and } j \text{ do not share a common border or } i = j. \end{cases} \tag{2}$$

Regarding fiscal discipline, we use $\mathbf{D}_d$, $\mathbf{D}_o$ and $\mathbf{D}_w$ for the debt-to-GDP ratio criterion and $\mathbf{B}_d$, $\mathbf{B}_o$ and $\mathbf{B}_w$ for the budget deficit-to-GDP ratio criterion. For this, we introduce both a spatial debt neighborhood matrix $\tilde{\mathbf{D}}$ and a spatial budget deficit neighborhood matrix $\tilde{\mathbf{B}}$ with dimensions $n \times n$, where n is the number of countries. For the case of public debt, we define its typical entry in row i and column j, $\tilde{D}_{ij}$, as follows:

$$\tilde{d}_{ij} = \begin{cases} 1 & \text{if } i \text{ and } j \text{ are both above (or both below) the 60 percent of the debt-to-GDP ratio} \\ 0 & \text{if } i \text{ and } j \text{ do not share similarities in terms of debt-to-GDP ratio or } i = j. \end{cases} \tag{3}$$

Similarly, for the case of the budget balance, we define its typical entry in row i and column j, $\tilde{B}_{ij}$, as follows:

$$\tilde{b}_{ij} = \begin{cases} 1 & \text{if } i \text{ and } j \text{ are both above (or both below) the 3 percent of the deficit-to-GDP ratio} \\ 0 & \text{if } i \text{ and } j \text{ do not share similarities in terms of deficit-to-GDP ratio or } i = j. \end{cases} \tag{4}$$

As $\mathbf{W}$, $\mathbf{D}$ and $\mathbf{B}$ will be used to measure the FDI interdependencies across countries, the main diagonal of $\tilde{\mathbf{W}}$, $\tilde{\mathbf{D}}$ and $\tilde{\mathbf{B}}$ is set to 0, as a country does not exert an influence on itself. As is common in the spatial econometrics litera-

[11] An excellent introduction to spatial econometric origin-destination models can also be found in chapter 8 of LeSage and Pace (2009).

ture, we use row-normalized matrices. The necessary steps to construct the final amplified matrices and the spatial autoregressive vectors are described in Appendix B.

As pointed out above, we can distinguish between origin-based, destination-based and OD-based dependence for each of the three dimensions of neighborhood. Hence, we will consider three separate variants of our spatial regression model (see cases 1 to 3 in the following equation):

$$\begin{aligned}
\ln \mathbf{FDI} \;=\; & \beta_0 + \beta_1 \ln \mathbf{GDP}_d + \beta_2 \ln \left(\mathbf{GDP/POP}\right)_d + \\
& \beta_3 \ln \mathbf{GDP}_o + \beta_4 \ln(\mathbf{GDP/POP})_o + \\
& \beta_5 \ln \mathbf{DIST} + \beta_6 \mathbf{CONTIG} + \beta_7 \mathbf{COMLANG} + \\
& \beta_8 \mathbf{COLONY} + \beta_9 \mathbf{EU}_o + \beta_{10} \mathbf{EU}_d + \\
& \beta_{11} \mathbf{EURO}_o + \beta_{12} \mathbf{EURO}_d + \\
& \left\{ \begin{array}{ll}
\text{(case 1:)} & \rho_o^W \mathbf{W_o} \ln \mathbf{FDI} + \rho_d^W \mathbf{W_d} \ln \mathbf{FDI} + \rho_w^W \mathbf{W_w} \ln \mathbf{FDI} \\
\text{(case 2:)} & \rho_o^D \mathbf{D_o} \ln \mathbf{FDI} + \rho_d^D \mathbf{D_d} \ln \mathbf{FDI} + \rho_w^D \mathbf{D_w} \ln \mathbf{FDI} \\
\text{(case 3:)} & \rho_o^B \mathbf{B_o} \ln \mathbf{FDI} + \rho_d^B \mathbf{B_d} \ln \mathbf{FDI} + \rho_w^B \mathbf{B_w} \ln \mathbf{FDI}
\end{array} \right\} \\
& + \mathbf{e} \qquad (5)
\end{aligned}$$

Note that we use an origin-centric data matrix notation for Equation (5).[12] For our estimations, we use a Bayesian Markov Chain Monte Carlo (MCMC) approach following LeSage and Thomas-Agnan (2015) and estimate the spatial interaction model given in Equation (5) separately for every year and every neighborhood dimension (cases 1 to 3) in order to analyze the evolution of the different channels of interdependence over time.[13] Note that the spatial lags would be perfectly collinear with the origin- and destination fixed effects we included in the panel gravity models from Section 2. We therefore omit these effects for the spatial econometric model. If the financial and public debt crises have increased the interdependencies between foreign direct investments due to spillover effects across markets, our estimations

[12] See LeSage and Pace (2008) for an introduction to the notation.

[13] We generate 6000 draws from the Markov chain and throw away the first 3000 draws for burn-in.

will pick this up.[14]

3.3 Data

In addition to the data used for our panel regressions, the spatial OD model also needs observations for the investment of origin country o in destination country $d = o$, i.e., domestic investment in itself, and so for all countries (and years) in the data set. Obviously, UNCTAD data on *foreign* direct investment do not contain information about the level of domestic investments. Therefore, we follow the approach from Alamá-Sabater et al. (2016a) and construct our measure of domestic investment by subtracting the sum of foreign direct investment stocks from all source countries different than o, i.e., $FDI_{oo} = CAPITAL_o - \sum_{o,o \neq d} FDI_{od}$ from a measure of country o's capital stock, $CAPITAL_o$. We use capital stock data from the Penn World Tables 8.1.[15] As the last year available of the Penn World Tables 8.1 is 2011, we can only consider the period from 2001 to 2011 in our spatial econometric analysis.

3.4 Results

Does fiscal discipline gain importance for FDI interdependencies during the financial and public debt crises? And does the importance of geography for FDI interdependencies diminish during these periods?

We report the time series of the three estimated coefficients for origin-, destination- and OD-based dependence from 2001 to 2011 in Figures 5 to 7. Figure 5 shows the evolution of interdependencies using the geographic channel weighting matrices, i.e., case (1) in Equation (5). Figure 6 shows the evolution using the debt neighborhood criterion, i.e., case (2) in Equation (5) and Figure 7 shows the evolution using the budget balance neighborhood criterion, i.e., case (3) in Equation (5). Note that we do not report the time

[14] We do not take a stance on whether these measured interdependencies should be called "contagion", see Forbes and Rigobon (2002) for a lucid discussion of this topic.

[15] We use *ck*, the capital stock in current million US$ (PPP). For an overview of the Penn World Tables and their capital stock measures, see Feenstra et al. (2013), Feenstra et al. (2015a), Feenstra et al. (2015b) and Inklaar and Timmer (2013).

evolution of the other included regressors for brevity and only focus on the evolution of the spatial dependence parameters.

As can be seen in panel (a) of Figure 5, we find significant effects for origin-based dependence between FDI stocks from geographically close FDI origin countries. This implies that when FDI stocks in a destination country from a particular origin country increase, so will the FDI stocks from origin countries that share a common border with the origin country. As the coefficients of the spatial lags are bounded between -1 and 1, we can directly interpret their size and sign as the strength and direction of the dependence. While we find an increase in the level of the dependence after 2004, the confidence intervals for the pre-crisis and crisis years overlap, so that we could not reject the hypothesis that geographic origin dependence was stable at, e.g., 0.25 throughout the whole sample period. Turning to panel (b), we also find significant positive destination-based dependence which is stronger than the origin-based dependence. This implies that when FDI stocks in a destination country from a particular origin country increase, they will also increase in countries which share a common border with the destination country. As with origin-based geographic dependence, we cannot rule out the possibility that destination-based dependence has remained constant at, e.g., 0.4 throughout the whole period. We do observe a somewhat stronger decline of origin-destination-based dependence, see panel (c). While it is positive and significant until 2006, i.e., there is significant evidence that FDI stocks correlate between the neighbors of both origin and destination countries, this significance is lost beginning in 2007 as we find that the confidence intervals increase after 2006. This may hint at an increase in uncertainty for the investment decisions of investors, which may well be due to the ensuing financial and then public debt crisis in the EU. Also note that geographic spatial dependence of FDI is not a given, as Blanco (2012) does not find spatial autocorrelation of FDI across Latin American countries.

How does this geographic dependence compare to dependence due to fiscal discipline? In Figure 6, we show the evolution of dependence of FDI stocks when using the debt criterion as our neighborhood criterion. As can be seen in panel (a), origin-based dependence between FDI stocks in a par-

ticular country and stocks from origin countries that share the same status as Maastricht debt compliers is found to be positive and significant. Interestingly, the estimated coefficients indicate roughly the same level of dependence as for the geographic dependence channel. Also, dependence seems to stay constant over time and does not significantly increase during the crisis years. In panel (b), we also find significant effects of destination based dependence according to the debt criterion. And again, we do not find any significant increase during the crisis years. The level of dependence, however, is higher than for the debt channel. We find a larger difference in panel (c) concerning OD-based dependence. Whereas this type of dependence was significant for the pre-crisis years using the geographic criterion, we do not find any significant effect of OD-based dependence using the debt criterion.

Let us now turn to Figure 7 which considers our last criterion of neighborhood, i.e., interdependence between countries which are similar in terms of their status as compliers or non-compliers concerning the deficit criterion. We again find significant and positive origin-based dependence, as can be seen in panel (a). Interestingly, uncertainty seems to increase in the crisis years, as can be seen by the widening of the confidence intervals after 2007. We also find similarly significant levels of destination-based dependence as evidenced by panel (b). Again, the fiscal discipline dependence is larger than the geographic destination-based dependence. Finally, turning to panel (c), we again find no significant effect of OD-based dependence for the deficit channel.

Our results can be compared to the findings of Blasques et al. (2016). They find evidence for time-varying degrees of dependence between credit default swap spreads between European countries with high levels of bilateral debt holdings during the financial crisis. While we do find FDI interdependencies along the two fiscal discipline channels, we do not find much evidence for a time-varying pattern or a clear relationship to the events during the financial crisis. Blasques et al. (2016) treat time-variation in the spatial dependence parameters as evidence for contagion, following Forbes and Rigobon (2002). In this vein, we do find evidence for interdependence between FDI stocks, but no evidence for contagion in FDI. In this sense,

one can see FDI as less prone to "irrational exuberance" than pure portfolio investments in stock markets and other financial markets.

Summing up our findings from both Sections 2 and 3, it seems as if investors do not care that much about fiscal discipline directly, neither of the short-run nor long-run kind, in the sense that there is no *direct* impact of fiscal discipline on the level of FDI. However, we do find evidence for FDI interdependence between countries with similar Maastricht complier status, i.e., evidence for what we labeled the *indirect* effect of fiscal discipline. It does seem that investors do group countries in two separate bins: Maastricht complier and Maastricht non-complier countries. If investors change the level of FDI in one country, this has spillover effects on other countries with the same Maastricht complier status, both in origin and destination countries of FDI. This effect seems stronger than the geography interdependence channel when we compare the size of the estimated spatial correlation coefficients.[16] Therefore, while the sensibleness of arbitrary macroeconomic policy rules like the Maastricht criteria may be debatable as they may ultimately be used for political reasons (see De Grauwe, 2009), it seems as if they do impact investor behavior nonetheless, at least indirectly.[17]

4 Conclusions

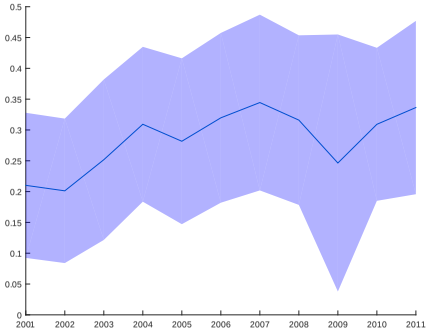
Fiscal discipline has been a core policy concern during the recent financial and subsequent public debt crises and continues to be at the center of many policy debates. Fiscal discipline, i.e., balanced budgets and low levels of public debt are seen as key ingredients to promote growth and investment by some scholars but are put into doubt by others. Surprisingly, the academic literature so far has not considered whether international investors of FDI

[16] One may think that our debt and deficit dependence matrices only pick up the variation in the geographic dimension. But the variation in sharing a common border versus sharing the same Maastricht complier status is decidedly different (see Figure 1 in Alamá-Sabater et al., 2016b and also varies over time (see Figures 1 and 2 in Section 2.3.2 of this manuscript), contrary to the time-constant geography channel.

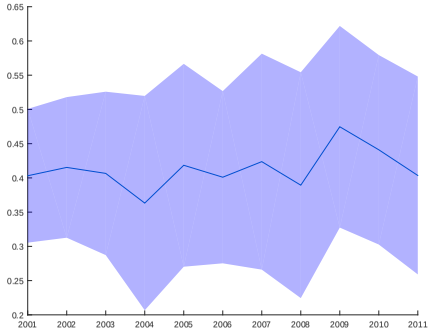
[17] Recent evidence by Pescatori et al. (2014) hints at the fact that instead of the *level* of public debt, the *growth rate* may be more important as a driver of growth prospects.

Figure 5: Evolution of geographic dependence

(a) origin-based dependence



(b) destination-based dependence



(c) OD-based dependence

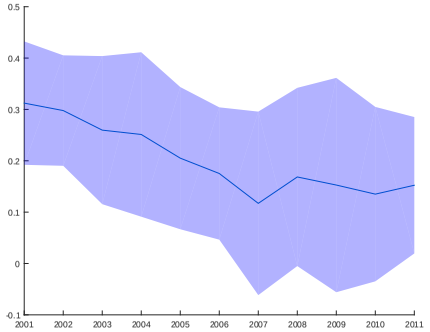
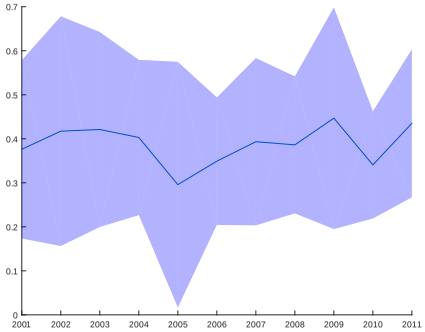
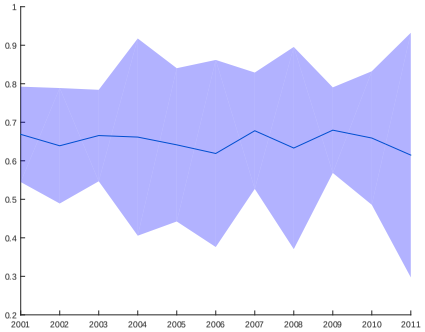


Figure 6: Evolution of debt dependence

(a) origin-based dependence



(b) destination-based dependence



(c) OD-based dependence

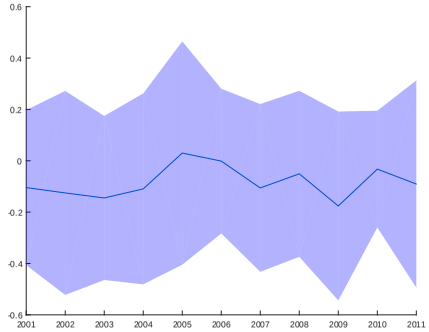
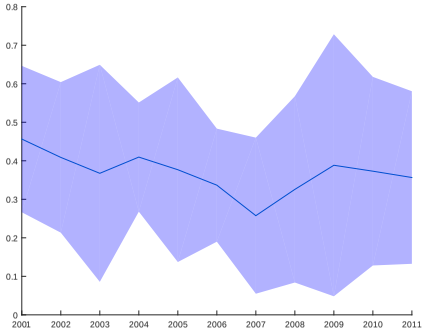
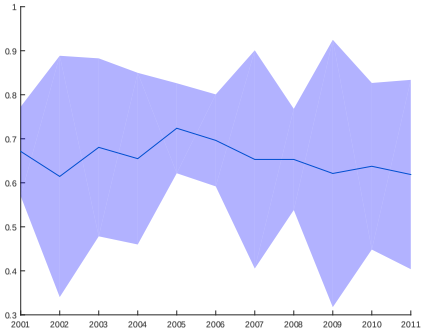


Figure 7: Evolution of deficit dependence

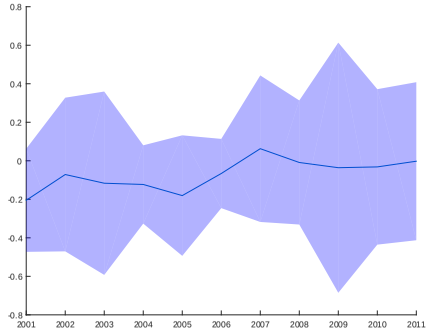
(a) origin-based dependence



(b) destination-based dependence



(c) OD-based dependence



take into account fiscal discipline in their investment decisions.

We investigate whether the level of public debt and the budget balance have a significant impact on bilateral FDI stocks for a large panel of countries. As fiscal discipline is a cornerstone of the Maastricht criteria and the Stability and Growth Pact of the European Union, we also investigate the impact of fiscal discipline for investments into and within EU member countries. Interestingly, we do not find a significant *direct* effect of fiscal discipline on bilateral FDI stocks. We then go on and investigate what we call an *indirect* effect of fiscal discipline on FDI within the EU: we document that investors of FDI discriminate between Maastricht compliers and non-compliers. Using spatial econometric techniques, we show that FDI stocks are correlated across countries with a similar status as a Maastricht complier and non-complier. For example, we find a significant spatial dependence between investments *from* countries that both violate the Maastricht debt or deficit criterion. Similarly, we find spatial dependence between investments *into* these countries. We also show that this interdependence is fairly stable over time and has not increased during the financial and public debt crises. In this sense, we find that FDI does not exhibit the contagion property typical of portfolio investments in the stock market found in the financial contagion literature. This has important implications for the evaluation of both FDI and fiscal policies within the EU and beyond.

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Appendix

A Descriptive statistics

The following table presents summary statistics for the regression sample used in Table 1.

Table A.1: Summary statistics

Variable	Mean	Std. Dev.	N
FDI_{odt}	2126.023	12993.487	50846
$\ln(FDI)_{odt}$	4.54	2.857	34921
$\ln(GDP)_{ot}$	25.65	2.177	67453
$\ln(GDP)_{dt}$	25.114	2.218	67348
$\ln(POP)_{ot}$	16.165	2.245	68553
$\ln(POP)_{dt}$	16.27	1.916	68552
$\ln(DIST)_{od}$	8.356	0.942	65640
$CONTIG_{od}$	0.052	0.221	65700
$COMLANG_{od}$	0.174	0.379	65700
$COLONY_{od}$	0.035	0.183	65700
EU_{ot}	0.329	0.47	68556
EU_{dt}	0.247	0.431	68556
$EURO_{ot}$	0.223	0.416	68556
$EURO_{dt}$	0.15	0.357	68556
$DEBT_{ot}$	55.137	31.222	39378
$DEBT_{dt}$	51.877	30.022	35694
$BUDGETBALANCE_{ot}$	-1.923	4.818	52986
$BUDGETBALANCE_{dt}$	-1.841	4.581	52247

B Constructing the amplified spatial weighting matrices

To construct the spatial weighting matrices, we follow the methodology set out in LeSage and Pace (2008). We use a four country example to illustrate. Table A.2 shows the 4×4 matrix $\tilde{\mathbf{D}}$ for four countries in 2007: the UK, Spain, France and Italy. The corresponding (i, j) element of the matrix takes the

value of 1 when countries i and j are neighbors, i.e., they are both above (or both below) the 60 percent limit of the debt-to-GDP ratio established by the Maastricht criteria, and zero otherwise. In 2007, the UK and Spain present debt-to-GDP ratios equal to 43.5 and 35.5 and hence both comply with the debt criterion (compliers); France and Italy present debt-to-GDP ratios equal to 64.4 and 99.8 and hence violate the criterion (non-compliers). Hence, Spain and the UK are considered neighbors, and also France and Italy are considered neighbors. This example nicely illustrates that $\tilde{\mathbf{D}}$ covers a distinct set of variation than geographic neighborbood.

As is common in spatial econometrics, the diagonal elements of the matrix $\tilde{\mathbf{D}}$ are set to zero. We can then divide each row of $\tilde{\mathbf{D}}$ by its respective row sum to receive the row-stochastic weight matrix $\mathbf{D}$ which is typical for many spatial econometric applications.

Table A.2: Illustration of matrix for similarity in fiscal discipline $\tilde{\mathbf{D}}$

	UK	Spain	France	Italy
UK	0	1	0	0
Spain	1	0	0	0
France	0	0	0	1
Italy	0	0	1	0

Destination-based dependence captures the effect that FDI stocks from one origin country in a destination country may be correlated with the FDI stocks from the origin country in countries which are neighbors to the destination country. This dependence is captured by the spatial lag $\mathbf{D_d}\ln \mathbf{FDI}$.

To construct this spatial lag, let us consider $\mathbf{D}\ln \mathbf{FDI}_1$, which is a vector which contains the average of the FDI stocks from the first country (i.e., the UK) in all neighboring destinations, where neighborhood is defined as having the same status (debt complier/non-complier) as the destination country of investments in 2007. Similarly, we can construct the same spatial lag for all n origin countries and stack the resulting vectors. In matrix notation, this

operation can be represented by the $n^2 \times n^2$ matrix $\mathbf{D}_d$:

$$\mathbf{D}_d = \mathbf{I}_n \otimes \mathbf{D}, \tag{A.1}$$

where $\otimes$ denotes the Kronecker product and $\mathbf{I}_n$ is a $n \times n$ identity matrix.

Origin-based dependence is captured by the spatial lag of the dependent variable for all FDI stocks invested by neighboring countries of the origin country. This spatial lag is represented by $\mathbf{D_o}\ln \mathbf{FDI}$. In our example, foreign direct investment from Spain in France is related to the foreign direct investment in France from countries that have the same status as Spain in terms of Maastricht debt compliance (i.e., the UK). Then, we can define $\mathbf{D}_o$ as follows:

$$\mathbf{D}_o = \mathbf{D} \otimes \mathbf{I}_n. \tag{A.2}$$

Finally, we can construct a measure of spatial origin-to-destination dependence. This sort of FDI interdependence is measured by the spatial lag $\mathbf{D_w}\ln \mathbf{FDI}$, which reflects the spatial correlation between FDI stocks from countries which are neighbors to the origin country to countries which are neighbors of the destination country. We measure this dependence by $\mathbf{D}_w$ in the following way:

$$\mathbf{D}_w = \mathbf{D}_o\mathbf{D}_d = \mathbf{D} \otimes \mathbf{D}. \tag{A.3}$$