The geography of the great rebalancing in intra-euro area bond markets during the sovereign debt crisis[*]

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January 9, 2015

Abstract

During the sovereign debt crisis investors rebalanced out of stressed and into non-stressed euro area countries, thereby contributing to the tensions in euro area financial markets. This paper examines the geographical pattern of this great rebalacning. Specifically, we test whether euro area and non-euro area investors adjusted their holdings of debt securities of euro area stressed and non-stressed countries disproportionately relative to benchmarks derived from a standard gravity model for portfolio choice. We find that non-euro area investors under-invested in stressed euro area countries, but did not over-invest in non-stressed euro area countries. As regards intra-euro area flows, we do not find evidence for a disproportionate slowdown of capital flows from non-stressed into stressed euro area countries. Instead, our results suggest that investors in stressed euro area countries disproportionately shifted capital into debt securities of non-stressed euro area countries. Finally, we find that both non-euro area investors' under-investment in stressed countries and stressed euro area investors' over-investment in non-stressed euro area countries ceased after the announcement of the ECB's OMT programme.

Keywords: Foreign investment, international capital flows, euro area sovereign debt crisis, gravity model.
JEL-Classification: F34, F36, G15.

1 Introduction

The euro area sovereign debt crisis had a marked impact on cross-border investments in euro area debt markets. Heightened concerns about the sustainability of public finances in some euro area countries resulted in a rebalancing out of stressed and into non-stressed euro area countries that contributed to the fragmentation of euro area financial markets. However, little is known about the geographical pattern of debt flows to euro area countries during the sovereign debt crisis. In particular, it has yet to be explored whether the great rebalancing out of stressed and into non-stressed euro area countries has been a mere euro area phenomenon caused by euro area investors, or whether international investors likewise rebalanced their portfolios of euro area debt securities. Understanding the extent to which the great intra-euro area rebalancing, and ultimately the tensions in euro area financial markets, has been a 'domestic' phenomenon has important implications, as the policy measures that would have been most adequate in each case in order to alleviate such excessive volatility are different. On the one hand, if the rebalancing mainly reflected a domestic phenomenon, official flows could offset 'sudden stops' of private capital flows through an increase of Target balances. On the other hand, if foreign investors were the main driver of the observed portfolio adjustments residency-based capital flow management measures might be more effective from a conceptual point of view (see IMF, 2012).

This paper aims to shed light on the geographic patterns of capital flows that were contributing to the tension in euro area financial markets during the sovereign debt crisis. In particular, we build on the literature on cross-border financial investment to compare actual changes in the portfolio allocation of foreign and domestic investors during the sovereign debt crisis to those a standard gravity model for portfolio choice based on informational frictions and transaction costs would predict. Using data from the IMF's Coordinated Portfolio Investment Survey (CPIS) between end-2009 and end-2011, we find that foreign (non-euro area) investors disproportionately reduced their holdings of bond securities of stressed euro area countries; however, foreign investors' under-investment in stressed euro area countries was not accompanied by an over-investment in non-stressed euro area countries' bond markets.[1] Similarly, we do not find evidence for an underinvestment of non-stressed euro area investors in stressed euro area countries. Instead, our results suggest that investors in stressed euro area countries disproportionately shifted capital into debt securities of non-stressed euro area countries. This intra-euro area capital flight is likely to be among the main drivers of the excessive volatility in intra euro area debt flows, the resulting tensions in peripheral debt markets and the fragmentation of euro area financial markets. Finally, we find that the under-investment by foreign investors in stressed euro area countries as well as the capital flight by investors in stressed euro area countries ceased after the announcement of the ECB's Outright Monetary Transactions (OMT) programme.

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[1]Throughout this paper, we use the terms "over" and "under-investment" as synonyms for shifts in a country's portfolio allocation which exceed or fall short of the predictions derived from a gravity model for international portfolio choice.

Our work is related to four strands of the literature. First, our paper is related to the literature on the patterns of cross-border portfolio flows during the global financial crises in 2007/08 (see Fratzscher, 2012; Milesi-Ferretti and Tille, 2011; Broner et al., 2013; Galstyan and Lane, 2013; Ghosh et al., 2014). In contrast to this literature, we focus on cross-border portfolio investment patterns during the euro area sovereign debt crisis in 2010/12. In particular, we build on the gravity-type foundation of international trade in financial assets as put forth by Martin and Rey (2004) and follow the empirical framework of Galstyan and Lane (2013) to study cross-country differences in global investors' adjustments of euro area bond portfolios. While Galstyan and Lane (2013) are concerned with the patterns of global portfolio capital flows during the global financial crisis, we focus on portfolio capital flows involving the euro area during the sovereign debt crisis. Second, our paper is related to the literature studying the effect of Economic and Monetary Union (EMU) on financial integration across countries within the euro area (see Lane, 2006; De Santis and Gérard, 2006; Blank and Buch, 2007; Spiegel, 2009b). While we adopt the same empirical approach, our paper is concerned with examining the nature of financial integration within the euro area and with the rest of the world by distinguishing between stressed and non-stressed euro area countries; moreover, we focus on the time period during the sovereign debt crisis rather than the early period of EMU. Third, our work also relates to the literature which investigates the effectiveness of policy measures taken at the European level and aimed at eliminating the tail risk of a euro area break-up (see Altavilla et al., 2014; De Santis, 2014). While this literature investigates the impact of policy measures on domestic macroeconomic variables such as output, bond yields and inflation, we focus on their possible impact on foreign and domestic portfolio investment in the euro area. Finally, our paper is related to the literature on the determinants of bilateral cross-border capital flows and investment patterns (see Portes and Rey, 2005; Lane and Milesi-Ferretti, 2008; Forbes, 2010; Okawa and van Wincoop, 2012). We build on the gravity approaches developed in these papers in order to analyse the patterns of foreign and domestic investment in euro area debt markets during the sovereign debt crisis.

The rest of the paper is organised as follows. In Section 2, we describe the dataset and report descriptive statistics on the developments of global investors' portfolio adjustments during the sovereign debt crisis and in the post-OMT period. Section 3 presents our empirical model and core results. Robustness checks are discussed in Section 4. Finally, Section 5 concludes.

2   Data

In this paper we examine the extent to which foreign (non-euro area) and domestic (intra-euro area) investment in the euro area has been disproportionate relative to benchmarks derived from a gravity model for international portfolio choice during the euro area sovereign debt crisis. To do so, we would ideally use a panel dataset on bilateral capital flows. In particular, the broad

bilateral dimension is necessary in order to establish a meaningful benchmark of investments which could be compared to the actual data on foreign and domestic investments in the euro area. Unfortunately, such data do not exist for a broad set of investor and destination countries. Therefore, as is standard in the literature we resort to data on bilateral portfolio debt holdings from the IMF's CPIS (see Lane, 2006; De Santis and Gérard, 2006; Lane and Milesi-Ferretti, 2008; Coeurdacier and Martin, 2009; Galstyan and Lane, 2013).[2]

2.1 The CPIS Data

The CPIS dataset provides information on bilateral portfolio investment holdings for around 70 investor and over 200 destination countries. The dataset reports annual (end-December) holdings for the time period 2001-2012 and semiannual data from 2013H1 onwards.[3] Given that the euro area sovereign debt crisis was mainly associated with stress in debt markets, the analysis in this paper is confined to debt securities.[4] A major disadvantage of the CPIS data is that the reported stock positions are not adjusted for valuation effects that arise due to changes in asset prices and exchange rates. Therefore, a change in stocks does not necessarily correspond to a flow. We address this issue in the regression analysis by including destination country fixed effects (see Section 3.1).

In order to analyse the geographical patterns of portfolio debt investments during the sovereign debt crisis based on the CPIS data, we consider the change in holdings between end-2009 and end-2011. In particular, holdings of euro area debt instruments as of end-2009 should not have been affected by the looming euro area crisis yet. And given the restriction to the annual frequency of the CPIS data up to 2012, holdings as of end-2011 should most accurately reflect the cumulated impact of the sovereign debt crisis on foreign and domestic investors' euro area debt holdings; by contrast, end-2012 positions are likely to have already been impacted by the policy measures that were taken at the European and the national level during the second half of 2012, including the launch of the Banking Union and the ECB's announcement of the modalities of OMT. In extensions to our baseline analysis in Section 3.3, we study the geographical patterns of portfolio debt investments after OMT. To do so, we consider the change in holdings between end-2011

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[2]Alternatively, a number of papers have used data on bilateral bank exposures obtained from the Bank for International Settlements (see Blank and Buch, 2007; Kalemli-Ozcan et al., 2010; Coeurdacier and Martin, 2009; Spiegel, 2009a,b).

[3]The CPIS has various limitations (see Lane and Milesi-Ferretti, 2008). First, data for some major economies, including China, are missing. Second, the CPIS only provides information on the proximate destination of foreign portfolio investments, distorting the data for financial centers; for that reason, major financial centres, such as Luxembourg, Switzerland and offshore tax havens, are excluded from the analysis. Third, being based on the residence principle, the CPIS does not account for the possibility that a resident entity may be foreign owned (see also Zucman, 2013). Finally, the CPIS does not distinguish between debt issued by public and private agents, including financial institutions and corporate issuers.

[4]The CPIS also includes information on bilateral equity and short-term money market asset and liability positions. However, equity and money-market holdings might be driven by factors that are different from those that determine debt securities holdings. In addition, available information on money market instruments in the CPIS is considerably sparser across countries than for debt securities.

and mid-2013. The cumulated impact of these measures which restored investor confidence in euro area debt markets should be reflected most accurately by mid-2013 holdings.[5]

2.2 Descriptive Statistics

2.2.1 Developments During the Euro Area Sovereign Debt Crisis

Figures 3 and 4 show major non-euro area and euro area countries' holdings of euro area debt as of end-2009, split by stressed and non-stressed euro area host countries. Two main findings stand out. First, as of end-2009, major non-euro area economies' debt exposures to the euro area were largely concentrated on non-stressed countries, in particular in Germany and France. Second, exposures to stressed countries were not only low relative to investments in non-stressed economies but also in absolute terms. To put the magnitudes of these holdings into perspective, as of end-2009, the combined holdings of the US, the UK and Japan (USD 512 billion) were smaller than French investors' holdings of stressed euro area country debt, which totaled almost USD 750 billion (Figure 4).

Turning to changes in stock positions between end-2009 and end-2011, Figure 5 suggests that foreign investors' holdings of stressed euro area country debt dropped by around USD 138 billion (19%). At the same time, foreign holdings of non-stressed euro area country debt remained broadly unchanged (+2%, or USD 25 billion). In turn, foreign investors' holdings of non-euro area countries' debt increased by almost USD 1 trillion over the two-year period ending in December 2011. Therefore, the descriptive statistics suggest that foreign investors shifted funds into non-euro area countries, rather than noticeably rebalancing across euro area countries during the euro area sovereign debt crisis.

Note that the changes in stock positions displayed in Figure 5 are not adjusted for valuation effects: Changes in stock positions may stem from actual flows as well as from changes in asset prices and exchange rates. Purging these valuation effects from the stock positions would require detailed knowledge about the currency and maturity composition of the holdings, on which data do not exist. However, the evidence for foreign investors not having rebalanced noticeably across stressed and non-stressed euro area countries is unlikely to be driven by valuation effects. As regards movements in bond prices, the valuation effects during the sovereign debt crisis reduced the value of stressed euro area country debt as bond prices generally fell; similarly, valuation effects increased the value of non-stressed country debt as bond prices increased. In turn, valuation effects stemming from changes in the US dollar exchange rate—CPIS data are reported in US dollar for all countries—decreased the value of both stressed and non-stressed

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[5]Importantly, as of mid-2013 global debt holdings should not have been affected much yet by the discussions of the US Fed tapering its asset purchases.

euro area country debt due to the appreciation of the US dollar against the euro;[6] but due to the larger stock of debt liabilities of non-stressed euro area countries, the appreciation of the US dollar reduced the absolute value of the total stock of non-stressed euro area country debt more than that of stressed euro area country debt. Overall, the impact of US dollar appreciation on the valuation of euro area debt liabilities should have been small compared to the valuation effects stemming from bond prices. In particular, between end-2009 and end-2011 the US dollar appreciated by around 9% against the euro. This compares to an increase in bond prices of 22% in, for example, Germany and a decline of 65% in, for example, Greece. Thus, if anything, purging valuation effects from the data would result in an even less pronounced rebalancing by foreign investors in euro area countries' debt markets.

Turning to euro area investors, their holdings of stressed euro area countries' debt plunged by around USD 750 billion, equivalent to almost one third of the initial holdings. Holdings of non-stressed euro area countries' debt, in turn, decreased merely by 6% or USD 180 billion. Moreover, the data suggest that euro area investors generally repatriated foreign investments during the sovereign debt crisis, as indicated by the marked drop in holdings of non-euro area debt.

The role of valuation effects for changes in stock positions of euro area investors is more difficult to assess than for non-euro area investors. First, the rise in bond prices of non-stressed countries' debt implies an underestimation of the actual reduction in euro area investors' holdings of non-stressed countries' debt. Second, the fall in stressed euro area countries' bond prices implies an overestimation of the actual reduction in euro area investors' holdings of stressed countries' debt. Overall, thus, it is hard to assess the extent to which taking into account valuation effects would alter the relative magnitude of the reductions in euro area investors' holdings of stressed and non-stressed countries' debt. The gravity model we use in the next section allows us to address the role of valuation effects and to shed more light on the relative importance of intra-euro area flows.

2.2.2 Developments in the Post-OMT Period

In the post-OMT period, dynamics in global investors' holdings of euro area debt changed markedly relative to the pre-OMT period. In particular, both euro area and foreign investors' stocks of euro area debt bounced back in the 18-months period between end-2011 and end-June 2013, increasing by around USD 150 billion and USD 375 billion, respectively. Two more detailed findings stand out. First, neither non-euro area nor domestic investors' total exposure to stressed euro area countries debt markets continued to decrease notably in the post-OMT period. Second, foreign investors' positions in non-stressed debt markets surged, partly at the

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[6]Euro area liabilities are predominantly denominated in either euro or—to a lesser extent—US dollar. For most euro area countries, the share of foreign currency denominated liabilities that is issued in third currencies is less than 10% (see Lane and Shambaugh, 2010).

expense of debt holdings in major non-euro area economies, including the US, Japan, the UK and Canada.

3   Empirical Results

3.1   A Gravity Model for International Portfolio Debt Investment

While the raw data for changes in holdings are informative, it is difficult to judge whether and which of these flows were abnormal or disproportionate relative to flows that would be predicted by standard determinants of portfolio adjustment. In order to impose more structure on our analysis, we benchmark changes in cross-border bond holdings during the sovereign debt crisis based on a standard gravity model of international portfolio choice (see also Portes and Rey, 2005; Galstyan and Lane, 2013). A gravity equation for trade in financial assets has been derived by Martin and Rey (2004), who put forth a general equilibrium model of asset trade with fully optimizing agents and endogenous market capitalisation.[7] Specifically, we examine the variation in the changes in bilateral portfolio debt holdings between end-2009 and end-2011 across 52 investor[8] and 112 destination countries[9] based on the following model:

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\begin{aligned}
\Delta log(Stock_{ij0911}) = \alpha_i + \alpha_j + \beta_1 log(Stock_{ij09}) + \beta_2 log(Import_{09ij}) + \\
\beta_3 log(Distance_{ij}) + \beta_4 Language_{ij} + \beta_5 Z_{ij} + \epsilon_{ij},
\end{aligned}
\tag{1}
$$

where $\Delta log(Stock_{ij0911})$ is the log-change of country i's holdings of country j's long-term debt between end-2009 and end-2011, α_i and α_j are investor and destination country fixed effects, $log(Stock_{ij09})$ is country j's debt held by country i at end-2009, $log(Import_{ij09})$ is the value

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[7]Papers studying the determinants of international portfolio holdings include Lane (2006), Blank and Buch (2007) Kalemli-Ozcan et al. (2010), Lane and Milesi-Ferretti (2008), Coeurdacier and Martin (2009), as well as Spiegel (2009a,b).

[8]All euro area investor countries are included, with the exception of Malta due to market specifics and Luxembourg due to its role as a financial center. Non-euro area investor countries include: Argentina, Australia, Brazil, Bulgaria, Canada, Chile, Colombia, Czech Republic, Denmark, Hungary, Iceland, India, Indonesia, Israel, Japan, Kazakhstan, Republic of Korea, Kuwait, Lithuania, Malaysia, Mexico, New Zealand, Norway, Pakistan, Philippines, Poland, Russian Federation, South Africa, Sweden, Thailand, Turkey, Ukraine, the UK, the US, Uruguay and Venezuela.

[9]All euro area destination countries are included, with the exception of Malta and Luxembourg. Non-euro area destination countries include: Albania, Algeria, Angola, Argentina, Armenia, Australia, Bangladesh, Belarus, Bolivia, Bosnia and Herzegovina,Botswana, Brazil, Brunei Darussalam, Bulgaria, Cabo Verde, Cameroon, Canada, Central African Republic, Chile, China, P.R. Mainland, Colombia, Congo, Republic of, Cote d'Ivoire, Croatia, Czech Republic, Denmark, Dominica, Egypt, El Salvador, Gabon, Georgia, Ghana, Guatemala, Guinea, Guinea-Bissau, Guyana, Hungary, Iceland, India, Indonesia, Iran, Islamic Republic of, Israel, Japan, Jordan, Kazakhstan, Kenya, Korea, Republic of, Kuwait, Kyrgyz Republic, Lao People's Democratic Republic, Liberia , Macedonia, FYR, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mexico, Mongolia, Morocco, Mozambique, Namibia, New Zealand, Niger, Norway, Oman, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Qatar, Russian Federation, Rwanda, Saudi Arabia, South Africa, Sri Lanka, Sudan, Swaziland, Sweden, Tanzania, Thailand, Turkey, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Venezuela, Republica Bolivariana de, Vietnam, Yemen, Republic of, Zambia, Zimbabwe.

of bilateral imports of country i from country j in 2009, and $Distance_{ij}$ and $Language_{ij}$ are standard gravity variables that control for the distance between countries i and j and whether they share a common language.[10,11] Finally, Z_{ij} is a vector of dummies which equal unity for specific country pairs. In line with the existing literature, the latter are included in order to test whether changes in portfolio debt holdings between specific country groups during the euro area sovereign debt crisis were disproportionately small relative to what gravity variables that reflect informational frictions and transportation costs would predict.

The investor and destination country fixed effects α_i and α_j capture common portfolio dynamics (see Galstyan and Lane, 2013) and multilateral resistance terms (see Okawa and van Wincoop, 2012). Specifically, α_i controls for uniform shifts in investor country i's holdings of foreign debt assets, thereby capturing exogenous changes in a country's net foreign asset position vis-à-vis all destination countries. By comparison, α_j controls for uniform shifts in the destination country j's foreign debt liability position, thereby capturing valuation effects that arise due to exchange rate and asset price movements.[12,13]

3.2 Portfolio Allocations During the Euro Area Sovereign Debt Crisis

The regression results for the specification in Equation (1) are reported in Table 1.[14] The initial stock of bilateral debt holdings as well as the standard gravity variables are statistically significant and have the expected sign in all regressions reported in Table 1. In particular, the results suggest that global investors' adjustment of portfolio holdings was negatively correlated with the level of initial bilateral holdings, and positively correlated with the initial level of imports. The former result suggests, for example, that global investors increased their exposure in countries in which they had been under-invested.[15] Moreover, in line with standard gravity considerations, investors have over-invested in countries that are closer in distance and that share the same official language.

The regression in column (1) of Table 1 also tests whether foreign investors have disproportionately adjusted their holdings of euro area bond securities during the sovereign debt crisis relative

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[10]The model derived in Martin and Rey (2004) suggests to include investor and destination country characteristics such as market capitalisation and consumption as explanatory variables in the regression. However, notice that in our specification all country-specific variables are absorbed into the investor and host-country fixed effects.

[11]For the empirical analysis of portfolio adjustments in the post-OMT period the notation for the corresponding time period changes accordingly to end-2011 and mid-2013.

[12]Specifically, α_j captures exchange rate effects because CPIS data are reported in US dollar for all countries.

[13]In order to exploit as much cross-sectional information in the CPIS data as possible when purging the valuation effects, we consider a two-stage approach based on the Frisch-Waugh-Lovell theorem. Specifically, in a first-stage regression $\Delta log(Stock_{ij0911})$ is regressed on α_i and α_j for as many observations as possible. The residuals from this and analogous regressions for the right-hand side variables in Equation (1) are then used in a second-stage regression as dependent and explanatory variables. The number of observations in regression of $\Delta log(Stock_{ij0911})$ on α_i and α_j may be larger than those in all following regressions, namely in case some data for the explanatory variables are missing.

[14]All regressions are estimated using GLS. Robust standard errors are reported.

[15]This finding has also been put forth by Galstyan and Lane (2013) for the period of the global financial crisis.

to the changes in holdings across all bilateral country pairs in the sample, controlling for gravity variables. Specifically, the dummy variable "NonEA to EA" equals unity if the investor country is a non-euro area country and the destination country is a euro area member state; the coefficient estimate is negative and statistically significant, suggesting that between end-2009 and end-2011 foreign investors have under-invested in euro area bond markets: Foreign investors under-invested by 18% in euro area debt securities relative to average investments across all country pairs and controlling for the remaining explanatory variables over this period.[16]

The regression in column (2) of Table 1 tests whether the under-investment by foreigners in euro area bond markets occurred uniformly across stressed and non-stressed euro area countries, or whether a marked under-investment in stressed countries was accompanied by an over-investment in non-stressed euro area countries. The coefficient estimate for the dummy variable "NonEA to Stressed"—which equals unity for non-euro area investor and stressed euro area destination countries—is negative and statistically significant. By contrast, the dummy variable "NonEA to NonStressed"—which equals unity if the investor country is a non-euro area country and the destination country a non-stressed euro area country—is not statistically significant. Thus, the evidence suggests that foreigners only under-invested in stressed euro area countries, and that they did not rebalance by over-investing in non-stressed euro area countries.[17]

As regards intra-euro area flows, we examine—in the vein of Forbes and Warnock (2012) and Merler and Pisani-Ferry (2012)—whether the data supports the hypothesis of an intra-euro area 'sudden stop'—i.e. an under-investment of non-stressed euro area investors in stressed euro area countries; and/or whether there is any evidence for a 'capital flight' by stressed euro area countries' investors into non-stressed euro area countries' bond markets.

The investment strategy of euro area investors is analysed in column (3) of Table 1. The data do not provide evidence for an under-investment of non-stressed euro area countries' investors in stressed euro area countries' debt markets. Relative to their large initial debt holdings in stressed countries, the close trade ties and the relative geographical proximity, non-stressed countries did not disproportionately reduce their portfolio allocation in stressed countries during the sovereign debt crisis. By contrast, the data do provide evidence for a capital flight.[18] Specifically, relative to the predictions from the gravity model stressed euro area countries significantly over-invested in non-stressed countries' bond markets between end-2009 and end-2011. Thus, our results suggest that the capital flight by stressed countries' investors into non-stressed countries' debt markets was significantly and economically important and may thus have been among the main drivers of financial market fragmentation in the euro area during the sovereign debt crisis.

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[16]The calculation is $e^{\beta} - 1$.

[17]Note, that a failure to fully capture valuation effects would make it more likely for us to find an overinvestment by foreign investors into non-stressed euro area countries. Yet, we do not find such evidence.

[18]Note again, that a failure to fully capture valuation effects would make it more likely to find evidence for an under-investment by non-euro area investors in stressed euro area countries. Yet, we can we reject the null hypothesis of a 'sudden stop' by non-euro area investors.

Notice that the results in column (3) in Table 1 do not provide support for the the so-called intermediation channel. According to this hypothesis proposed by Hale and Obstfeld (2014), a large part of foreign investments in stressed euro area countries' capital markets prior to the sovereign debt crisis had been intermediated through non-stressed countries. If this channel was empirically relevant in the CPIS data, the coefficient estimates for the dummy variables "NonEA to NonStressed" and "Non-Stressed to Stressed" in column (3) in Table 1 would be negative and statistically significant.

3.3 Portfolio Allocations After OMT

Existing evidence suggests that the policy measures taken by the ECB during the sovereign debt crisis—in particular the announcement of its OMT programme—contributed to alleviating euro area financial market fragmentation and effectively eliminated the tail risk of a euro area break-up (Altavilla et al., 2014; De Santis, 2014). Against this background, column (4) in Table 1 reports results from regressions for changes in debt holdings for the time period after the announcement of OMT.[19] Specifically, the regression sheds light on whether the under-investment by foreign investors in euro area stressed countries' debt markets and the capital flight by stressed euro area countries' investors into non-stressed euro area countries we find for the period during the sovereign debt crisis ceased after the various measures taken at the European and the national level in the course of the second half of 2012.

Indeed, the results suggest that foreign investors did not continue to under-invest in stressed euro area countries debt securities in the 18 months spanning the time period between end-2011 and mid-2013. Similarly, we do not find evidence for over-investment by stressed euro area countries' investors in non-stressed euro area economies after the announcement of the OMT modalities. Moreover, there is no evidence for disproportionate portfolio shifts neither by foreign investors in non-stressed euro area countries nor by non-stressed euro area investors in stressed euro area portfolio debt markets during this period.

4 Robustness

In this section we test the sensitivity of our results to various modifications of our underlying regression sample.

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[19]For the post-OMT period Cyprus is excluded from the regressions due to the local banking crisis in 2013.

4.1 Robustness to Investor Country Groups

We start by examining the robustness of our findings for the investment behaviour across foreign investor country groups. In particular, we investigate whether our baseline results of an under-investment by foreign investors in stressed euro area countries' bond markets and the lack of an over-investment in non-stressed euro area countries are driven by specific non-euro area investor country groups, or whether this has been a common investment strategy across non-euro area investors. Columns (1) and (2) of Table 2 report the results for a sample of non-euro area investor countries only, which is split into major advanced economies and rest of the world.[20] The results suggest that the baseline results of an under-investment by foreign investors in bond markets of stressed euro area countries and the lack of a parallel over-investment in non-stressed euro area economies hold across foreign investor groups. Moreover, the results presented in column (1) show that investors in major advanced economies—in contrast to investors in the rest of the world—under-invested in both euro area stressed and non-stressed debt markets; and that the magnitude of under-investment has been comparable in size. [21]

4.2 Robustness to Destination Country Groups

Our baseline findings are based on the coefficient estimates for various country-pair dummy variables and may therefore be sensitive to the benchmark group. For instance, foreign investments in stressed euro area economies may have been disproportionately low relative to investments in emerging market economies, which have been subject to a surge in net capital flows in the aftermath of the global financial crisis (see, for instance, Ghosh et al., 2014). At the same time, investments may have been proportionate relative to other major advanced economies, which may themselves have been subject to low inward investments against the background of deteriorating public finances, muted growth and low interest rates. For this reason, we split the baseline sample by destination country groups. The specification in column (4) of Table 2 excludes all non-major advanced destination countries. And in column (5) all major advanced economies are excluded. Our baseline results are confirmed in both specifications, suggesting that global investors under-invested in stressed euro area countries also relative to other major advanced economies and the rest of the world. Similarly, stressed euro area countries investors over-invested in non-stressed euro area countries also relative to other advanced economies and the rest of the world. At the same time, the results illustrate that foreign (non-stressed euro area economies) investments in non-stressed (stressed) euro area economies have not been disproportionate relative to investments in major (non-euro area) advanced economies and the rest

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[20]The group of major advanced economies comprises the US, Japan, the UK and Canada. The group of other investor countries includes all other non-euro area investor countries listed in Section 3.1.

[21]Note that the finding of an under-investment by major advanced economies in euro area non-stressed debt markets does still not provide sufficient support for the empirical relevance of the intermediation channel. As discussed in Section 3.2, for this channel to be relevant, non-stressed euro area countries would have needed to under-invest in stressed euro area countries. However, this sample does not include euro area countries.

of the world.

4.3 Robustness to Small Observations, Euro Area Financial Centres and Investments in Equity Markets

Further to the above robustness checks, we test whether the baseline results reported in column (3) of Table 1 continue to hold if (i) we exclude all non-major advanced economies (destination and investor countries,) (ii) we drop euro area countries with large financial centres (Belgium and Ireland), and if (iii) we consider on equity instead of debt markets.

The CPIS dataset includes many small economies which have either limited or zero bilateral foreign asset and liability positions. Given the baseline specification which is estimated for log-changes of stock positions, this implies that small absolute changes of stock positions can lead to substantial log-changes. To see wether such instances affect our main findings, we exclude all non-euro area and non-major economies from the specification reported in column (1) of Table 3.

The baseline specification excludes major euro area and non-euro area financial hubs, such as Luxembourg, Switzerland, Singapore and Hong Kong. However, we have not excluded Belgium and Ireland—which also have large financial sectors—from the baseline sample, in particular in order not to exclude two euro area economies which may have exhibited substantial changes in their asset and liability positions during the sovereign debt crisis. In column (2), we exclude Belgium and Ireland, both as investor and destination country. The baseline results continue to hold across both specifications, as suggested in columns (1) and (2) of Table 3, suggesting that our results are neither driven by distorting observations for small economies, nor by euro area financial centres.[22]

Finally, we test whether the disproportionate portfolio rebalancing of global investors during the euro area sovereign debt crisis was confined to euro area *bond* markets, or whether global investors also disproportionately adjusted their portfolios of euro area *equity* markets. Column (3) of Table 3 clearly illustrates that disproportionate rebalancing of global investors was confined to euro area bond markets. This is in line with theoretical considerations and empirical findings that bond markets are more prone to be driven by default risks, whereas equity market developments during the sovereign debt crisis were mainly related to progress in structural reforms and the growth outlook (see, for instance, ECB, 2013).

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[22]The results also hold when Belgium and Ireland are excluded separately.

4.4 Robustness to Data on Portfolio Bond *flows*

The CPIS data are based on stock positions which change over time due to valuation effects that arise from changes in market prices and exchange rates. As described in Section 3.1, the destination country fixed effects α_j pick up part of the latter, but might do so only imperfectly. Therefore, as a robustness check we repeat our analysis using data on net euro area bond purchases by foreign residents provided by the US Treasury and the Japanese Ministry of Finance.

In particular, we consider the regression

$$np_i = \alpha + \beta_1 ln(Stock_{i09}) + \beta_2 ln(Import_{i09}) + \beta_3 ln(Distance_i) +$$
$$\beta_4 Language_i + \beta_4 EA_i^{stressed} + \beta_5 EA_i^{(non-stressed)} + \epsilon_i, \tag{2}$$

where np_i represents cumulated net foreign bond purchases by either US or Japanese residents scaled by destination country GDP and EA_i^j indicate stressed and non-stressed euro area countries.[23]

Columns (1) and (2) in Table 4 report the results from the estimation of Equation (2) for US and Japanese net foreign bond purchases data for the time period January 2010 to December 2011. The coefficient estimates suggest that in line with the results from Section 3 both Japanese and US investors under-invested in stressed euro area countries' debt markets during the sovereign debt crisis, as reflected by the statistically significant and negative stressed euro area country dummy.

Columns (3) and (4) in Table 4 report the results from regressions for the time period after the announcement of OMT (August 2012 to April 2013). The results again confirm our baseline findings, suggesting that neither Japanese nor US investors continued to under-invest in stressed euro area countries' debt markets after July 2012. Moreover, Japanese and US investors seem to have over-invested somewhat in non-stressed euro area countries.

5 Conclusions

In this paper we examine the geographical pattern of the great intra euro area rebalancing observed during the sovereign debt crisis. Relative to benchmarks from a standard gravity model of international portfolio choice, foreign investors under-invested in stressed euro area countries' debt markets during the sovereign debt crisis but did not in parallel overinvest in non-stressed

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[23]The data have been transformed so that positive numbers reflect inflows to destination countries. Euro area countries are included individually in the regressions for Japanese data and aggregated into stressed and non-stressed blocks for the US data in order to account for secular trends in net bond purchases in some individual non-stressed euro area countries.

euro area countries. By contrast, our results suggest that capital flight of stressed euro area country investors into non-stressed euro area countries was the main contributor the excessive volatility in intra euro area financial debt flows. Finally, we find that the under-investment of foreigners in stressed euro area countries and the over-investment of stressed countries in non-stressed countries ceased after the announcement of OMT.

These findings have some interesting implications. In particular, the results suggest that extreme tail risks for the euro exchange rate due to a 'sudden stop', i.e. a sharp under-investment of foreign investors in euro area economies, may have been limited. This finding is in line with the relatively modest depreciation of the euro exchange rate at the peak of the sovereign debt crisis. Moreover, as the great rebalancing was mainly a domestic phenomenon, characterized by an intra-euro area 'flight' of private capital, the possibility to offset private by official flows through Target balances was crucial. Finally, our results suggest that the measures taken at the European level in mid-2012 are likely to have contributed to alleviating tensions in euro area financial markets by offsetting intra-euro area capital flight.

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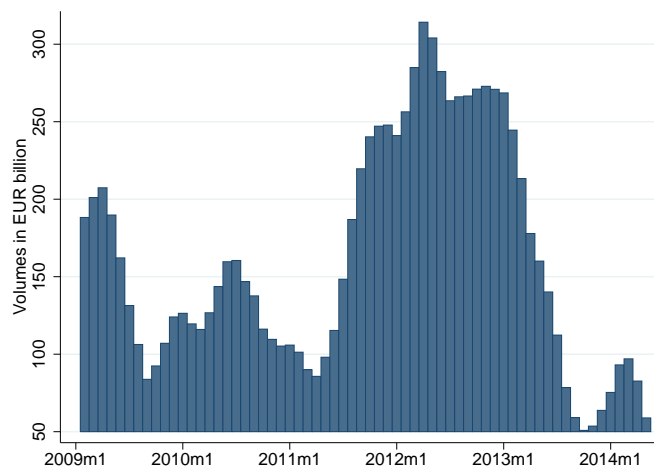
A   Figures

Figure 1: Bond liabilities of euro area stressed economies
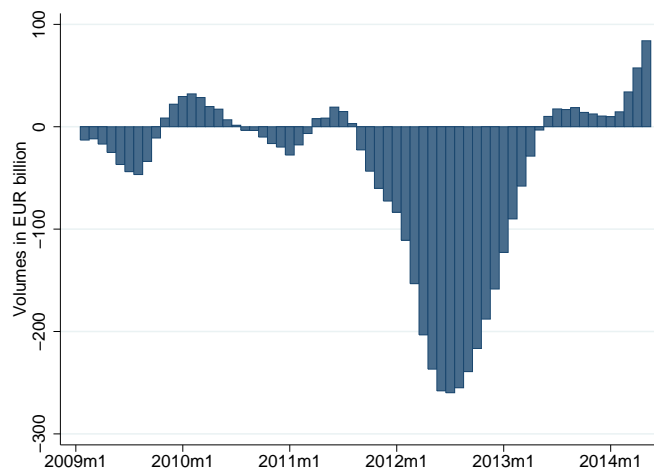
Figure 2: Bond liabilities of euro area non-stressed economies

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Figure 3: Major non-euro area countries' holdings of euro area debt as of end-2009
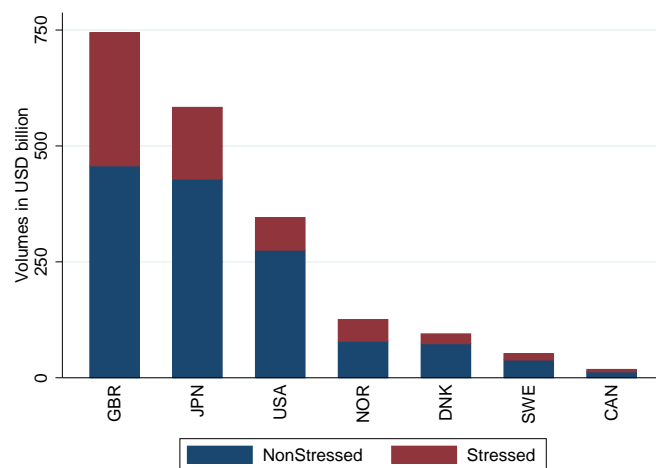
Figure 4: Major euro area countries' holdings of euro area debt as of end-2009
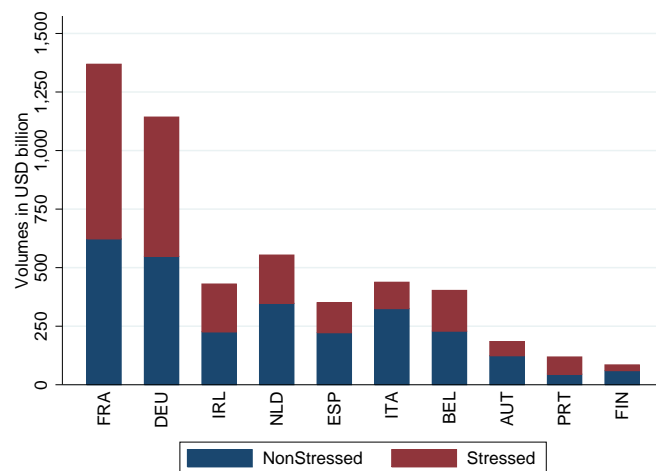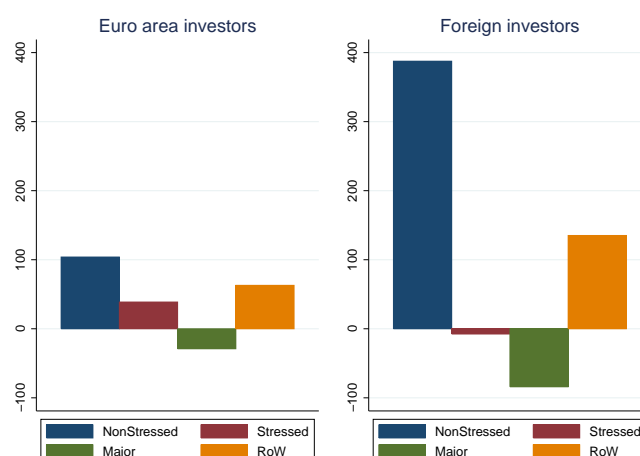
Figure 5: Changes in euro area and non-euro area investors' debt holdings between end-2009 and end-2011 by destination region (non-valuation adjusted)
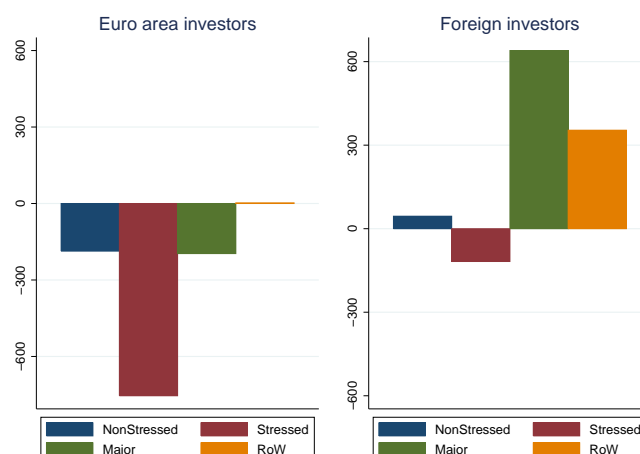
Figure 6: Changes in euro area and non-euro area investors' debt holdings between end-2011 and end-2013 by destination region (non-valuation adjusted)

B Tables

Table 1: Baseline results: Regression estimates of changes in long-term debt

	(1) Pre-OMT (1)	(2) Pre-OMT (2)	(3) Pre-OMT (3)	(4) Post-OMT
Stock in 2009	-0.319***	-0.319***	-0.321***	-0.232***
	(0.034)	(0.034)	(0.034)	(0.027)
Imports in 2009	0.061**	0.062**	0.060**	0.084***
	(0.025)	(0.025)	(0.025)	(0.025)
Distance	-0.304***	-0.301***	-0.311***	-0.107**
	(0.046)	(0.046)	(0.046)	(0.048)
Common offic. language	0.367***	0.370***	0.380***	-0.045
	(0.113)	(0.113)	(0.113)	(0.111)
NonEA to EA	-0.194**			
	(0.081)			
NonEA to Non-stressed		-0.145	-0.128	0.013
		(0.101)	(0.101)	(0.098)
NonEA to Stressed		-0.272**	-0.252**	-0.161
		(0.124)	(0.125)	(0.117)
Non-stressed to Stressed			0.151	0.076
			(0.106)	(0.078)
Stressed to Non-stressed			0.376**	0.203
			(0.146)	(0.126)
Constant	0.009	0.009	-0.009	-0.013
	(0.030)	(0.030)	(0.031)	(0.032)
Observations	1725	1725	1725	1581
R^2	0.19	0.19	0.19	0.11

Source: Authors' calculations based on CPIS data.
Notes: Robust standard errors reported below in parentheses. The R^2 captures the variation in portfolio adjustments that is explained by the second-stage regressors, i.e. excluding the investor and destination country dummies.
*Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

Table 2: Robustness checks I: Sample splits by investor and destination country groups

	(1)	(2)	(3)	(4)
	Investor country groups		Destination country groups	
	Major	RoW	Major + EA	RoW +EA
Stock in 2009	-0.151***	-0.357***	-0.276***	-0.336***
	(0.046)	(0.052)	(0.054)	(0.035)
Imports in 2009	0.024	0.069	0.096**	0.063**
	(0.040)	(0.047)	(0.047)	(0.026)
Distance	-0.099	-0.302***	-0.241***	-0.318***
	(0.060)	(0.071)	(0.052)	(0.048)
Common offic. language	-0.102	0.783***	0.395**	0.387***
	(0.153)	(0.210)	(0.182)	(0.124)
NonEA to Non-stressed	-0.348**	-0.115	-0.159	-0.127
	(0.175)	(0.129)	(0.113)	(0.102)
NonEA to Stressed	-0.410**	-0.303*	-0.296**	-0.255**
	(0.207)	(0.161)	(0.133)	(0.125)
Non-stressed to Stressed			0.026	0.168
			(0.123)	(0.107)
Stressed to Non-stressed			0.299**	0.384***
			(0.151)	(0.146)
Constant	0.077	0.014	0.039	-0.013
	(0.057)	(0.065)	(0.062)	(0.033)
Observations	263	715	653	1571
R^2	0.08	0.22	0.15	0.21

Source: Authors' calculations based on CPIS data.
Notes: Robust standard errors reported below in parentheses. The R^2 captures the variation in portfolio adjustments that is explained by the second-stage regressors, i.e. excluding the investor and destination country dummies.
Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Robustness checks II: Small and zero observations, euro area financial centres, and equity markets

	(1) Exclude RoW	(2) Drop EA financial centres	(3) Equities
Stock in 2009	-0.197***	-0.328***	-0.278***
	(0.049)	(0.036)	(0.029)
Imports in 2009	0.038	0.066**	0.094***
	(0.053)	(0.027)	(0.025)
Distance	-0.190***	-0.318***	-0.236***
	(0.055)	(0.050)	(0.040)
Common offic. language	0.294**	0.361***	0.238**
	(0.147)	(0.128)	(0.113)
NonEA to Non-stressed	-0.311*	-0.109	0.030
	(0.186)	(0.101)	(0.092)
NonEA to Stressed	-0.353*	-0.264*	0.055
	(0.209)	(0.152)	(0.109)
Non-stressed to Stressed	-0.046	0.117	0.041
	(0.126)	(0.134)	(0.109)
Stressed to Non-stressed	0.254*	0.315*	-0.123
	(0.156)	(0.170)	(0.109)
Constant	0.057	-0.008	-0.033
	(0.068)	(0.032)	(0.033)
Observations	340	1567	1798
R^2	0.13	0.20	0.15

Source: Authors' calculations based on CPIS data.
Notes: Robust standard errors reported below in parentheses. The R^2 captures the variation in portfolio adjustments that is explained by the second-stage regressors, i.e. excluding the investor and destination country dummies.
*Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

Table 4: Robustness checks III: Regression estimates of net foreign bond purchases based on US TICS and Japanese MoF data

	(1)	(2)	(3)	(4)
	Pre-OMT		Post-OMT	
	US TICS	Japanese MoF	US TICS	Japanese MoF
Stock in 2009	0.001	0.008*	-0.013$^+$	-0.004
	(0.006)	(0.004)	(0.009)	(0.003)
Imports in 2009	0.005	-0.021*	0.018$^+$	0.008
	(0.008)	(0.012)	(0.012)	(0.007)
Distance	-0.052***	-0.008	-0.031*	0.004
	(0.013)	(0.012)	(0.015)	(0.010)
Common offic. language	-0.004		0.009	
	(0.025)		(0.031)	
Non-stressed	-0.001	-0.003	0.051*	0.072$^+$
	(0.014)	(0.026)	(0.027)	(0.051)
Stressed	-0.037***	-0.103***	0.023	0.021
	(0.012)	(0.032)	(0.023)	(0.018)
Constant	0.398***	0.101	0.401**	-0.038
	(0.134)	(0.154)	(0.159)	(0.142)
Observations	42	38	42	38
Adjusted R^2	0.17	0.34	0.02	0.02

Source: Authors' calculations based on CPIS data.
Notes: Robust standard errors reported below in parentheses.
Significance levels: $+$ $p < 0.20$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.