Private and public risk-sharing in the euro area*

Jacopo Cimadomo†, Oana Furtuna‡, Massimo Giuliodori§

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Abstract

This paper investigates the contribution of private and public channels for consumption risk-sharing in the EMU. In particular, we explore the role of financial integration versus international financial assistance for risk-sharing across euro area countries over the period 1999-2015. In addition, we present a time-varying test which allows estimating how risk-sharing has evolved since the start of the EMU, and in particular during the recent crisis. Our results suggest that, whereas in the early years of the EMU only about 40% of output shocks were smoothed, in the aftermath of the euro zone's sovereign debt crisis more than 70% of output shocks are absorbed. This progressive improvement of the shock absorption capacity is due to a higher financial integration, but also to the activation of the European Financial Stability Facility (EFSF) loans for Greece and other euro zone economies in 2010. We also show that cross-border holdings of equities and debt seem to be more effective than cross-border bank loans in isolating households from country-specific shocks, therefore contributing to consumption smoothing.

JEL codes: C23, E62, G11, G15.

Keywords: risk-sharing, time-variation, financial integration, international financial assistance.

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† European Central Bank, Fiscal Policies Division, Sonnemannstr. 20, 60314, Frankfurt am Main, Germany, email: Jacopo.Cimadomo@ecb.int.

‡ Amsterdam School of Economics, University of Amsterdam, Roetersstraat 11, 1018 WB Amsterdam, The Netherlands, email: O.Furtuna@uva.nl.

§ Amsterdam School of Economics, University of Amsterdam, Roetersstraat 11, 1018 WB Amsterdam, The Netherlands, email: M.Giuliodori@uva.nl.

1. Introduction

The architecture and the functioning of the European Economic and Monetary Union (EMU) have been severely challenged in the context of the recent global financial crisis and in particular during the 2010-2012 euro-zone's sovereign debt crisis. Many commentators have argued that the lack of appropriate risk-sharing mechanisms at the euro area level may have contributed to aggravate the severity of the economic downturn in the euro zone periphery and may have delayed the recovery in the aftermath of the crisis (see, e.g., Allard, 2011).

Against this background, the Five President Report[5] highlights that euro area countries have to take steps, both individually and collectively, to compensate for the national adjustment tools they gave up on entry in the EMU. First, when economic shocks occur, each country has to be able to respond effectively. Second, they may also smooth the impact of shocks through risk-sharing within the EMU. In the short term, this risk-sharing can be achieved through integrated financial and capital markets (private risk-sharing) combined with the necessary common backstops, i.e., a last resort financial safety net. In the medium term, public risk-sharing could be enhanced through a mechanism of fiscal stabilisation for the euro area as a whole. This centralized fiscal capacity would strengthen existing (but limited in size) fiscal risk sharing mechanisms within the EMU (e.g., financial support to countries under stress via EFSF/ESM loans).

This paper presents several contributions. First, based on a sample of 11 euro area countries for the period 1999-2015, we explore the role of financial integration versus international financial assistance to distressed euro zone countries, i.e., official bilateral assistance via the European Financial Stability Facility (EFSF)[6], for consumption risk-sharing. The underlying intuition is that bilateral loans to distressed countries helped national governments in these countries to maintain a certain level of public expenditure. For example, they contributed to finance public salaries and pensions, which otherwise would have been cut even more dramatically. Therefore, our testable hypothesis is that these loans helped sustaining private consumption in the euro zone periphery.

Second, we propose a time-varying test which allows estimating how risk-sharing has evolved in the euro zone before the 2010-2012 European sovereign debt crisis and in its aftermath. Third, we analyse the degree of risk sharing and the relative importance of the private and public risk-sharing channels in different groups of euro area countries, distinguishing between "South" and North" countries.

[5] See https://ec.europa.eu/priorities/sites/beta-political/files/5-presidents-report_en.pdf.
[6] See https://www.esm.europa.eu/efsf-overview.

Our paper also contributes to the existing literature by making use of a unique dataset of cross-border bank loans from the Bank for International Settlements (BIS). The confidential version of the BIS International Locational Banking Statistics reports the outstanding bilateral positions of banking sectors in 44 reporting countries against residents of the countries where they are located. We augment this information with data from the Coordinated Portfolio Investment Survey (CPIS) of the International Monetary Fund, recording bilateral cross-border holdings of portfolio investment securities, as well as their breakdown into debt and equity assets. Due to data availability, previous studies have focused on specific waves of the CPIS survey (Fratszcher and Imbs, 2009). We exploit the cross-sectional variation in bilateral exposures as well as the growing time coverage of the dataset, and provide what is to our knowledge the first use of the database as a time series in the context of cross-country risk-sharing.

We focus on the deviation of personal consumption growth with respect to GDP growth across EMU countries, as suggested by the reference literature in this field (see, in particular, Asdrubali et al., 1996; Sørensen and Yosha, 1998). The underlying idea is that, in case of perfect risk-sharing, consumption growth differentials across countries should be independent from output growth differentials, given that fluctuations in GDP are smoothed via (private and public) risk-sharing channels and do not affect consumption. More specifically, we follow Fratzscher and Imbs (2009) and, based on our unique data on bilateral financial holdings and bilateral fiscal assistance, we estimate bilateral risk-sharing specifications which allow us to take full advantage of the cross-country information among euro area countries.

Our results suggest that, first, in the early years of the EMU only about 40% of output shocks were smoothed. However, in the aftermath of the euro-zone's sovereign debt crisis, more than 70% of output shocks are absorbed. The progressive improvement of the shock absorption capacity is due to a higher financial integration, but also to the activation of the European Financial Stability Facility (EFSF) loans for Greece and other euro zone economies in 2010. In addition, as regards private channels of risk sharing, cross-border holdings of equity and debt seem to be more effective than cross-border bank loans in smoothing consumption. Finally, our results suggest that risk-sharing seem to have worked better within homogeneous groups of countries, rather than between "North" and "South" countries.

The paper is organised as follows. Section 2 presents a short review of the related literature on risk-sharing. Section 3 describes the methodology and the dataset used in the empirical analysis. Section 4 comments on the results. Finally Section 5 concludes.

2. Related literature

The literature on income and consumption risk-sharing has expanded considerably in the last three decades, reflecting stronger interest in the economic profession and among policy-makers on how countries (or states within a federation) may better isolate from idiosyncratic shocks hitting their economies.

Empirical analyses of cross-country consumption risk-sharing are motivated by a testable prediction of the international real business cycle model with complete markets. In a world with a single internationally-traded contingent bond that pays out in units of the final consumption good, the Euler equations for the asset holdings indicate that the marginal rates of substitution between current and state-contingent future consumption should be equal across countries at each point in time. Therefore, in an equilibrium characterized by perfect risk-sharing, the countries exhibit the same growth rate of consumption at each point in time (Canova and Ravn, 1996).

One of the earlier and most influential contributions is Asdrubali *et al.* (1996). The authors propose a framework aimed at quantifying the amount of risk sharing among states in the United States. They find that, over the period 1963-1990, 39 percent of shocks to gross state product were smoothed by capital markets, 13 percent were smoothed by the federal government (via taxes, transfers, and grants to states), 23 percent were smoothed by credit markets while the remaining 25 percent were unsmoothed. However, del Negro (2002) highlights that – once measurement error in income and consumption is taken into account - the actual amount of risk sharing across US states may be significantly lower than what suggested by Asdrubali *et al*. (1996).

More recently, a number of empirical studies focus on financial variables and document that greater financial globalization tend to lead to increased risk-sharing, at least among industrial countries. For example, Sørensen *et al*. (2007) show that international home bias in debt and equity holdings declined during the period 1993-2003 which was accompanied by an increase in international risk sharing. The underlying intuition is that more internationally diversified investment portfolios allows generating income unrelated to fluctuations in domestic GDP, therefore better isolating agents from idiosyncratic shocks hitting their economies (see, also, Kose *et al*., 2007).

However, these findings generally refer to periods of financial upturn, while the effects of more financial market integration may be reversed during financial market downturns. In addition, if globalization leads to stronger co-movement between international stock markets, the benefits of gross-border holdings of financial assets might be limited (see, e.g., Beine *et al*., 2010). This is sometimes referred to as the "knife-edge" property of the financial markets: financial interconnections work as a shock absorber (i.e., leading to risk-sharing) in certain states of the world. In others, interconnections tend to generate shock amplification, i.e., risk-spreading (see Tasca and Battiston,

2011, Balli *et al*., 2013). Finally, in a recent paper, del Rio *et al*. (2017) focus on the role of the current account, and in particular TARGET balances via the ECB, in influencing risk sharing in the EMU. Their findings point to a reduction of risk sharing during and after the crisis with the current account channel being mainly responsible for this reduction.

Our paper connects, in particular, with Fratzscher and Imbs (2009). However, differently from these authors, we do not focus on the implications of transaction costs in influencing the degree of risk sharing via capital markets. Instead, we analyse the role of both public and private risk sharing channels in the euro zone, with a focus on the recent crisis.

3. Methodology and data

3.1 Empirical setup

Most tests of consumption risk-sharing test the link between deviations of country-level consumption growth from the average consumption growth observed in the rest of the world. Under the null hypothesis of perfect risk-sharing, the growth of per capita consumption should be decoupled from the growth of per capita output for any country i, thus yielding a risk-sharing coefficient equal to zero. Under the alternative hypothesis, a coefficient statistically different from zero indicates the absence of perfect risk-sharing, and its magnitude reflects the extent of the deviation from the theoretical benchmark.

Although informative, this approach remains silent on differences in risk-sharing observed over time or across country pairs. Heterogeneity can be gauged from a three-dimensional panel of consumption growth and income growth differentials observed across country pairs over time. The panel allows for the inclusion of time fixed effects to capture aggregate shocks, as well as for country-pair fixed effects which control for time-invariant bilateral characteristics that can explain average differences across country pairs.

In a three-dimensional panel, the basic risk-sharing test becomes:

$$(\Delta \log C_{i,t} - \Delta \log C_{j,t}) = \alpha + \beta(\Delta \log Y_{i,t} - \Delta \log Y_{j,t}) + \gamma Z_{ij,t-1} + \eta_t + \mu_{ij} + \varepsilon_{ij,t} \quad (1)$$

Where we denote the log-growth of variable X as $\Delta log X_{i,t}$, $C_{i,t}$ denotes household consumption and $Y_{i,t}$ stands for output in country i at time t. The richest specification includes time fixed effects η_t, country pair fixed effects μ_{ij} and a set of control variables $Z_{ij,t}$ that vary across pairs (ij) and over time. It is worth mentioning that correct econometric inference requires us to address the symmetry generated by constructing all variables as growth differentials. To avoid double counting we only

keep one observation per country pair and thus for a sample of *N* countries and *T* time periods we use a total of *TN(N-1)/2* observations.

To account for the risk-sharing wedge generated by international differences in taxation Epstein, *et al.* (2016) augment the business cycle model with distortionary taxes and find that an increase in the relative consumption tax or capital income tax growth leads to a lower relative consumption growth. Following Epstein *et al.* (2016), the Z matrix of controls includes the difference in the growth rate of statutory value added taxes ($\Delta VAT_{ij,t}$) and the difference in personal income taxes on distributed profit between countries i and j (and $\Delta PIT_{ij,t}$ respectively). In addition to the tax rate differentials, Z also includes the inflation differential ($\Delta INFL_{ij,t}$) and the 10-year sovereign bond yield differential between countries i and j ($\Delta YIELD_{ij,t}$). The inclusion of the former is theoretically justified by the link between the relative growth rates of consumption and the dynamics of the exchange rate (Backus and Smith, 1993). In the Eurozone context (characterized by unit nominal exchange rates) we proxy for real exchange rate differentials by accounting for the relative dynamics of prices across countries. From a modelling perspective, in a New Keynesian framework cross-country inflation differentials impact relative consumption growth.

For part of the time period we investigate, the interest rate spreads in Europe are strongly affected by sovereign default risk, thus rationalizing the inclusion of the government bond yield differentials in the empirical specification. Theoretically, we can rationalize the importance of government bond yields for risk-sharing by means of a two country New Keynesian model where sovereign default risk affects differences in borrowing costs across countries: a larger default risk premium in one country would translate into higher relative borrowing costs, thus exerting downward pressure on the relative growth rate of consumption. In light of these theoretical considerations we condition the test of cross-country risk-sharing on the chosen set of controls, and in order to mitigate concerns about reverse causality in annual data, we use lagged values of all the covariates.

Financial and fiscal channels are at play in the insurance of idiosyncratic shocks. Private sectors in different countries can share risk with each other via the capital market, through cross-ownership of productive assets, or through lending and borrowing on the international credit market. High cross-country risk sharing is achieved, for example, if the income from foreign assets is high when domestic output growth is low, thus ensuring that wealth effects support consumption smoothing in spite of the negative domestic income shock. As the returns of securities are directly tied to the business cycle experienced by in the residence country of the issuer rather than the economic conditions in the country of the equity holder, they have scope for effective risk-sharing channels (Demyanyk, *et al.* , 2008). Last but not least, if the banking sector in country i experiences a negative shock, international banks from home countries unaffected by the same shock can provide the necessary credit in the host economy.

The role of fiscal transfers has been explored in country-level studies, with results indicating that transfers from the federal budget can play a significant role in the smoothing of regional shocks (Bayoumi and Masson, 1995). This motivates our focus on the role played by fiscal transfers for consumption risk-sharing in the euro area.

In order to explore the role of financial and fiscal integration as sources of time-varying heterogeneity in risk-sharing, we allow for nonlinearities in the empirical specification. Following Fratzscher and Imbs (2009), we use interaction terms of continuous variables to model the dependence of the risk-sharing coefficient on measures of financial and fiscal integration. Given our focus on the dynamics of risk-sharing over time, we enrich the Fratzscher and Imbs (2009) model by allowing for the interacting variables to vary both across pairs and over time.

To this end, we construct time-varying bilateral measures of financial and fiscal integration. The financial integration measure is computed following Epstein *et al.* (2016) as the sum of claims of country i over country j and claims of country j over country i, scaled by the sum of nominal income in country i and country j:

$$INT_{ij,t} = \frac{A_{i\to j,t} + A_{j\to i,t}}{Y_{i,t} + Y_{j,t}} \quad (2)$$

First, we proxy for financial integration by replacing $A_{i\to j,t}$ with the sum of cross-border bilateral loans and cross-border portfolio investment ($FIN_{ij,t}$). Then we create two separate measures of integration for each of the two asset categories, namely $LOAN_{ij,t}$ and $PORT_{ij,t}$. Lastly, we further differentiate between debt and equity within the category of portfolio investment, and compute measures of integration for the corresponding assets: $DEBT_{ij,t}$ and $EQUITY_{ij,t}$. We further use formula (2) to compute a measure of fiscal integration. In this case $A_{i\to j,t}$ is replaced by the financial assistance provided by country i to country j and channelled via the EFSF at a given point in time.[7] We illustrate the extent of time variation exhibited by these proxies in Figure 1.

Accounting for nonlinearities in risk-sharing, the full model we estimate takes the form:

$$\begin{aligned}(\Delta \log C_{i,t} - \Delta\ \log C_{j,t}) \\ &= \alpha + \beta_0\left(\Delta\log Y_{i,t} - \Delta\log Y_{j,t}\right) + \beta_1\left(\Delta\log Y_{i,t} - \Delta\log Y_{j,t}\right)LOAN_{ij,t-1} \\ &+ \beta_2\left(\Delta\log Y_{i,t} - \Delta\log Y_{j,t}\right)EQUITY_{ij,t-1} + \beta_3\left(\Delta\log Y_{i,t} - \Delta\log Y_{j,t}\right)DEBT_{ij,t-1} \\ &+ \beta_4\left(\Delta\log Y_{i,t} - \Delta\log Y_{j,t}\right)EFSF_{ij,t-1} + \gamma Z_{ij,t-1} + \eta_t + \mu_{ij} + \varepsilon_{ij,t} \quad (3)\end{aligned}$$

[7] While all countries in our sample are contributors to the EFSF, we distinguish only 3 recipient countries, namely Greece, Portugal and Ireland.

Formally, the coefficient capturing risk-sharing between country *i* and *j* will be equal to the sum of the income growth differential coefficient (β_0) and the coefficients that capture how risk-sharing is related to *K* measures of fiscal/financial integration ($\beta_1, \beta_2, \beta_3, \beta_4$):

$$\beta = \beta_0 + \sum_{k=1}^{K} \beta_k \, INT_{ij,t-1}^{k} \quad (4)$$

In this nonlinear model, the null hypothesis of perfect risk-sharing amounts to testing whether the β coefficient in equation (4) is not statistically different from zero. For positive values of β_0 and positive financial and fiscal integration indices, negative coefficients for the interaction terms indicate that higher values of integration improve cross-country consumption risk-sharing.

3.2 Data

Given the focus of our analysis, we restrict attention to a sample of 11 euro-zone member countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. Our dataset is collected at the yearly frequency and covers the period 1999-2015. Although our analysis initially comprised all EA12 countries, we exclude Luxembourg from our sample given its status as a financial hub and the cross-border exposures observed in its case which indicate it as a clear outlier.[8]

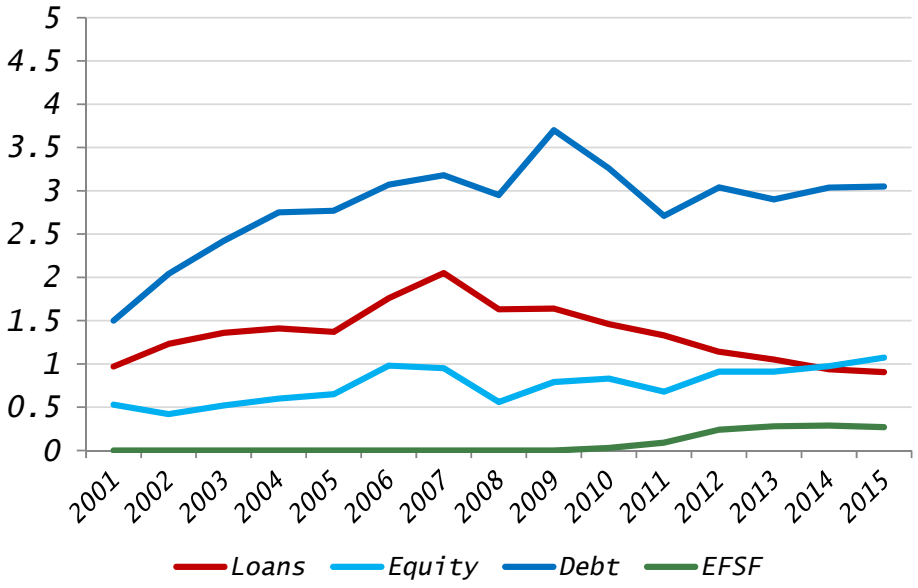
For our country and time sample, we construct a rich dataset combining information from multiple sources. As a first building block we use the confidential BIS International Locational Banking Statistics, which reports bilateral positions of the banking sector in country i against each counterparty country j. The data is recorded using the residence principle, thus accurately reflecting cross-country exposures. To minimize the overlap with portfolio investment data, we restrict our attention to cross-border loans. We combine the BIS information with bilateral data on portfolio investment from the IMF Coordinated Portfolio Investment Survey (CPIS). The CPIS consists of data on cross-border holdings of equity and debt securities, collected from holders by means of a survey and classified according to the residence of the issuer. In line with Lane and Milesi-Ferretti (2007), we prefer using asset stocks as opposed to flows because they provide a better proxy for wealth. Data on bilateral EFSF assistance is retrieved from ECB sources and represent the amount (in current EUR) flowing from each contributor to each recipient country in the euro area and channelled through the stability fund.

[8] Due to the lack of data availability for the period we consider we exclude more recent members of the euro area.

In additional to financial variables, we use standard macroeconomic variables available from Eurostat, namely final consumption of households and gross domestic product at market prices. We deflate the series using by the harmonized index of consumer prices with reference year 2010. Finally, we divide them by total population. Therefore, consumption and GDP data are in real per capita terms.

Following Epstein, *et al.* (2016), we account for the role of relative tax differentials by including these as control variables in our estimation. We favour the use of statutory tax rates as opposed to measures of effective taxation derived from national accounts in order to alleviate the concerns about endogeneity to the dynamics of consumption. The tax differentials are constructed from data on tax rates. We use the statutory standard VAT rate and the overall (corporate plus personal) statutory tax rate on distributed profit, both available at annual frequency from the OECD Tax Database. We further augment the set of control variables with the 10-year sovereign bond yield and the consumer price index from the OECD Main Economic Indicators.[9] .

Figure 1: Financial integration and EFSF assistance in the euro area



Notes: Annual country-pair averages in percentage points of GDP. "Loans", "Equity", "Debt" and "EFSF" are defined as the sum of the relevant bilateral exposure of country *i* in country *j* and the bilateral exposure of country *j* in country *i* over the sum of the GDP of countries *i* and *j*.

[9] More information on the sources, construction and coverage of the variables is reported in the Data Appendix.

4. Empirical results

4.1 Baseline results

In Table 1 we report the results of the simple bilateral risk-sharing regression as in equation (1), linking consumption growth differentials to output growth differentials (and some other controls). A coefficient on the GDP differential term $\left(\Delta\log Y_{i,t} - \Delta\log Y_{j,t}\right)$ equal to zero would signal perfect risk-sharing, given that output growth differentials would not be reflected in consumption growth differentials. A coefficient equal to one would indicate no risk-sharing. Table 1 shows the results from the GLS estimation, with AR(1) term and robust standard errors, across different specifications. In particular, column (1) shows the results with no controls added to the simple consumption-output regression, and with no fixed effects. Column (2) adds country-pair fixed effects, column (3) year fixed effects, and column (4) both types of fixed effects. Column (5) includes our set of controls namely $\Delta VAT_{ij,t-1}$, $\Delta PIT_{ij,t-1}$ and the real 10-year sovereign bond yield differential $\Delta RYIELD_{ij,t-1}$, which is defines as $\Delta YIELD_{ij,t-1} - \Delta INFL_{ij,t-1}$. Finally, column (6) reports the regression results where the latter two terms are included separately.

Table 1 indicates that, across all specifications, the coefficient on the output differential is rather stable and in the interval 0.40-0.45. This indicates that, on average over the full sample, about 55%-60% of output shocks are smoothed in the euro zone, while the remaining 40%-45% is unsmoothed. The VAT and PIT rate differentials show a negative and significant coefficient. Indeed, an increase in these tax rates in country *i* is expected to lead to a decrease in consumption in that country relative to country *j*, which is reflected in a negative sign of the related coefficients. As regards the other controls, the coefficient on the real bond yield is negative indicating a depressive effect of this variable on consumption. When the real yield is split into nominal yield and inflation differentials, it turns out that the coefficient of the latter is insignificant while the one of the nominal bond yield has the expected negative sign. Finally, it should be stressed that our regressions are characterized by a large number of observations (i.e., 760 in the regression with controls, 870 in the simplest regression without controls), due to the fact that we exploit the bilateral dimension of our dataset (we have 55 unique country pairs).

Table 1: Risk sharing in EMU countries: baseline results.

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\log Y_{i,t} - \Delta\log Y_{j,t}$	0.452***	0.475***	0.419***	0.439***	0.446***	0.400***
	(0.0187)	(0.0187)	(0.0183)	(0.0184)	(0.0392)	(0.0191)
$\Delta VAT_{ij,t-1}$					-0.228***	-0.178**
					(0.0610)	(0.0780)
$\Delta PIT_{ij,t-1}$					-0.0595***	-0.055***
					(0.0179)	(0.0166)
$\Delta RYIELD_{ij,t-1}$					-0.175***	
					(0.0289)	
$\Delta INFL_{ij,t-1}$						0.0239
						(0.0630)
$\Delta YIELD_{ij,t-1}$						-0.175***
						(0.0338)
Constant	-0.0683	-0.161	0.723***	0.649	0.513*	0.615
	(0.0910)	(0.573)	(0.272)	(0.746)	(0.273)	(0.769)
# of observations	870	870	870	870	760	760
# of unique country pairs	55	55	55	55	55	55
# of countries	11	11	11	11	11	11
Pair Fixed Effects	NO	YES	NO	YES	YES	YES
Year Fixed Effects	NO	NO	YES	YES	YES	YES

Notes: GLS estimation with AR(1) term and robust standard errors (in parenthesis) of equation (1). ***, ** and * refer to the 1%, 5% and 10% statistical significance.

Table 2 reports the results from richer specifications, in which several interaction terms have been added to the simple specification of Table 1 (Column 6). In particular, as in equation (2) we interact the output growth differential with (i) international finance assistance, as represented by EFSF loans between two euro zone countries, and (ii) the terms representing financial integration (i.e., sum of bilateral bank loans and bilateral portfolio holdings). We deem appropriate to always include country-pairs fixed effects and year fixed effects. In column (1) we augment the simple specification of equation (1) with only the interaction term based on the international financial assistance. The results show that the coefficient on the EFSF loans is large, negative and highly significant, thus contributing to push the coefficient on output growth differentials towards zero. This indicates that financial assistance has contributed strongly to risk sharing in the euro zone, after 2010 (when the EFSF loans were activated). In column (2) we only include the interaction term based on the overall financial

integration index $FIN_{ij,t}$. The regression results suggest a significant effect of financial integration in reducing consumption growth differential across countries. This finding is robust also when controlling simultaneously for the official financial assistance (column (3)). We then add separately the interaction terms for bilateral bank loans (column (4)), bilateral portfolio holdings (column (5)), and loans and portfolio holdings (column 6). Finally, in column (1) we add simultaneously all three financial integration terms together with the EFSF loan term.

The results show that bilateral bank loans are either insignificant or tend to decrease risk sharing, as revealed by the positive interaction coefficient in columns (6) and (7). This result may appear counter-intuitive, but is consistent with the recent research which highlights that banking integration may lead to business cycle de-synchronization (see, e.g., Kalemli-Ozcan *et al.*, 2013). The underlying intuition in our risk-sharing framework is the following: in a financially integrated world, if county *i* is hit by negative (positive) output shock, both domestic and foreign banks decrease (increase) lending in country *i* and might increase (decrease) lending in the non-affected country *j* thereby causing a further divergence of consumption growth differentials. The other regressions suggest that portfolio holdings have the expected negative sign, which would lead to more risk-sharing. This result is driven by equity and debt holdings, with the effects of equity being stronger than debt. The coefficients on the other control variables tend to preserve the sign shown in Table 1: PIT rate differentials are always negative and highly significant, together with bond yield differentials. The contribution of VAT rate differentials is also negative, but the coefficient tends to be insignificant.

Figure 2 shows the evolution of the overall risk-sharing coefficient (as defined in equation (4)) based on the estimates of the last column of Table 2 and where the interaction terms are evaluated at their annual country-pair means (see Figure 1). Indeed, an important main value added of our analysis is that it allows deriving a time-varying estimate for the degree of risk-sharing in the EMU. The figure indicates that the risk-sharing coefficient declines from a value of around 0.60 in the early 2000s, to around 0.25 at the end of the sample. This reveals - perhaps surprisingly - that risk-sharing has progressively improved in the EMU, and also during the recent crisis period. Our framework also allows to pin down the relative contribution of each factor in explaining the time evolution of the overall risk sharing coefficient. Indeed, Figure 3 reports the individual contribution of cross-border bank loans, cross-border holdings of equity and debt (i.e., portfolio) and official financial assistance (EFSF) to the time evolution of the risk-sharing coefficient. It turns out that portfolio integration has been increasingly important as a shock absorber, until 2008. In 2009, at the beginning of the crisis, the coefficient on portfolio slightly increases, thus revealing a less positive contribution to risk sharing in that year. This might be possibly due to the fact that the 2009 recessionary shock hit all countries (and financial markets) simultaneously in the euro zone, therefore cross border holdings of financial asset

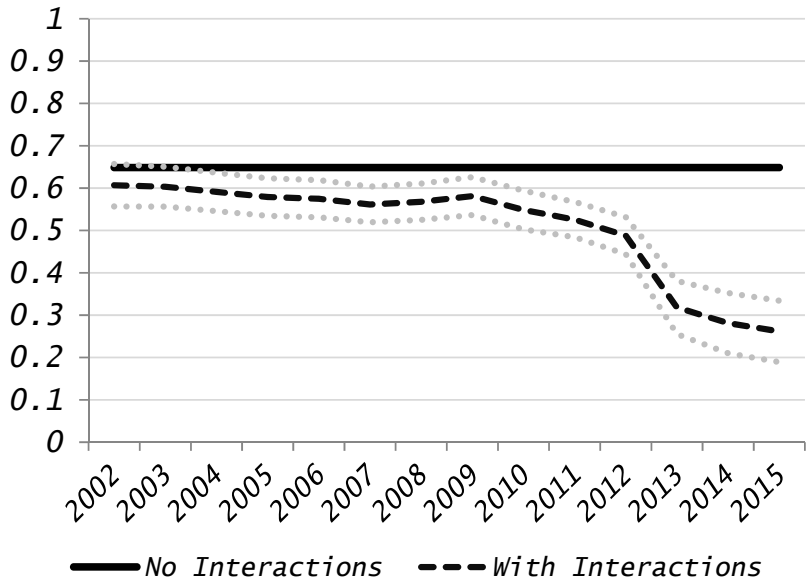
did not benefit households and consumers. Since 2010, the contribution of international portfolio holdings has been broadly stable. Financial assistance through the EFSF has been a very important shock-absorber mechanism since 2010, when such loans were activated. Indeed, EFSF assistance mainly explains the improvement of risk sharing in the last part of the sample. Finally, cross-border loans have contributed negatively, and in a rather stable way, to risk-sharing. However, the impact of this factor seems to become less powerful since 2008, as reflected in the related coefficient declining progressively towards zero.

Table 2: Risk sharing in the euro area: the role of financial integration and EFSF assistance.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta\log Y_{i,t} - \Delta\log Y_{j,t}$	0.485***	0.575***	0.596***	0.467***	0.702***	0.666***	0.647***
	(0.0198)	(0.0307)	(0.0299)	(0.0233)	(0.0284)	(0.0302)	(0.0323)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})EFSF_{ij,t-1}$	-1.128***		-1.014***	-1.216***	-0.740***	-0.816***	-0.942***
	(0.126)		(0.126)	(0.126)	(0.118)	(0.120)	(0.129)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})FIN_{ij,t-1}$		-0.0228***	-0.0162***				
		(0.00303)	(0.00298)				
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})LOAN_{ij,t-1}$				0.00410		0.0338***	0.0291***
				(0.00701)		(0.00724)	(0.00845)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})PORT_{ij,t-1}$					-0.0372***	-0.0412***	
					(0.00385)	(0.00444)	
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})DEBT_{ij,t-1}$							-0.0301***
							(0.0110)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})EQUITY_{ij,t-1}$							-0.0465***
							(0.00998)
$\Delta VAT_{ij,t-1}$	-0.0890	-0.148*	-0.0950	-0.0862	-0.0972	-0.102	-0.0549
	(0.0756)	(0.0775)	(0.0748)	(0.0742)	(0.0751)	(0.0736)	(0.0754)
$\Delta PIT_{ij,t-1}$	-0.0338**	-0.0514***	-0.0320**	-0.0295*	-0.0417***	-0.0330**	-0.0266*
	(0.0159)	(0.0156)	(0.0152)	(0.0156)	(0.0148)	(0.0147)	(0.0148)
$\Delta INFL_{ij,t-1}$	0.0694	0.0716	0.104*	0.116**	0.0743	0.127**	0.130**
	(0.0599)	(0.0606)	(0.0582)	(0.0584)	(0.0582)	(0.0566)	(0.0566)
$\Delta YIELD_{ij,t-1}$	-0.436***	-0.0921***	-0.339***	-0.408***	-0.275***	-0.279***	-0.348***
	(0.0437)	(0.0333)	(0.0450)	(0.0442)	(0.0436)	(0.0438)	(0.0490)
Constant	0.413	0.470	0.301	0.365	0.306	0.254	0.236
	(0.722)	(0.722)	(0.676)	(0.683)	(0.683)	(0.639)	(0.655)
	0.485***	0.575***	0.596***	0.467***	0.702***	0.666***	0.647***
# of observations	760	731	731	733	758	731	715
# of unique country pairs	55	55	55	55	55	55	55
# countries	11	11	11	11	11	11	11
Pair Fixed Effects	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES

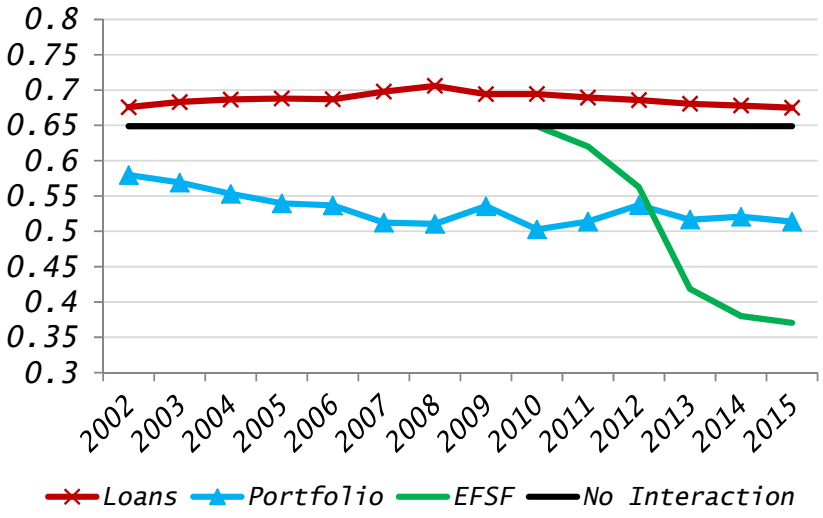
Notes: GLS estimation with AR(1) term and robust standard errors (in parenthesis) of equation (3). ***, ** and * refer to the 1%, 5% and 10% statistical significance.

Figure 2: Evolution of risk sharing in the euro area.



Notes: "No Interactions" refers to the risk-sharing coefficient β_0 in equation (3) and is based on the estimate of column (7) of Table 2. "With Interactions" refers to the overall risk-sharing coefficient defined in equation (4) and based on the estimates in column (7) of Table 2. The interaction terms are evaluated at their annual country-pair means (see Figure 1). Confidence bands correspond to the 95% level of statistical significance.

Figure 3: Contribution of financial integration and EFSF assistance for risk-sharing.



Notes: "No Interactions" refers to the risk-sharing coefficient β_0 in equation (3) and is based on the estimate of column (7) of Table 2. "Loans" reports the risk-sharing coefficient calculated as $\beta_0 + \beta_1 * LOAN_{t-1}$. "Portfolio" reports the risk sharing coefficient calculated as $\beta_0 + \beta_2 * EQUITY_{t-1} + \beta_3 * DEBT_{t-1}$. "EFSF" reports the risk-sharing coefficient calculated as $\beta_0 + \beta_4 * EFSF_{t-1}$. The interaction terms are evaluated at their annual country-pair means (see Figure 1).

4.2 Results in sub-groups countries and the role of the crisis

Table 3 reports the panel estimation results from the split of the sample in two groups: "South" and "North" countries. The first group includes the euro zone "vulnerable" countries, i.e., the one most hit by the recent crisis: Greece, Portugal, Ireland, Spain and Italy. The second group includes Austria, Belgium, Germany, Finland, France and the Netherlands. Column (1) reports the results from the baseline regression including all countries, for comparison. Column (2) shows the results for the South group. It emerges that the role of EFSF loans was stronger in this group compared to the full sample, which makes sense given that all recipients of EFSF loans were in this group. The coefficient on bank loans maintains a positive and significant sign, while equity holdings still contribute positively to risk-sharing, as reflected in the negative coefficient. The coefficient on debt is now is positive (although significant only at the 10% level), suggesting that cross border holding of debt of other vulnerable countries may have led to shock amplification rather than shock absorption. As regards the North group, the coefficient on equity is still negative and higher than for the South group, but it is statistically not significant. As regards the overall risk-sharing coefficient (equation (5)), in the North group it has been broadly stable and high, indicating that around 70% of output shocks were absorbed over the 1999-2015 period. In the South group, risk sharing was low at the start of the sample (about 30% of shock absorbed) and progressively improved over time, mainly due to the introduction of EFSF loans.

Finally, in column (4) we test for the degree of risk-sharing among South and North countries. Namely, we only focus on all pairs between South and North countries, thus excluding the North-North and South-South pairs. The results show an overall risk-sharing coefficient somewhat higher than in the full sample, and significantly higher than in the North-only and South-only groups. This finding seems to suggest that risk-sharing in the euro zone has operated mainly within "homogeneous" group of countries, rather than between the North and the South countries. The other coefficients are broadly in line with the full sample. An interesting difference emerges for debt holdings, whose coefficient is now higher than for the other groups and significantly negative. This suggests that the degree of cross-border financial integration based on debt security holdings between North and South countries contributed effectively as a shock absorber in the euro area.

Table 3: Risk sharing in sub-groups of EMU countries

	(1) All	(2) South	(3) North	(4) North-South
$\Delta\log Y_{i,t} - \Delta\log Y_{j,t}$	0.647***	0.379***	0.373***	0.743***
	(0.0323)	(0.0748)	(0.0764)	(0.0408)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})EFSF_{ij,t-1}$	-0.942***	-1.663***		-0.688***
	(0.129)	(0.295)		(0.146)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})LOAN_{ij,t-1}$	0.0291***	0.186***	-0.0208	0.0428***
	(0.00845)	(0.0676)	(0.0217)	(0.00979)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})DEBT_{ij,t-1}$	-0.0301***	0.0634*	0.0224	-0.0577***
	(0.0110)	(0.0343)	(0.0281)	(0.0129)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})EQUITY_{ij,t-1}$	-0.0465***	-0.0588***	-0.107	-0.0562***
	(0.00998)	(0.0199)	(0.135)	(0.0133)
$\Delta VAT_{ij,t-1}$	-0.0549	-0.264	0.184	-0.0526
	(0.0754)	(0.172)	(0.118)	(0.0939)
$\Delta PIT_{ij,t-1}$	-0.0266*	-0.0632	-0.0277**	-0.0296
	(0.0148)	(0.0549)	(0.0127)	(0.0210)
$\Delta INFL_{ij,t-1}$	0.130**	0.149	0.0824	0.0806
	(0.0566)	(0.109)	(0.103)	(0.0733)
$\Delta YIELD_{ij,t-1}$	-0.348***	-0.522***	-0.502*	-0.291***
	(0.0490)	(0.122)	(0.301)	(0.0621)
# of observations	715	112	209	394
# of unique country pairs	55	10	15	30
# countries	11	5	6	11
Pair Fixed Effects	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES

Notes: GLS estimation with AR(1) term and robust standard errors (in parenthesis) of equation (3). ***, ** and * refer to the 1%, 5% and 10% statistical significance. "All" refers to all EMU countries and corresponds to column (7) of Table 2. "South" refers to all country pairs between vulnerable countries in the euro area (Greece, Spain, Italy, Portugal and Ireland). "North" refers to all country pairs between Northern countries in the euro area (Germany, the Netherlands, Belgium, Austria and Finland. "North-South" refers to all unique country pairs between Southern and Northern countries.

Table (4) reports the regression results when we split the sample in the pre-crisis period and crisis/post-crisis period. This allows to test if there was a change in the regression coefficients between the two periods. We set the start of the crisis in 2010, which corresponds with the beginning of the so-called European sovereign debt crisis. The results indicate that equity and debt holdings become significantly negative in the second period, suggesting that financial integration through this channel help risk-sharing. EFSF loans also show a negative and highly significant coefficient in the crisis period, contributing to risk-sharing. At the same time, the coefficient on cross-border bank loans turns positive in the crisis period, which may suggest that fragmentation in the euro zone banking sector may have affected negatively credit growth therefore also weighing negatively on consumption smoothing.

Table 4: Risk sharing and the role of the crisis.

	(1)	(2)
	Pre-crisis 1999-2009	Crisis/Post-crisis 2010-2015
$\Delta\log Y_{i,t} - \Delta\log Y_{j,t}$	0.367***	0.721***
	(0.0534)	(0.0418)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})EFSF_{ij,t-1}$		-0.798***
		(0.116)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})LOAN_{ij,t-1}$	-0.00196	0.0880***
	(0.00753)	(0.0145)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})DEBT_{ij,t-1}$	0.0778***	-0.0921***
	(0.0185)	(0.0138)
$(\Delta\log Y_{i,t} - \Delta\log Y_{j,t})EQUITY_{ij,t-1}$	-0.0294*	-0.0265**
	(0.0177)	(0.0103)
$\Delta VAT_{ij,t-1}$	-0.170	-0.103
	(0.106)	(0.0811)
$\Delta PIT_{ij,t-1}$	-0.078***	0.0181
	(0.0127)	(0.0172)
$\Delta INFL_{ij,t-1}$	0.886***	-0.0774
	(0.0855)	(0.0692)
$\Delta YIELD_{ij,t-1}$	-7.437***	-0.306***
	(0.681)	(0.0444)
# of observations	715	
# of unique country pairs	55	
# countries	11	
Pair Fixed Effects	YES	
Year Fixed Effects	YES	

Notes: GLS estimation with AR(1) term and robust standard errors (in parenthesis) of equation (3). ***, ** and * refer to the 1%, 5% and 10% statistical significance. The two columns (1) and (2) report the estimates of the pre-crisis (1999-2009) and crisis/post-crisis (2010-2015) periods.

5 Conclusions

Many commentators have argued that the effects of the financial crisis and the European sovereign debt crisis have been aggravated by the absence of appropriate risk-sharing mechanisms within the EMU. In this paper, we propose a novel approach aimed at gauging the extent of consumption risk sharing, and its main drivers, among member countries since the start of the EMU. In particular, based on a sample of 11 euro area countries for the period 1999-2015, we explore the role of private channels (i.e., cross-border loans and holdings of financial assets), versus public channels (i.e., official financial assistance to distressed euro zone countries), for consumption risk-sharing. In addition, we analyse the degree of risk sharing and the relative importance of the private and public

risk-sharing channels in different groups of euro area countries, distinguishing between “South” and North” countries.

Our results suggest that the shock absorption capacity generated by international (private and public) channels has increased since the start of the EMU: in the early years of the EMU only about 40% of output shocks were smoothed, while in the aftermath of the euro zone’s sovereign debt crisis more than 70% of output shocks are absorbed. Both financial integration and international official assistance play an important role in explaining this improvement. At the same time, our results show that while banking integration (via cross-border loans) tends to exacerbate country differences in consumption, cross-border holdings of equities and debt are powerful channels in isolating households from country-specific shocks. Finally, our results suggest that risk-sharing seem to have worked better within homogeneous groups of countries, rather than between “North” and “South” countries.

The finding that risk-sharing has improved over time in the Eurozone, also during the recent crisis, is to some extent surprising. Yet, this finding – of course – does not imply that the severity of the crisis would have not been attenuated even further by a fully-fledged centralized fiscal capacity at the euro zone level.

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Data Appendix

Variable	Source	Definition	Sample coverage
Bilateral loan stocks	International Locational Banking Statistics- Bank for International Settlements (BIS)	Aggregate assets (in the form of loans) of banks in reporting countries vis-à-vis host country economies (banking and non-banking sectors). Quarterly, aggregated to annual (as averages).	1999-2015
Bilateral portfolio equity and debt stocks	Coordinated Portfolio Survey (CPIS) – International Monetary Fund (IMF)	Cross-border holdings of equities and debt securities self-reported by holder economies and classified by the economy of residence of the issuer.	2001-2015
Bilateral EFSF	European Stability Mechanism (ESM) and European Central Bank (ECB)	For the period before 2010 we set all values to zero.	1999-2015
Household consumption	Eurostat	Final consumption of households. Current prices, million euro, not seasonally adjusted. Quarterly, aggregated to annual (as averages).	1999-2015 Aggregate final consumption is not available for Ireland.
Household consumption	ECB Statistical Data Warehouse (SDW)	Final consumption expenditure of households and non-profit institutions serving households. Current prices, million euro.	1999-2015 Used only for Ireland.
Household consumption	Eurostat	Final consumption of households (durable goods, semi-durable goods). Current prices, million euro, not seasonally adjusted. Quarterly, aggregated to annual (as averages).	2000-2015 Durable and nondurable consumption not reported by Belgium and Ireland.
Gross domestic product	Eurostat	Gross domestic product at market prices. Current prices, million euro, not seasonally adjusted. Quarterly, aggregated to annual (as averages). We deflate GDP with all-items HICP (2010 = 100) from Eurostat (constructed from monthly data as quarterly averages).	1999-2015
Population	Eurostat	Total population national concept, Thousand persons, Seasonally and calendar adjusted data. Quarterly, aggregated to annual (as averages).	1999-2015
Value added tax	OECD Tax Database Table 2.A2.1	Standard Value Added Tax rate (General Sales Tax) - Annual.	2000-2015
Statutory tax on dividend income (PIT)	OECD Tax Database Table II.4.	Overall statutory tax rate on dividend income (Sum of the rate on distributed profit and the rate on grossed-up dividend). Annual.	2000-2015
Long-term (10Y) sovereign bond yield	OECD MEI (Main Economic Indicators)	Long-term (10Y) sovereign bond yield, not seasonally adjusted. Quarterly, aggregated to annual (as averages).	1999Q1 – 2015Q4
Consumer Price Index	OECD MEI (Main Economic Indicators)	Consumer Price Index, All items (Index 2010=100). Quarterly, aggregated to annual (as averages). We calculate inflation as the growth rate in the Consumer Price Index.	1999Q1 – 2015Q4

US/EUR exchange rate	ECB Statistical Data Warehouse (SDW)	ECB reference exchange rate, USD/EUR. Monthly, aggregated to annual (as averages). We use it to multiply GDP (in EUR) in order to match the currency of financial data (USD).	1999Q1 – 2015Q4