The Scandinavian
Journal of Economics

Scand. J. of Economics 116(1), 253–276, 2014
DOI: 10.1111/sjoe.12043

Debt Crises and Risk-Sharing: The Role of Markets versus Sovereigns

Sebnem Kalemli-Ozcan

University of Maryland, College Park, MD 20742, USA
kalemli@econ.umd.edu

Emiliano Luttini

University of Houston, Houston, TX 77004, USA
eeluttini@uh.edu

Bent Sørensen

University of Houston, Houston, TX 77004, USA
bsorense@central.uh.edu

Abstract

Using a variance decomposition of shocks to gross domestic product (GDP), we quantify the role of international factor income, international transfers, and saving in achieving risk-sharing during the recent European crisis. We focus on the subperiods 1990–2007, 2008–2009, and 2010 and consider separately the European countries hit by the sovereign debt crisis in 2010. We decompose risk-sharing from saving into contributions from government and private saving, and show that fiscal austerity programs played an important role in hindering risk-sharing during the sovereign debt crisis.

Keywords: Capital markets; income insurance; international financial integration

JEL classification: *E*2; *E*6; *F*15

I. Introduction

> The weather soon turned cold. All the food lying in the field was covered with a thick white blanket of snow that even the grasshopper could not dig through. Soon the grasshopper found itself dying of hunger. He staggered to the ants' hill and saw them handing out corn from the stores they had collected in the summer. He begged them for something to eat. "What!" cried the ants in surprise, "haven't you stored anything away for the winter? What in the world were you doing all last summer?" "I didn't have time to store any food," complained the grasshopper; "I was so busy playing music that before I knew it the summer was gone." (The Ant and the Grasshopper, *Aesop's Fables*)

Economic agents often rely on procyclical saving to smooth consumption. As Aesop's fable suggests, lack of saving in good times can hamper

consumption-smoothing in bad times. In this paper, we attempt to quantify if, and how, aggregate consumption in European Union (EU) countries was buffered from output fluctuations in the 1990–2010 period, with a focus on the recent European crisis.

We provide a metric for risk-sharing, which we also refer to as consumption-smoothing, starting from the Arrow–Debreu one-good benchmark model of consumers with identical constant relative risk-aversion utility functions who have access to complete financial markets. The benchmark model's key prediction is that consumption in each country is a constant share of aggregate world consumption.[1] An implication is that consumption growth rates in all countries are equal to the growth rate of world consumption, and we take this implication as the definition of perfect risk-sharing in this paper. Under perfect risk-sharing, the consumption growth of individual countries should be orthogonal to other factors, conditional on world consumption growth.

Starting with Mace (1991), who considered households, this body of literature generally tests whether or not consumption growth rates are orthogonal to income growth conditional on aggregate consumption. At the country level, Obstfeld (1994) has performed similar regressions, testing whether consumption is orthogonal to GDP growth and other variables, conditional on world consumption growth. There is also a parallel body of literature, starting with the influential work of Backus *et al.* (1992), that has compared correlations of consumption growth and output growth with those derived from a more general model with labor–leisure choice and investment. The similar conclusion is that the model of complete markets does not match the empirical data.[2]

The earlier body of literature tests the existence of full risk-sharing against the null of none, while we are interested in evaluating the amount of risk-sharing. To do so, we follow the methodology of Asdrubali *et al.* (1996) and Sørensen and Yosha (1998), who have undertaken a variance decomposition of shocks to GDP in order to discover the amount of risk-sharing achieved via various channels, such as governments versus markets.[3] We calculate how much of the shock to GDP is absorbed by various components of saving, in particular government saving, and other channels, such as net foreign factor income for the subperiods 1990–2007, 2008–2009, and 2010. We find that, overall, risk-sharing in the EU was

[1] See Obstfeld and Rogoff (1996) for a lucent exposition.

[2] See Lewis (1996) and Coeurdacier and Rey (2012) for extensive reviews of this body of literature.

[3] It is possible to translate the deviations from full risk-sharing into measures of welfare lost (see Van Wincoop, 1999; Kalemli-Ozcan *et al.*, 2001). However, such measures are extremely sensitive to the degree of persistence in output shocks, which is hard to estimate precisely.

significantly higher during 2008–2009 than it was during the earlier period, but total risk-sharing more or less collapsed in 2010.[4]

We study how the crisis affected risk-sharing for the "GIIPS" countries (Greece, Ireland, Italy, Portugal, and Spain), which were at the center of the sovereign debt crisis, compared to non-GIIPS countries (Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Sweden, and the UK).[5] For 1990–2009, risk-sharing was mainly due to procyclical government saving, but the amount of risk-sharing from government saving turned negative in 2010 for the GIIPS countries; government saving increased at the same time as GDP decreased. For these countries, our measure of overall risk-sharing turns negative because (conditional on world consumption growth) the decline in GDP in 2010 was accompanied by a more than proportional decline in consumption. This mirrors the behavior of emerging economies where government saving typically is countercyclical, as shown by Kaminsky *et al.* (2005).

If Ricardian equivalence holds, with private saving offsetting government saving one-to-one, the distinction between government and private saving should not matter. We do not rigorously test whether Ricardian equivalence holds. However, if consumption-smoothing from private saving does not fully offset changes in consumption-smoothing from government saving, then this indicates that it does not hold.[6]

We present the methodology in Section II followed by a description of the data in Section III. In Section IV, we report on the empirical analysis and we conclude in Section V.

---

[4] Sørensen and Yosha (1998) have found that country-level risk-sharing provided by markets was low in the period 1966–1990. Asdrubali *et al.* (1996), who were the first to decompose risk-sharing into channels such as market-provided and government-provided risk-sharing, have found that markets provided more risk-sharing (about 40 percent) than the federal government (about 15 percent) for US states in the period 1963–1990. Kalemli-Ozcan *et al.* (2003) have shown that markets provided a similar amount of risk-sharing within European countries (such as regions of Italy and regions of Germany), but much less (around 5 percent) between EU countries before the introduction of the euro. Kalemli-Ozcan *et al.* (2005) have shown that risk-sharing among EU countries increased in step with the introduction of the euro for the eurozone countries.

[5] Ireland is in some ways different, with government deficits mainly being the results of banking failures. Hence, a previous version of the paper did not include Ireland among the GIIPS; however, the results are broadly robust to this choice.

[6] Ricardian equivalence holds under quite restrictive assumptions, such as non-distortionary lump-sum taxes, fully developed financial markets, infinite horizons, and full information about future levels of income, government spending, and rates of return as highlighted by Barro (1999). Barro (1999) has mentioned, in addition to distortionary taxes, that a key reason why equivalence might fail is the existence of a large amount of debt, which can influence governments' incentives to default on outstanding obligations, disconnecting saving decisions between private and government sectors. Both of these conditions are relevant for Europe. Loayza *et al.* (2000) have rejected Ricardian equivalence for a wide range of countries.

II. Methodology: Measuring Channels of Risk-Sharing

Following Sørensen and Yosha (1998), we perform an accounting exercise, which quantifies the fractions of cross-sectional variance in GDP absorbed by wedges between GDP and consumption. We take GDP growth to be exogenous, although this is not crucial because our regressions are not structural.[7]

Consider the identity

$$\mathbf{GDP}_i = \frac{\mathbf{GDP}_i}{\mathbf{GNI}_i}\frac{\mathbf{GNI}_i}{\mathbf{NI}_i}\frac{\mathbf{NI}_i}{\mathbf{NNDI}_i}\frac{\mathbf{NNDI}_i}{\mathbf{CONS}_i}\mathbf{CONS}_i, \tag{1}$$

where **GNI** (gross national income) is GDP plus net factor income from abroad, **NI** (net national income) is gross national income minus depreciation, **NNDI** (net disposable income) is net national income plus net transfers from abroad, while **CONS** (total consumption, private plus government) is net disposable income minus saving. All the magnitudes are in per capita terms, and i is an index of countries. To stress the cross-sectional nature of our derivation, we suppress the time index.

We define GDP_{it}, GNI_{it}, NI_{it}, NNDI_{it}, and CONS_{it} as the log of country i's year t per capita GDP, gross national income, net national income, net national disposable income, and consumption, respectively. By taking logs and differences, multiplying by $\Delta\mathrm{GDP}$ (minus its mean), and taking the cross-sectional average on both sides of equation (1), we obtain the variance decomposition

$$\begin{aligned}\mathrm{var}\{\Delta\mathrm{GDP}\} = {} & \mathrm{cov}\{\Delta\mathrm{GDP} - \Delta\mathrm{GNI}, \Delta\mathrm{GDP}\} + \mathrm{cov}\{\Delta\mathrm{GNI} - \Delta\mathrm{NI}, \Delta\mathrm{GDP}\} \\ & + \mathrm{cov}\{\Delta\mathrm{NI} - \Delta\mathrm{NNDI}, \Delta\mathrm{GDP}\} + \mathrm{cov}\{\Delta\mathrm{NNDI} \\ & - \Delta\mathrm{CONS}, \Delta\mathrm{GDP}\} + \mathrm{cov}\{\Delta\mathrm{CONS}, \Delta\mathrm{GDP}\}.\end{aligned}$$

In this equation, "var{X}" and "cov{X,Y}" denote the statistics $(1/N)\sum_{i=1}^{N}(\mathrm{X}_i - \bar{\mathrm{X}})^2$ and $(1/N)\sum_{i=1}^{N}(\mathrm{X}_i - \bar{\mathrm{X}})(\mathrm{Y}_i - \bar{\mathrm{Y}})$, respectively, where N is the number of countries in the sample. Dividing by var{ΔGDP} we obtain

$$1 = \beta_{\mathrm{f}} + \beta_{\mathrm{d}} + \beta_{\tau} + \beta_{\mathrm{s}} + \beta_{\mathrm{u}},$$

where, for example,

$$\beta_{\mathrm{f}} = \frac{\mathrm{cov}\{\Delta\mathrm{GDP} - \Delta\mathrm{GNI}, \Delta\mathrm{GDP}\}}{\mathrm{var}\{\Delta\mathrm{GDP}\}},$$

is the ordinary least-squares (OLS) estimate of the slope in the cross-sectional regression of $\Delta\mathrm{GDP} - \Delta\mathrm{GNI}$ on $\Delta\mathrm{GDP}$, and similarly for β_{d},

[7] This approach is similar to that of growth and development accounting, which parse GDP growth into contributions from physical and human capital, as suggested by Solow (1957).

β_τ, and β_s. The last coefficient in the decomposition is given by

$$\beta_u = \frac{\text{cov}\{\Delta\text{CONS}, \Delta\text{GDP}\}}{\text{var}\{\Delta\text{GDP}\}},$$

which is the OLS estimate of the slope in the cross-sectional regression ΔCONS on ΔGDP.

If there is full risk-sharing, cov$\{\Delta\text{CONS}, \Delta\text{GDP}\} = 0$, and hence $\beta_u = 0$. If full risk-sharing is not achieved, consumption in country i varies positively with idiosyncratic shocks to country i's output and $\beta_u > 0$. A cross-sectional regression of consumption on output, controlling for fluctuations in world consumption is, therefore, a test of full risk-sharing.[8] The other coefficients quantify the role of the relevant wedges in bringing consumption closer to the Arrow–Debreu benchmark, and we use the more intuitive terminology that these coefficients measure the contributions from various "channels of consumption-smoothing". "Smoothing" from depreciation, which is mainly imputed, is not very interesting, but because it is the wedge between gross national income and net national income, it is included in order to have a full decomposition. In the following, we show that saving is the main channel of consumption-smoothing, as found for an earlier sample of European countries by Sørensen and Yosha (1998). One focus of the present paper is to decompose the contribution from saving into contributions from private (corporate plus household) saving and government saving. Government saving provides risk-sharing if it increases when GDP increases and decreases when GDP decreases, and the same holds for private saving.

We perform panel regressions of the form:

$$\begin{aligned}
\Delta\text{GDP}_{it} - \Delta\text{GNI}_{it} &= \alpha_f^t + \beta_f \Delta\text{GDP}_{it} + \epsilon_{itf},\\
\Delta\text{GNI}_{it} - \Delta\text{NI}_{it} &= \alpha_d^t + \beta_d \Delta\text{GDP}_{it} + \epsilon_{itd},\\
\Delta\text{NI}_{it} - \Delta\text{NNDI}_{it} &= \alpha_\tau^t + \beta_\tau \Delta\text{GDP}_{it} + \epsilon_{it\tau},\\
\Delta\text{NNDI}_{it} - \Delta\text{CONS}_{it} &= \alpha_s^t + \beta_s \Delta\text{GDP}_{it} + \epsilon_{its},\\
\Delta\text{CONS}_{it} &= \alpha_u^t + \beta_u \Delta\text{GDP}_{it} + \epsilon_{itu}.
\end{aligned}$$

As shown by Asdrubali *et al.* (1996), the coefficients estimated in the panel regression with time fixed effects equal weighted averages of the coefficients of year-by-year cross-sectional regressions. Therefore, the coefficients have the interpretation outlined in the variance decomposition. The first regression, to pick one, can alternatively be written as

$$-\Delta \log\left(1 + \frac{\mathbf{NFI}_{it}}{\mathbf{GDP}_{it}}\right) = \alpha_f^t + \beta_f \Delta\text{GDP}_{it} + \epsilon_{itf},$$

[8] This is precisely the test suggested by Mace (1991).

which highlights how income-smoothing, if positive, is obtained through countercyclical foreign net factor income (**NFI** = **GNI** − **GDP**), while the next-to-last equation can be written as

$$\Delta \log\left(1 + \frac{\mathbf{S}_{it}}{\mathbf{CONS}_{it}}\right) = \alpha_{\mathrm{s}}^{t} + \beta_{\mathrm{s}}\Delta \mathrm{GDP}_{it} + \epsilon_{it\mathrm{s}},$$

which highlights how consumption-smoothing, if positive, is obtained through procyclical total saving (**S** = **NNDI** − **CONS**).

It is hard to benchmark the optimal degree of saving in the face of the shocks that materialized in the Great Recession. Saving in good times and dis-saving in bad times is a form of "self-insurance" against consumption fluctuations. However, the optimal amount of saving depends, from the point of view of models of forward-looking consumers, on the persistence of income shocks. The standard permanent income hypothesis (PIH) model implies that it is optimal to not smooth random walk shocks while independent and identically distributed (i.i.d.; temporary) income shocks should be mainly absorbed by saving. In this paper, we do not attempt to model the determinants of saving.[9]

If consumption (gross national income, etc.) is measured with error, this error might migrate to GDP (and other national account components) leading to upward bias in the coefficient to consumption (i.e., to an underestimate of risk-sharing). We believe that this is not a serious issue because GDP to a large extent is measured from the income side, and we believe that government saving, which is one of our main foci, is not measured with error because government budgets are public and subject to outside scrutiny.

The coefficient β_{f} measures risk-sharing from net income from abroad (with a negative estimate indicating dis-smoothing), β_{d} measures risk-sharing from depreciation, β_{τ} measures risk-sharing from international transfers, β_{s} measures risk-sharing from net saving, and β_{u} measures the fraction of GDP shocks reflected in consumption (i.e., the fraction of risk unsmoothed). The regressions all have the same regressor and therefore

[9] Models, such as those of Blundell *et al.* (2008) and Heathcote *et al.* (2012), typically allow for income to be composed of a mix of random walk shocks and i.i.d. shocks. More complicated models, which allow for credit constraints and large non-divisible durables such as housing, predict a more gradual adjustment to random walk shocks (see Luengo-Prado and Sørensen, 2008). However, it is hard to sort out the degree of persistence of shocks in a short panel of aggregate data. As in Attanasio and Davis (1996), a long time dimension is needed to sort out the structure of income shocks. Using the same framework as in the present paper and much longer time series, Asdrubali *et al.* (1996) have shown that US states with more persistent income shocks rely more on smoothing via capital markets and less on smoothing via saving. This pattern agrees with the broad predictions of forward-looking consumer models.

constitute a seemingly unrelated regression equations (SURE) model, where the estimation of single equations gives the same result as a system regression. We can therefore focus, in particular, on saving by estimating the impact of saving, or saving components, alone, without changing any interpretation of the results.

We estimate panel data regressions with GDP shocks interacted with dummy variables for particular time periods in order to examine whether the coefficients vary over time. We display the regression equations for consumption only (other equations follow the same approach in an obvious fashion):

$$\Delta \mathrm{CONS}_{it} = \alpha_{\mathrm{u}}^{t} + \beta_{\mathrm{u}}^{90-07} \Delta \mathrm{GDP}_{it} \times \mathrm{P}^{90-07} + \beta_{\mathrm{u}}^{08-09} \Delta \mathrm{GDP}_{it} \times \mathrm{P}^{08-09} + \beta_{\mathrm{u}}^{10} \Delta \mathrm{GDP}_{it} \times \mathrm{P}^{10} + \epsilon_{it\mathrm{u}},$$

where the dummy variables P^{90-07}, P^{08-09}, and P^{10} take the value unity for the years 1990–2007, 2008–2009, and 2010, respectively, and zero otherwise.

Furthermore, we allow the coefficient to vary between GIIPS and non-GIIPS, by estimating the regression

$$\begin{aligned}\Delta \mathrm{CONS}_{it} = {} & \alpha_{\mathrm{u}}^{t} + \alpha_{\mathrm{u}}^{\mathrm{GIIPS}} \mathrm{D}^{\mathrm{GIIPS}} + \alpha_{\mathrm{u}}^{\mathrm{NGIIPS}} \mathrm{D}^{\mathrm{NGIIPS}} + \beta_{\mathrm{u}}^{\mathrm{GIIPS}\,90-07} \Delta \mathrm{GDP}_{it} \\ & \times \mathrm{P}^{90-07} \times \mathrm{D}^{\mathrm{GIIPS}} + \beta_{\mathrm{u}}^{\mathrm{GIIPS}\,08-09} \Delta \mathrm{GDP}_{it} \times \mathrm{P}^{08-09} \times \mathrm{D}^{\mathrm{GIIPS}} \\ & + \beta_{\mathrm{u}}^{\mathrm{GIIPS}\,10} \Delta \mathrm{GDP}_{it} \times \mathrm{P}^{10} \times \mathrm{D}^{\mathrm{GIIPS}} + \beta_{\mathrm{u}}^{\mathrm{NGIIPS}\,90-07} \Delta \mathrm{GDP}_{it} \\ & \times \mathrm{P}^{90-07} \times \mathrm{D}^{\mathrm{NGIIPS}} + \beta_{\mathrm{u}}^{\mathrm{NGIIPS}\,08-09} \Delta \mathrm{GDP}_{it} \times \mathrm{P}^{08-09} \\ & \times \mathrm{D}^{\mathrm{NGIIPS}} + \beta_{\mathrm{u}}^{\mathrm{NGIIPS}\,10} \Delta \mathrm{GDP}_{it} \times \mathrm{P}^{10} \times \mathrm{D}^{\mathrm{NGIIPS}} + \epsilon_{it\mathrm{u}}.\end{aligned}$$

Here, $\mathrm{D}^{\mathrm{GIIPS}}$ takes the value unity for Greece, Ireland, Italy, Portugal, and Spain, and zero otherwise, while $\mathrm{D}^{\mathrm{NGIIPS}}$ takes the value unity for Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Sweden, and the UK, and zero otherwise.

The amount of smoothing obtained from procyclical saving, β_{s}, can be broken down into smoothing obtained via government and private (personal plus corporate) saving. In order to make the breakdown independent of the order in which we consider these components of saving, we linearize. The OLS formula for the coefficient is

$$\beta_{\mathrm{s}} = \frac{\mathrm{cov}\left(\Delta \mathrm{NNDI} - \Delta \mathrm{CONS}; \Delta \mathrm{GDP}\right)}{\mathrm{var}\left(\Delta \mathrm{GDP}\right)}.$$

Now, we consider

$$\Delta \mathrm{NNDI} - \Delta \mathrm{CONS} = \Delta \log \left(1 + \frac{\mathbf{S}}{\mathbf{CONS}}\right) \approx \frac{\mathbf{S}}{\mathbf{CONS}},$$

We define $\mathbf{S}^{\text{Priv}}$ and $\mathbf{S}^{\text{Gov}}$ as private and government net saving, respectively. Then, $\mathbf{S} = \mathbf{S}^{\text{Priv}} + \mathbf{S}^{\text{Gov}}$ and

$$\begin{aligned}\beta_{\text{s}} &\approx \frac{\text{cov}\left[\Delta(\mathbf{S}/\mathbf{CONS}); \Delta\text{GDP}\right]}{\text{var}\left(\Delta\text{GDP}\right)},\\ &= \frac{\text{cov}\left[\Delta(\mathbf{S}^{\text{Priv}}/\mathbf{CONS}); \Delta\text{GDP}\right]}{\text{var}\left(\Delta\text{GDP}\right)} + \frac{\text{cov}\left[\Delta(\mathbf{S}^{\text{Gov}}/\mathbf{CONS}); \Delta\text{GDP}\right]}{\text{var}\left(\Delta\text{GDP}\right)},\\ &= \beta_{\text{Priv}} + \beta_{\text{Gov}}.\end{aligned}$$

Here, β_{Priv} and β_{Gov} estimate the fraction (of GDP shocks) insured through procyclical private and government saving, respectively. We estimate those coefficients by running the following panel data regressions with time-fixed effects:

$$\Delta\frac{\mathbf{S}^{\text{Priv}}_{it}}{\mathbf{CONS}_{it}} = \alpha^{t}_{\text{Priv}} + \beta_{\text{Priv}}\Delta\text{GDP}_{it} + \epsilon_{it\text{Priv}},$$

$$\Delta\frac{\mathbf{s}^{\text{Gov}}_{it}}{\mathbf{CONS}_{it}} = \alpha^{t}_{\text{Gov}} + \beta_{\text{Gov}}\Delta\text{GDP}_{it} + \epsilon_{it\text{Gov}}.$$

III. Data

The main source of data for this study is the OECD. The GDP, gross national income, net national disposable income, (government plus private) consumption, and private and government saving are from the annual national accounts main aggregates, detailed tables, and simplified accounts sections. The CPI and nominal exchange rates are from the prices and purchasing power parities statistics, while the populations of the countries are from the demography and population statistics. In order to make our data comparable across countries and time, the GDP, national income, disposable income, consumption, and private and government saving are transformed to real per capita 2005 dollars.

Net government and external debt are from the World Economic Outlook (WEO) and the European Central Bank (ECB). In particular, government debt is net government debt (percentage of GDP) from the WEO, where this variable is defined as gross debt of the general government sector minus its financial assets in the form of debt instruments.[10] External debt is the

[10] The WEO defines general government gross debt as all liabilities that require payment or payments of interest and/or principal by the debtor to the creditor at a date or dates in the future (which includes debt liabilities in the form of special drawing rights, currency and deposits, debt securities, loans, insurance, pensions and standardized guarantee schemes, and other accounts payable). In addition, financial assets in the form of debt instruments include currency and deposits, debt securities, loans, insurance, pension, and standardized guarantee schemes, and other accounts receivable.

outstanding amount on the financial account of the balance of payments statistics at the end of the fourth quarter of each year from the ECB data warehouse.[11]

IV. Empirical Analysis

Descriptive Statistics

Table 1 shows net government and net external debt by country. As expected, the GIIPS are heavily indebted, with Greece having government debt equal to 144 percent of GDP and Italy having debt roughly similar to GDP in 2010. Spain's net debt is lower than that of many non-GIIPS. This indicates that the level of debt is just one of several factors determining sovereign debt crises, as also highlighted by Reinhart and Rogoff (2009). Net external debt is at the level of GDP for Greece, Portugal, and Spain, but much lower at 24 percent for Italy. Ireland had external debt of about 84 percent of GDP in 2010 but had low government debt before the crisis hit: 21 percent pre-2008 and 33 percent in 2008–2009. However, Irish net government debt ballooned to 75 percent of GDP in 2010 because of large government bailouts of banks. The level of net government debt varies widely between the non-GIIPS from −65 percent of GDP in Finland in 2010 to 79 percent in Belgium in 2010. Net external debt is low for all non-GIIPS, with Belgium's net foreign assets (negative debt) at 64 percent of GDP in 2010.

Graphical Exposition

Our story can be told roughly from the figures. Figures 1(a) and 1(b) consider GIIPS and non-GIIPS, respectively, for the years after 2000. We display GDP growth in percent year-by-year and split it into the change in consumption (as a share of GDP) – with a slight abuse of language, we interpret this as risk not shared – and the remainder, which we interpret as the fraction of GDP risk shared. The figures do not literally tell a story about risk-sharing because there is no adjustment for the aggregate non-insurable component, but the *prima facie* evidence displayed holds up in the empirical analysis in the next subsection.

From the figures, most risk is not shared, although non-GIIPS countries shared a non-negligible amount of risk during the period 2000–2007, while the GIIPS shared little risk in those years. In the good year 2005, consumption increased faster than GDP leading to "negative risk-sharing". In 2008 and 2009, the major amount of GDP risk is shared for non-GIIPS with low

[11] The series were incomplete for France and Belgium; in both cases, we fill the missing values with data from Lane and Milesi-Ferretti (2007); see http://www.philiplane.org/EWN.html.

Table 1. *Descriptive statistics: government and external debt*

	Net government debt			Net external debt		
	2000–2007	2008–2009	2010	2000–2007	2008–2009	2010
Panel A: GIIPS						
Greece	94	120	144	65	82	96
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
Ireland	21	33	74	16	84	88
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
Italy	89	92	99	14	24	23
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
Portugal	52	73	88	62	102	107
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
Spain	39	36	49	50	86	88
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
Panel B: Non-GIIPS						
Austria	43	45	52	20	12	8
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
Belgium	86	76	79	–37	–46	–64
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
Denmark	12	–5	–1	8	0	–13
	(2.87)	(5.23)	.	(5.78)	(5.65)	.
Finland	–47	–57	–65	44	4	–11
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
France	56	67	76	–5	11	7
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
Germany	48	53	56	–13	–29	–34
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
The Netherlands	25	21	27	7	–10	–22
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
Sweden	–1	–15	–20	20	9	7
	(2.87)	(5.23)	.	(5.79)	(5.65)	.
UK	35	53	70	16	13	23
	(2.87)	(5.23)	.	(5.79)	(5.65)	.

Notes: Net government and external debt, as percentages of GDP, averaged over the periods 2000–2007, 2008–2009, and 2010. Standard deviations are given in parentheses. Net government and external debt are from the WEO and the ECB, and are defined as in Figure 3.
Source: Authors' own calculations based on WEO and ECB data.

consumption growth rates in spite of large drops in GDP, with the amount of risk shared in 2008 over 100 percent (positive consumption growth in spite of negative GDP growth). For the GIIPS, consumption declined very little in 2008 in spite of a large drop in GDP, while the drop in GDP in 2009 clearly led to declining consumption; in 2010, consumption fell by almost as much as GDP, indicating little risk-sharing.

Figures 2(a) and 2(b) decompose GDP growth into changes in foreign net factor income, private saving, government saving, and consumption – all as shares of GDP, so that these components add up to GDP. Shares that are on the same side of the x-axis as GDP growth contribute to consumption-smoothing. We see, for non-GIIPS, the dominant role of government saving

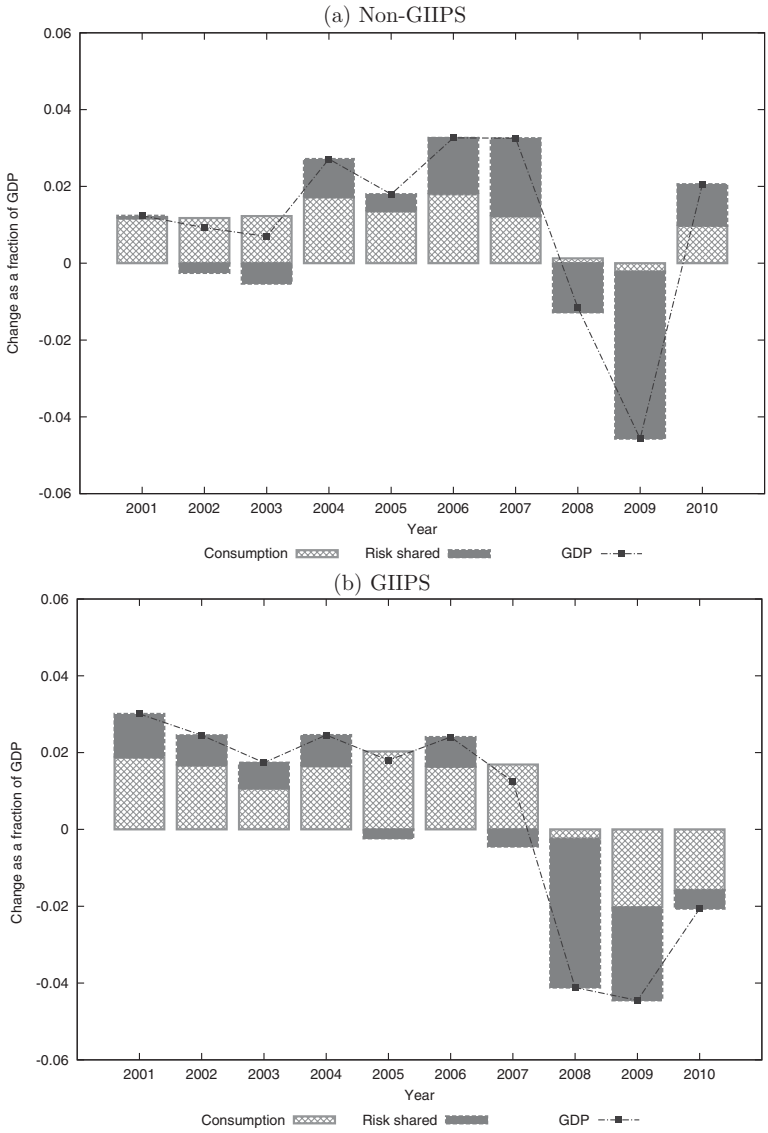

Fig. 1. Risk-sharing. Figure 1(a) and 1(b) display the annual growth of aggregate GDP and (hatched shading) aggregate consumption as a share of GDP (i.e., the dollar change in consumption as a fraction of lagged GDP) for GIIPS and non-GIIPS, respectively. The change in consumption can be interpreted as the amount of GDP risk not shared, while the difference between GDP growth and consumption growth can be interpreted as the amount of risk shared in a given year. GIIPS denotes Greece, Ireland, Italy, Portugal, and Spain and non-GIIPS denotes Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Sweden, and the UK

Source: Authors' own calculations based on OECD data.

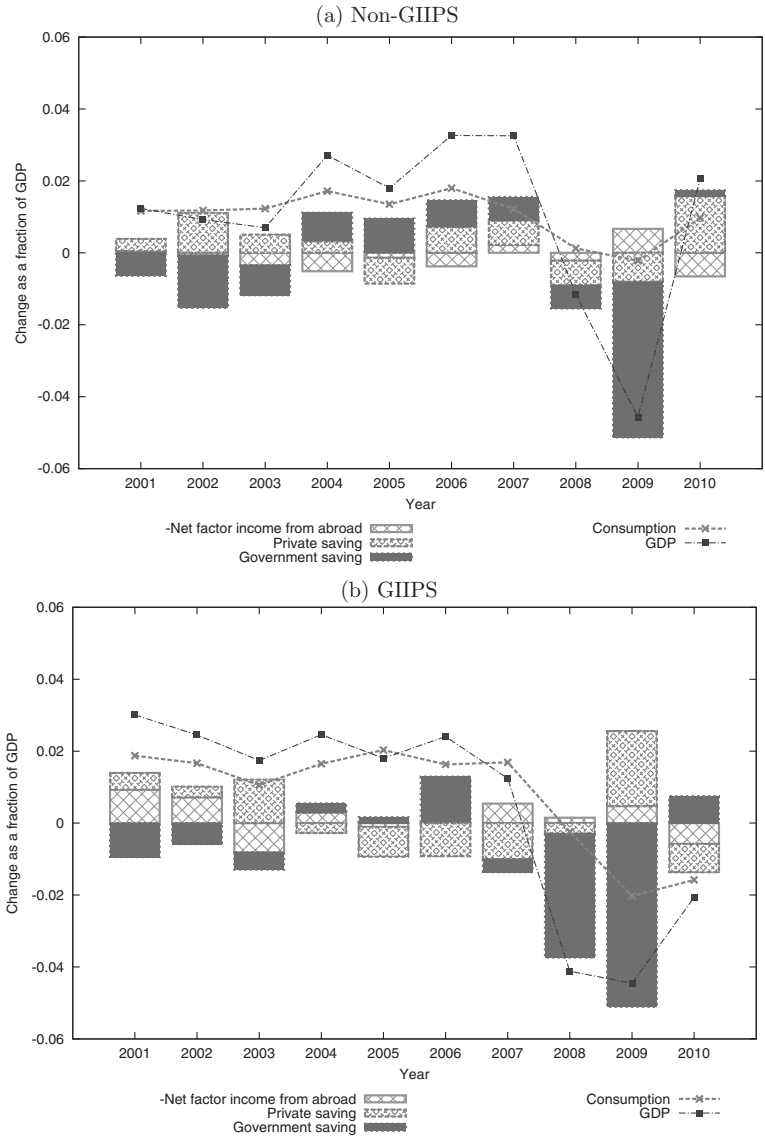

Fig. 2. Decomposition of GDP growth. The bars in Figure 2(a) and 2(b) represent the annual growth of aggregate net factor payments from the domestic country (i.e., net factor income with the sign reversed), aggregate government saving, and aggregate private saving – all as shares of GDP. The height of each bar can be interpreted as the amount of risk shared through a specific factor, and the vertical distance between GDP and consumption as the total amount of risk shared in a given period. GIIPS denotes Greece, Ireland, Italy, Portugal, and Spain and non-GIIPS denotes Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Sweden, and the UK

Source: Authors' own calculations based on OECD data.

in smoothing consumption, with negative saving during the periods 2001–2003 and 2008–2009, and positive saving during the period 2004–2007. Government saving is positive in 2010, reflecting budget tightening in response to heavy government debt burdens, but very close to zero. Private saving visibly buffered GDP shocks for the non-GIIPS countries during the period 2008–2009 and absorbed most of the GDP growth in 2010. For the GIIPS, almost all risk-sharing during 2008 and 2009 was provided by governments, which increased deficits, while private saving increased in 2009 dis-smoothing GDP shocks. In 2010, where GDP growth was negative for the GIIPS, the sovereign debt crisis forced government saving to dis-smooth because the governments tightened budgets dramatically and risk-sharing was basically only provided by private saving in 2010. For GIIPS, net foreign factor income also provided some consumption-smoothing in 2010.

Figures 3(a) and 3(b) display the evolution of net government debt and net external (foreign) debt for GIIPS and non-GIIPS. It is immediately apparent that the governments of GIIPS countries have been more heavily indebted for the full period. In particular, since 2007, the indebtedness of GIIPS has increased rapidly. Regarding net external debt, the two groups of countries were at similar debt levels in 2000 but, while net foreign debt has dwindled to nil for the non-GIIPS, it has steadily increased for the GIIPS. In 2010, government debt of GIIPS was over 90 percent and net foreign debt was about 80 percent. This is a typical sovereign debt scenario where a heavy government debt burden is reflected in heavy net foreign indebtedness.

Figures 4(a) and 4(b) show how international capital flows (defined here as minus the current account balance), for GIIPS in particular, are dominated by debt flows. It is clear that before the crisis, during the period 2001–2007, the increased degree of financial integration helped channel funds from the European core to, in particular, Greece, Ireland, Portugal, and Spain as these countries experienced booms in productivity. However, most of the capital flows were in the form of debt. When the Great Recession hit, capital flows declined while government debt flows ballooned.

Regression Analysis

Table 2 reports on the channels of risk-sharing by the chosen subperiods. Panel A displays averages across all countries while Panel B displays results for GIIPS and non-GIIPS. For the 1990–2007 period, net factor income from abroad in Panel A is insignificant at 5 percent. Net factor income is a function of cross-ownership of financial assets – the type of risk-sharing that matches up best with the stylized Arrow–Debreu model.

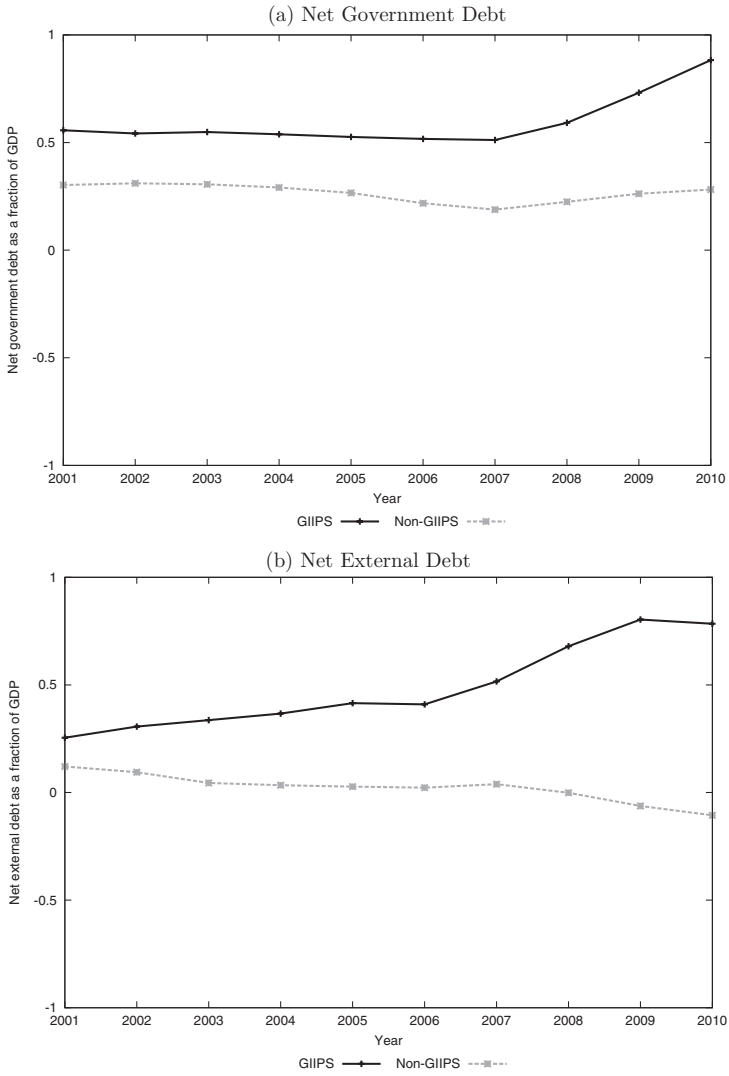

Fig. 3. Net government and external debt: non-GIIPS versus GIIPS. Net government and external debt are aggregate net government and external debt (each as a fraction of aggregate GDP) for each country group. Country data on net government and external debt are from the WEO and the ECB. Net government debt is defined as gross debt of the general government sector minus its financial assets in the form of debt instruments. External debt is the outstanding amount on the financial account of the balance of payments statistics at the end of the fourth quarter of each year. GIIPS denotes Greece, Ireland, Italy, Portugal, and Spain. Non-GIIPS denotes Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Sweden, and the UK

Source: Authors' own calculations based on WEO and ECB data.

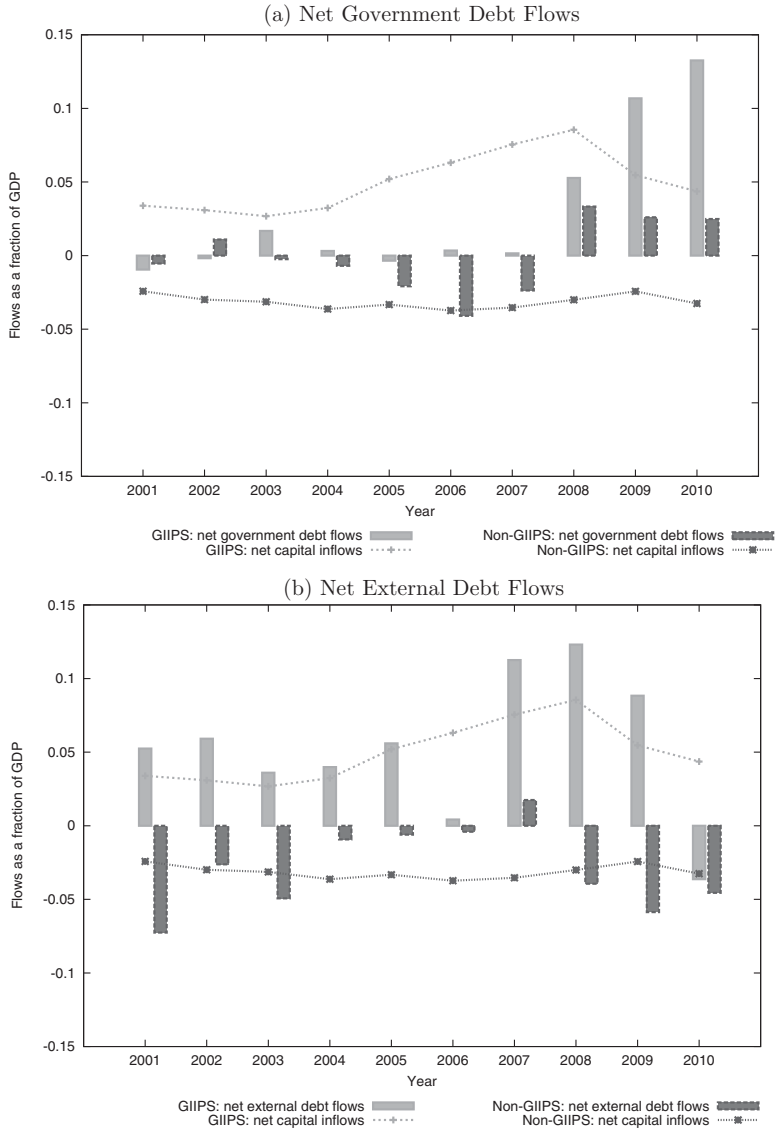

Fig. 4. Net government and external debt flows: non-GIIPS versus GIIPS. For each country group, net government and external debt flows are measured as the change in aggregate net government and external debt. Capital inflows is the aggregate current account surplus with the sign reversed (each as a fraction of aggregate GDP). Country data on net government debt and current accounts are from the WEO and net external debt is from the ECB. Net government debt and external debt are defined as in Figure 3. GIIPS denotes Greece, Ireland, Italy, Portugal, and Spain and non-GIIPS denotes Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Sweden, and the UK
Source: Authors' own calculations based on WEO and ECB data.

Table 2. *Risk-sharing*

	Channels of risk-sharing				Unsmoothed
	β_f	β_d	β_τ	β_s	β_u
Panel A: Group					
GDP (1990–2007)	5	–7	0	49***	53***
	(0.87)	(–1.57)	(–0.00)	(5.47)	(7.62)
GDP (2008–2009)	4	–1	5	52***	40***
	(0.35)	(−0.43)	(1.17)	(3.77)	(2.91)
GDP (2010)	1	–21***	1	33***	86***
	(0.16)	(–4.45)	(0.68)	(3.04)	(6.26)
Panel B: Non-GIIPS versus GIIPS					
GDP (1990–2007) (non-GIIPS)	–5	–11***	–1	60***	57***
	(–1.53)	(–4.24)	(–0.46)	(6.19)	(8.10)
GDP (2008–2009) (non-GIIPS)	25	–5	7	57***	16
	(1.65)	(–1.16)	(1.52)	(3.02)	(1.02)
GDP (2010) (non-GIIPS)	12	–23**	6	60***	45***
	(0.86)	(–2.54)	(1.06)	(3.23)	(4.32)
GDP (1990–2007) (GIIPS)	12***	–5**	1	31***	61***
	(3.01)	(–2.29)	(0.55)	(4.66)	(12.69)
GDP (2008–2009) (GIIPS)	–3	1	4	47***	51***
	(–0.29)	(0.21)	(0.82)	(2.70)	(2.61)
GDP (2010) (GIIPS)	–13	–21***	1	19	114***
	(–1.59)	(–4.26)	(0.17)	(1.55)	(14.13)
No. of observations			281		

Notes: In Panel A, we estimate the relations $\Delta\text{GDP}_{it} - \Delta\text{GNI}_{it} = \alpha_f^t + \sum_x \beta_f^x \Delta\text{GDP}_{it} \times \text{P}^x + \epsilon_{it\text{f}}$, $\Delta(\text{GNI} - \text{NI})_{it} = \alpha_d^t + \sum_x \beta_d^x \Delta\text{GDP}_{it} \times \text{P}^x + \epsilon_{it\text{d}}$, $\Delta(\text{NI} - \text{NNDI})_{it} = \alpha_\tau^t + \sum_x \beta_\tau^x \Delta\text{GDP}_{it} \times \text{P}^x + \epsilon_{it\tau}$, $\Delta \log[1 + (\mathbf{S}_{it}/\mathbf{CONS}_{it})] = \alpha_s^t + \sum_x \beta_s^x \Delta\text{GDP}_{it} \times \text{P}^x + \epsilon_{its}$, and $\Delta\text{CONS}_{it} = \alpha_u^t + \sum_x \beta_u^x \Delta\text{GDP}_{it} \times \text{P}^x + \epsilon_{it\text{u}}$. Here, x belongs to $\{90-07, 08-09, 10\}$; GDP, GNI, NI, and CONS are log GDP, gross national income, net national income, net national disposable income, and total consumption, respectively; **S** is net saving; **CONS** is total consumption; P^x is a dummy variable for the period x; and α^t are time fixed effects. The panel shows the β^x coefficients. The estimated values of β_f, β_d, β_τ, and β_s are interpreted as the percentage of consumption-smoothing obtained through international capital markets, physical capital depreciation, net transfers, and domestic saving, respectively. Here, $1 - \beta_u^x$ is interpreted as the percentage of output shocks smoothed in period x. In Panel B, we estimate the relations $\Delta\text{GDP}_{it} - \Delta\text{GNI}_{it} = \alpha_f^t + \sum_y \alpha_f^y \text{D}^y + \sum_y \sum_x \beta_f^{yx} \Delta\text{GDP}_{it} \times \text{D}^y \times \text{P}^x + \epsilon_{it\text{f}}$, $\Delta(\text{GNI} - \text{NI})_{it} = \alpha_d^t + \sum_y \alpha_d^y \text{D}^y + \sum_y \sum_x \beta_d^{yx} \Delta\text{GDP}_{it} \times \text{D}^y \times \text{P}^x + \epsilon_{it\text{d}}$, $\Delta(\text{NI} - \text{NNDI})_{it} = \alpha_\tau^t + \sum_y \alpha_\tau^y \text{D}^y + \sum_y \sum_x \beta_\tau^{yx} \Delta\text{GDP}_{it} \times \text{D}^y \times \text{P}^x + \epsilon_{it\tau}$, $\Delta \log[1 + (\mathbf{S}_{it}/\mathbf{CONS}_{it})] = \alpha_s^t + \sum_y \alpha_s^y \text{D}^y + \sum_y \sum_x \beta_s^{yx} \Delta\text{GDP}_{it} \times \text{D}^y \times \text{P}^x + \epsilon_{its}$, and $\Delta\text{CONS}_{it} = \alpha_u^t + \sum_y \alpha_u^y \text{D}^y + \sum_y \sum_x \beta_u^{yx} \Delta\text{GDP}_{it} \times \text{D}^y \times \text{P}^x + \epsilon_{it\text{u}}$. Here, y belongs to $\{\text{NGIIPS}, \text{GIIPS}\}$, D^y is a dummy variable for the group y, and the other variables and coefficients are defined as in Panel A. The panel shows the β^{yx} coefficients. All coefficients are estimated by feasible GLS using annual data from the period 1990–2010. The countries in the sample are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the UK. GIIPS represents Greece, Ireland, Italy, Portugal, and Spain while GIIPS are the other countries. The t-statistics are given in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

Here, we do not separate out interest payments on government debt from dividends and private interest income. However, we believe that the lack of private ownership across national borders results in low risk-sharing among the members the European Monetary Union, in contrast to US states for whom income-smoothing is very significant at about 40 percent and increasing slowly over time according to Asdrubali *et al.* (1996). Similarly, at the country level, Sørensen and Yosha (1998) have found no significant

risk-sharing from net factor income flows pre-1990. Splitting the sample into GIIPS and non-GIIPS, factor income flows significantly smoothed consumption for GIIPS before 2007 while providing insignificant risk-sharing for non-GIIPS. This likely reflects the fact that the GIIPS had relatively high growth before 2007, at the same time as dividends and interest payments from the GIIPS were high, as a result of large inflows of capital after these countries joined the eurozone.[12]

Our point estimates indicate that net factor income has provided economically important (12 percent) positive risk-sharing for non-GIIPS since 2007, although the sample is too short to obtain statistical significance. For the GIIPS, net factor income flows provided little smoothing during the period 2008–2009, but the estimate turns negative at 13 percent for 2010. This point estimate is not statistically significant, reflecting that the estimate is based on five observations, but it is believable that higher interest payments on government debt held abroad led to an unwelcome outflow of capital income at a time when GDP declined.[13]

Depreciation provides a fair amount of dis-smoothing, in that depreciation is an expense that is roughly constant. So, when GDP goes up, this expense becomes a smaller fraction of GDP, which our metric measures as dis-smoothing, and vice versa when GDP goes down. This channel is mechanical and not of much interest, but is included in order to have all wedges between GDP and consumption. International transfers are not large enough to provide significant risk-sharing.

Our focus in this paper is on the role of saving, because saving is such a large proportion of GDP, and because saving displayed such large variation during the crisis years that we are able to obtain statistically significant estimates. Before the Great Recession, saving absorbed 49 percent of shocks and this increased slightly to 52 percent in the period 2008–2009 before pulling back to 33 percent in 2010. This leaves a substantial amount of variation unsmoothed: 53 percent before the Great Recession, falling to 40 percent during the period 2008–2009, and 86 percent in 2010. Before 2008, GIIPS smoothed about 30 percent of GDP shocks through saving, while non-GIIPS smoothed a substantial 60 percent. During the period 2008–2009, smoothing through saving declined slightly to 57 percent among non-GIIPS while rising to 47 percent for the GIIPS. None the less, only an insignificant 16 percent was unsmoothed for the non-GIIPS, while

[12] Kalemli-Ozcan *et al.* (2005) have found that risk-sharing from foreign factor income turned significantly positive in the euro area around the time of the introduction of the euro.

[13] This result is a little unexpected because aggregate net factor income was positive for the GIIPS in 2010, according to Figure 2. However, Figure 2 does not control for time fixed effects (year-by-year "world averages"). Also, large countries will dominate the aggregates in Figure 2, but affect the regression less strongly.

Table 3. *Saving and risk-sharing*

	Saving	
	Government (β_{Gov})	Private (β_{Priv})
Panel A: Group		
GDP (1990–2007)	16**	33***
	(2.09)	(4.19)
GDP (2008–2009)	62***	–10
	(5.87)	(–0.98)
GDP (2010)	–24*	57***
	(–1.82)	(4.34)
Panel B: Non-GIIPS against GIIPS		
GDP (1990–2007) (non-GIIPS)	46***	14**
	(7.85)	(2.46)
GDP (2008–2009) (non-GIIPS)	38***	19
	(2.73)	(1.36)
GDP (2010) (non-GIIPS)	17	44*
	(0.65)	(1.69)
GDP (1990–2007) (GIIPS)	15***	16***
	(2.71)	(2.89)
GDP (2008–2009) (GIIPS)	73***	–25**
	(6.67)	(–2.33)
GDP (2010) (GIIPS)	–38**	57***
	(–1.98)	(2.97)
No. of observations	281	

Notes: In Panel A, we jointly estimate the relations $\Delta(\mathbf{S}^j_{it}/\mathbf{CONS}_{it}) = \alpha^t_j + \sum_x \beta^x_j \Delta\text{GDP}_{it} \times \text{P}^x + \epsilon_{itj}$, for $j = \{\text{Gov, Priv}\}$, with the constraints $\beta^x_{\text{Gov}} + \beta^x_{\text{Priv}} = \beta^x_{\text{s}}$, where $\mathbf{S}^{\text{Gov}}$ and $\mathbf{S}^{\text{Priv}}$ are government and private saving, respectively, **CONS** is total consumption, GDP, x, P^x, β^x_{s}, and α^t are defined as in Panel A of Table 2. The panel shows the β^x coefficients. The coefficients β^x_{Gov} and β^x_{Priv} are interpreted as the amount of consumption-smoothing reached through government and private saving, respectively, during period x. In Panel B, we jointly estimate the relations $\Delta(\mathbf{S}^j_{it}/\mathbf{CONS}_{it}) = \alpha^t_j + \sum_y \alpha^y_j \text{D}^y + \sum_y \sum_x \beta^{yx}_j \Delta\text{GDP}_{it} \times \text{D}^y \times \text{P}^x + \epsilon_{itj}$, for $j = \{\text{Gov, Priv}\}$, with the constraints $\beta^{yx}_{\text{Gov}} + \beta^{yx}_{\text{Priv}} = \beta^{yx}_{\text{s}}$. Here, y and D^y are defined as in Panel B of Table 2, and the other variables and coefficients are defined as in Panel A of this table. The panel displays the β^{yx} coefficients. All coefficients are estimated by feasible GLS, using the same countries, country groups, and periods as in Table 2. The t-statistics are given in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

51 percent of shocks went unsmoothed for GIIPS during the period 2008–2009. However, as the sovereign crisis raised its ugly head, risk-sharing collapsed among the GIIPS mainly because of the collapse of procyclical saving. Indeed, for the GIIPS, each percent decline in GDP in 2010 was accompanied by a more than 1 percent decline in consumption, while the fraction unsmoothed for non-GIIPS was 45 percent.

Is the collapse in risk-sharing a result of changes in the behavior of government or private saving? Table 3 shows that government saving for non-GIIPS absorbed 46 percent of GDP shocks before the crisis, while private saving absorbed 14 percent. For GIIPS, private saving smoothed 16 percent of shocks, similar to the results for non-GIIPS, while risk-sharing from government saving was 15 percent (i.e., low compared to the

non-GIIPS), indicating that the government surpluses of the fast-growing GIIPS were not very high. In the period 2008–2009, as GDP fell, GIIPS governments dis-saved to the extent that government dis-saving absorbed 73 percent of the fall in GDP (after controlling for the aggregate unsmoothable component), while government dis-saving absorbed 38 percent of shocks among the non-GIIPS. Among the GIIPS, private saving increased as GDP fell, leading to a negative contribution to risk-sharing, partly offsetting the governments dis-saving. However, for non-GIIPS, the contribution from private saving was roughly unchanged at 19 percent (although statistically insignificant). In 2010, risk-sharing from government saving declined to an insignificant 17 percent for non-GIIPS because government saving was positive but negligible, as shown in Figure 2, but positive private saving helped smooth consumption significantly. For GIIPS in 2010, private dis-saving provided substantial consumption-smoothing at 57 percent; however, positive government saving resulted in significant dis-smoothing at −38 percent. This emphasizes the main point of our paper: government budgets cannot provide substantial smoothing over long and deep recessions unless governments save in advance. This contrasts to risk-sharing through cross-ownership of stocks – foreign investors will share the risk of falling stock values, but this does not, in general, lead to debt spirals where high debt leads to risk of sovereign default, which leads to higher interest payments, leading to increasing debt, and so on.

In Table 4, using the national account identity, $\mathbf{S} = \mathbf{CA} + \mathbf{I} - \delta\mathbf{K}$, where $\mathbf{CA}$ is the surplus on the current account and $\mathbf{I} - \delta\mathbf{K}$ is net investment, we explore how the "uses" of saving – domestic physical investment or cross-border asset purchases – contributed to consumption-smoothing. For non-GIIPS, self-insurance, in the form of procyclical real investment at home, provided substantial risk-sharing before the Great Recession at 46 percent, while procyclical current-account surpluses provided less, but still statistically significant, smoothing at 14 percent. In the 2008–2009 Great Recession years, these channels contributed about equally, with high significance, with 32 percent of the GDP decline offset by declining current accounts and 25 percent by investment. For 2010, for the non-GIIPS, smoothing via the current account was not significant, although the point estimate is numerically large but negative. Procyclical real investment absorbed 86 percent of GDP growth for the non-GIIPS in 2010. For the GIIPS, the current account surplus dis-smoothed consumption by being countercyclical before the Great Recession, leading to 11 percent dis-smoothing. However, in the period 2008–2009, the current-account balances for the GIIPS improved, at the same time as GDP contracted, leading to significant dis-smoothing at −22 percent. During the period 2008–2009, this dis-smoothing was outweighed by sharply declining real investment, which helped smooth consumption substantially at 69 percent. For the GIIPS, real investment

Table 4. *Capital flows, investment, net exports, and risk-sharing*

	Net investment (β_{I})	Net capital outflows (β_{CA})	Net exports (β_{NX})
Panel A: Group			
GDP (1990–2007)	50***	–1	11*
	(7.05)	(–0.11)	(1.84)
GDP (2008–2009)	57***	–5	–1
	(5.94)	(–0.53)	(–0.05)
GDP (2010)	64***	–31***	–27**
	(5.44)	(–2.66)	(–2.29)
Panel B: Non-GIIPS versus GIIPS			
GDP (1990–2007) (non-GIIPS)	46***	14***	5
	(9.31)	(2.80)	(1.01)
GDP (2008–2009) (non-GIIPS)	25**	32***	51***
	(2.12)	(2.68)	(3.72)
GDP (2010) (non-GIIPS)	85***	–25	–11
	(3.89)	(–1.14)	(–0.60)
GDP (1990–2007) (GIIPS)	41***	–11**	7
	(8.94)	(–2.36)	(1.21)
GDP (2008–2009) (GIIPS)	69***	–22**	–21
	(7.45)	(–2.35)	(–1.22)
GDP (2010) (GIIPS)	53***	–34**	–44***
	(3.24)	(–2.08)	(–2.72)
No. of observations		281	

Notes: In Panel A, the first two columns show the β^x coefficients from jointly estimating $\Delta(\mathbf{I}_{it}/\mathbf{CONS}_{it}) = \alpha_{\mathrm{I}}^t + \sum_x \beta_{\mathrm{I}}^x \Delta\mathrm{GDP}_{it} \times \mathrm{P}^x + \epsilon_{it\mathrm{I}}$ and $\Delta(\mathbf{CA}_{it}/\mathbf{CONS}_{it}) = \alpha_{\mathrm{CA}}^t + \sum_x \beta_{\mathrm{CA}}^x \Delta\mathrm{GDP}_{it} \times \mathrm{P}^x + \epsilon_{it\mathrm{CA}}$, with the constraints $\beta_{\mathrm{I}}^x + \beta_{\mathrm{CA}}^x = \beta_{\mathrm{s}}^x$. The third column shows the β^x coefficients from estimating $\Delta[\mathrm{GDP} - \log(\mathbf{GDP} - \mathbf{NX})]_{it} = \alpha_{\mathrm{NX}}^t + \sum_x \beta_{\mathrm{NX}}^x \Delta\mathrm{GDP}_{it} \times \mathrm{P}^x + \epsilon_{it\mathrm{NX}}$, where **I**, **CA**, **NX**, **GDP**, and **CONS** are net investment, current account, net exports, GDP, and consumption, respectively. Here, GDP, x, P^x, β_{s}^x, and α^t are defined as in Table 2, and β_{I}, β_{CA}, and β_{NX} are interpreted as consumption-smoothing obtained through net investment, net capital outflows, and trade, respectively. In Panel B, the first two columns show the β^{yx} coefficients from jointly estimating $\Delta(\mathbf{I}_{it}/\mathbf{CONS}_{it}) = \alpha_{\mathrm{I}}^t + \sum_y \alpha_{\mathrm{I}}^y \mathrm{D}^y + \sum_y \sum_x \beta_{\mathrm{I}}^{yx} \Delta\mathrm{GDP}_{it} \times \mathrm{D}^y \times \mathrm{P}^x + \epsilon_{it\mathrm{I}}$ and $\Delta(\mathbf{CA}_{it}/\mathbf{CONS}_{it}) = \alpha_{\mathrm{CA}}^t + \sum_y \alpha_{\mathrm{CA}}^y \mathrm{D}^y + \sum_y \sum_x \beta_{\mathrm{CA}}^{yx} \Delta\mathrm{GDP}_{it} \times \mathrm{D}^y \times \mathrm{P}^x + \epsilon_{it\mathrm{CA}}$, with the constraints $\beta_{\mathrm{I}}^{yx} + \beta_{\mathrm{CA}}^{yx} = \beta_{\mathrm{s}}^{yx}$. The third column shows the β^{yx} coefficients from estimating $\Delta[\mathrm{GDP} - \log(\mathbf{GDP} - \mathbf{NX})]_{it} = \alpha_{\mathrm{NX}}^t + \sum_y \alpha_{\mathrm{NX}}^y \mathrm{D}^y + \sum_y \sum_x \beta_{\mathrm{NX}}^{yx} \Delta\mathrm{GDP}_{it} \times \mathrm{D}^y \times \mathrm{P}^x + \epsilon_{it\mathrm{NX}}$, where y and D^y are defined as in Panel B of Table 2, and the other variables and coefficients are defined as in Panel A of this table. All coefficients are estimated by feasible GLS, using the same countries, country groups, and periods as in Table 2. The t-statistics are given in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

declined in 2010, absorbing 53 percent of the decline in GDP growth, but the current accounts improved significantly, providing substantial dis-smoothing at 34 percent. For completeness, we also show income-smoothing through net exports.[14] Net exports absorb roughly the same as the current account, reflecting that these series are highly correlated, although the results for the current account generally are estimated with more precision during the crisis years.

[14] The relevant national accounts identity is GDP − CONS = I + (NX) where I is now is gross investment and NX is net exports. Gross investment behaves quite similar to net investment and we do not display smoothing through gross invest separately.

Table 5. *Crises and risk-sharing*

	Channels of risk-sharing				Unsmoothed
	β_f	β_d	β_τ	β_s	β_u
Panel A: financial crises and non-peripheral developed economies					
GDP (Others) (Core)	6	–4	–5	47***	56***
	(0.83)	(–0.85)	(–0.96)	(3.56)	(5.78)
GDP (1991–1994) (Core)	4	–4	–5	31**	74***
	(0.83)	(–1.08)	(–1.01)	(2.25)	(6.55)
GDP (1997–2001) (Core)	8	–10**	–2	41***	63***
	(0.86)	(–2.36)	(–0.54)	(3.06)	(6.07)
Panel B: financial crises in developed countries					
GDP (Others) (Nordic)	3	–14***	–3	86***	28***
	(0.79)	(–3.68)	(–0.92)	(8.90)	(3.24)
GDP (1991–1994) (Nordic)	–15***	–18***	–1	87***	47***
	(–3.68)	(–4.70)	(–0.65)	(5.06)	(3.27)
GDP (Others) (Japan)	–6	6	0	39*	61***
	(–0.76)	(0.82)	(0.04)	(1.96)	(4.20)
GDP (1997–2001) (Japan)	1	11	–7	38**	57**
	(0.12)	(0.75)	(–0.94)	(2.03)	(2.27)
No. of observations			323		

Notes: The decomposition is constructed in a similar manner to that in Panel B of Table 2, but now x and y belong to $\{91-94, 97-01, 08-09, 10, \text{OTHERS}\}$ (OTHERS includes the years 1990, 1995–1996, and 2002–2007) and {CORE, JAPAN, GIIPS, NORDIC}, respectively. Panel A shows the coefficients corresponding to CORE, while the coefficients in Panel B correspond to NORDIC and JAPAN. All coefficients are estimated by feasible GLS using annual data for the period 1990–2010. The countries considered in the sample are the same as in Table 2 but including Japan and Norway. CORE includes Austria, Belgium, Denmark, France, Germany, the Netherlands, and the UK, while NORDIC denotes Finland, Norway, and Sweden. The t-statistics are given in parentheses. ****, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

In order to examine whether the patterns observed for the GIIPS during the Great Recession are atypical, Table 5 displays the decomposition of risk-sharing during two severe crises affecting developed countries: the Nordic banking crisis of 1991–1994, which severely affected Finland, Norway, and Sweden, and the Japanese crisis of 1997–2001. Commenting only on the significant coefficients during the crises, we observe that the Nordic crisis was accompanied by severe dis-smoothing from net factor income, which might have been a result of high interest rates paid on Nordic debt, as the governments tried to defend the currency values. However, we are not able to verify this conjecture in this paper. In Japan, the overall patterns of risk-sharing did not change much during the crisis, with the fraction unsmoothed declining from 61 to 57 percent. However, in Finland, Norway, and Sweden, the fraction of shocks unsmoothed increased from 28 to 47 percent, mainly because of the perverse net factor income flows, because smoothing through saving was unchanged.

In Table 6, we consider the roles of government and private saving in providing risk-sharing during the crises in the Nordic countries and

Table 6. *Decomposing the contribution of saving*

	Saving		Saving	
	Government (β_{Gov})	Private (β_{Priv})	Net capital outflows (β_{CA})	Net investment (β_{I})
Panel A: financial crises and non-peripheral developed economies				
GDP (Others) (Core)	14	32***	13	33***
	(1.23)	(2.71)	(1.29)	(3.12)
GDP (1991–1994) (Core)	29*	2	–17	48***
	(1.91)	(0.12)	(–1.25)	(3.52)
GDP (1997–2001) (Core)	32**	9	34***	7
	(2.46)	(0.70)	(2.91)	(0.63)
Panel B: financial crises in developed countries				
GDP (Others) (Nordic)	76***	10	40***	46***
	(9.48)	(1.21)	(5.61)	(6.37)
GDP (1991–1994) (Nordic)	70***	17	10	77***
	(6.70)	(1.62)	(1.07)	(8.24)
GDP (Others) (Japan)	44	–6	–35	74***
	(1.52)	(–0.19)	(–1.35)	(2.84)
GDP (1997–2001) (Japan)	44	–7	–55*	93***
	(1.19)	(–0.18)	(–1.66)	(2.80)
No. of observations			323	

Notes: The decomposition is constructed in a similar manner to those in Panel B of Tables 3 and 4, but now x and y belong to {91 − 94, 97 − 01, 08 − 09, 10, OTHERS} (OTHERS includes the years 1990, 1995–1996, and 2002–2007) and {CORE, JAPAN, GIIPS, NORDIC}, respectively. Panel A shows the coefficients corresponding to CORE, while the coefficients in Panel B correspond to NORDIC and JAPAN. The coefficients in the first two columns are estimated as in Table 3, while those in Columns 3 and 4 are estimated as in Table 4. The countries, country groups, and periods are the same as in Table 5. The t-statistics are given in parentheses. ∗∗∗, ∗∗, and ∗ denote significance at the 1, 5, and 10 percent levels, respectively.

Japan. The amount of smoothing from government saving hardly changed when the crisis hit: it was 76 percent in the Nordic countries during the non-crisis years, dropping to 70 percent during the crisis, while the point estimates for risk-sharing through government saving in Japan, in spite of being statistically insignificant, remained constant at 44 percent. In both the Nordic countries and Japan, the contribution to smoothing from real investment increased in the crises. However, the main outcome from these results is that the pattern found for the GIIPS during the sovereign debt crises is unusual for developed European countries, although similar patterns hold in emerging economies, as described by Kaminsky *et al.* (2005).

V. Conclusion

Risk-sharing collapsed in Greece, Ireland, Italy, Portugal, and Spain in 2010. We show that this was the result of government austerity programs, which were forced upon these countries because of their vulnerable external

and internal asset positions. For other EU countries, risk-sharing from government saving declined but did not turn negative.

References

Asdrubali, P., Sørensen, B. E., and Yosha, O. (1996), Channels of Interstate Risk Sharing: United States 1963–1990, *Quarterly Journal of Economics 111*, 1081–1110.

Attanasio, O. and Davis, S. (1996), Relative Wage Movements and the Distribution of Consumption, *Journal of Political Economy 104*, 1227–1262.

Backus, D., Kehoe, P., and Kydland, F. (1992), International Real Business Cycles, *Journal of Political Economy 100*, 745–775.

Barro, R. (1999), Notes on Optimal Debt Management, *Journal of Applied Economics 2*, 281–289.

Blundell, R., Pistaferri, L., and Preston, I. (2008), Consumption Inequality and Partial Insurance, *American Economic Review 98*, 1887–1921.

Coeurdacier, N. and Rey, H. (2012), Home Bias in Open Economy Financial Macroeconomics, CEPR Discussion Paper 8746.

Heathcote, J., Storesletten, K., and Violante, G. (2012), Consumption and Labor Supply with Partial Insurance: An Analytical Framework, Federal Reserve Bank of Minneapolis Staff Report 432.

Kalemli-Ozcan, S., Sørensen, B. E., and Yosha, O. (2001), Economic Integration, Industrial Specialization, and the Asymmetry of Macroeconomic Fluctuations, *Journal of International Economics 55*, 107–137.

Kalemli-Ozcan, S., Sørensen, B. E., and Yosha, O. (2003), Risk Sharing and Industrial Specialization: Regional and International Evidence, *American Economic Review 93*, 903–918.

Kalemli-Ozcan, S., Sørensen, B. E., and Yosha, O. (2005), Asymmetric Shocks and Risk Sharing in a Monetary Union: Updated Evidence and Policy Implications for Europe, in H. Huizinga and L. Jonung (eds.), *The Internationalisation of Asset Ownership in Europe*, Cambridge University Press, New York.

Kaminsky, G. L., Reinhart, C., and Végh, C. A. (2005), When It Rains, It Pours: Procyclical Capital Flows and Macroeconomic Policies, in M. Gertler and K. Rogoff (eds.), *NBER Macroeconomics Annual 2004*, Vol. 19, MIT Press, Cambridge, MA.

Lane, P. R. and Milesi-Ferretti, G. M. (2007), The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970–2004, *Journal of International Economics 73*, 223–250.

Lewis, K. (1996), What Can Explain the Apparent Lack of International Consumption Risk-Sharing?, *Journal of Political Economy 104*, 267–297.

Loayza, N., Schmidt-Hebbel, K., and Serven, L. (2000), What Drives Private Saving Across the World?, *Review of Economics and Statistics 82*, 165–181.

Luengo-Prado, M. J. and Sørensen, B. E. (2008), What Can Explain Excess Smoothness and Sensitivity of State-Level Consumption?, *Review of Economics and Statistics 90*, 65–80.

Mace, B. (1991), Full Insurance in the Presence of Aggregate Uncertainty, *Journal of Political Economy 99*, 928–956.

Obstfeld, M. (1994), Are Industrial-Country Consumption Risks Globally Diversified?, NBER Working Paper 4308.

Obstfeld, M. and Rogoff, K. (1996), *Foundations of International Macroeconomics*, MIT Press, Cambridge, MA.

Reinhart, C. and Rogoff, K. (2009), *This Time Is Different: Eight Centuries of Financial Folly*, Princeton University Press, Princeton, NJ.

Solow, R. (1957), Technical Change and the Aggregate Production Function, *Review of Economics and Statistics 39*, 312–320.
Sørensen, B. E. and Yosha, O. (1998), International Risk Sharing and European Monetary Unification, *Journal of International Economics 45*, 211–238.
Van Wincoop, E. (1999), How Big Are Potential Welfare Gains From International Risk Sharing?, *Journal of International Economics 47*, 109–135.