WORKING paper

BANQUE DE FRANCE
EUROSYSTÈME

Risk Sharing in Europe: New Empirical Evidence on the Capital Markets Channel

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September 2020, WP #781

ABSTRACT

This paper assesses the effectiveness of risk sharing mechanisms in Europe by breaking down the factor income components into their sub-components, and aims to further examine whether financial integration and international portfolio diversification boosts or dampens risk sharing. Using a panel of European countries, we compare the years before and after the 2008 financial crisis. We extend the literature by properly taking into account the heterogeneity (in both country and time dimensions) in the panel through new econometric models. Our results show that financial income has become a major channel of risk sharing in recent years and that a higher integration in the bond and equity markets significantly improves risk sharing in the long term.

Keywords: Euro Area, Risk Sharing, Financial Integration, Cross-Sectional Dependence

JEL classification: C23, C51, E21, F36.

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This work was supported by French National Research agency Grants ANR-17-EURE-0020. The views expressed in this article do not necessarily reflect Banque de France's or Eurosystem's opinion.

NON-TECHNICAL SUMMARY

Since the 2010 debt crisis in Europe, a consensus has emerged to develop stabilisation mechanisms within the euro area to improve its ability to absorb asymmetric shocks. Two main channels are currently studied. The first channel relies on private sector cross-border investments, with the objective of improving risk sharing. In particular, the current initiatives to develop the Capital Markets Union in order to ease cross-border investments in bonds and equity could help strengthen risk sharing via foreign financial incomes. The second adjustment channel is related to the creation of public stabilisation tools such as a common budget or a European Unemployment Stabilization Fund.

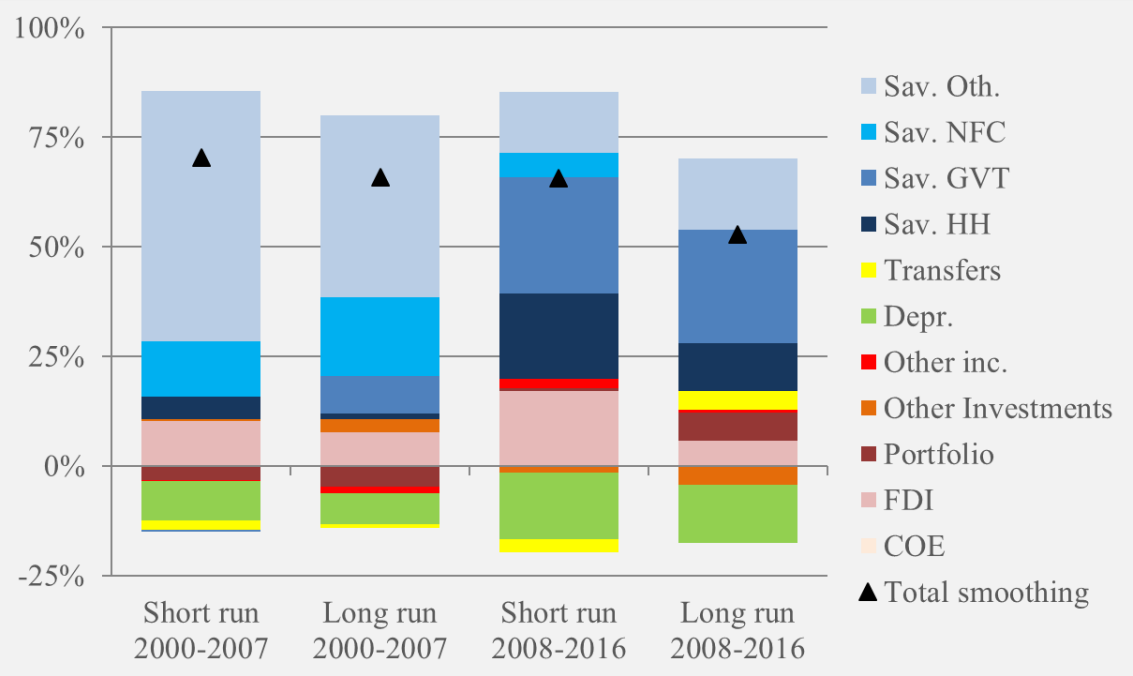
This paper proposes to estimate the degree of risk sharing in Europe using a new methodology. We break down factor income flows into their sub-components in order to analyse the effect of diversified financial ownership through portfolio income flows, foreign direct investments, other investment income and other primary income. Based on this finer disaggregation of the usual channels, we find new empirical evidence of risk sharing in Europe and learn about the institutional sectors that bear the adjustment of negative shocks.

We enrich the current approaches by accounting for possible heterogeneous effects across countries and years to avoid biased estimations, as this aspect is overlooked in the bulk of the literature. We assume that the reaction of consumption to common shocks can be heterogeneous, at least because European countries have heterogeneous economic structures. Moreover, we use quarterly data, the highest available frequency, which are well suited to potentially volatile financial flows in the balance of payment and to the risks related to capital markets. Our model also reflects the fact that GDP shocks are likely to be persistent over time, hampering the absorption of idiosyncratic income shocks over time. We therefore estimate error-correction models of risk sharing and show that the absorption channels can be different in the short and long term.

We find that, in Europe, savings is a major smoothing channel of the idiosyncratic shocks to GDP. Until 2008, non-financial corporations played a major role by adjusting their savings in response to GDP fluctuations. Since then, cross-border consumption smoothing has mostly occurred through variations in household and government savings. Although the channel related to international factor income can sometimes be destabilizing, we find that capital income has mostly contributed to stabilising consumption following shocks to GDP. The role of FDI income is particularly strong and portfolio income has become the main stabiliser in the long term after 2008. Furthermore, estimates show that higher integration of bond and equity markets should contribute to improving risk sharing in Europe.

Finally, we show that ignoring the heterogeneity of reactions to common shocks and not distinguishing between short-term and long-term effects can substantially affect the estimates of the degree of risk sharing. Consequently, we provide new and more robust evidence that further financial integration should contribute to improving the shock adjustment capacity in Europe via capital income.

Contribution of the channels of risk sharing



Notes: Sav. Oth.: savings from other sectors and measurement errors; Sav. NFC: savings of non-financial corporations; Sav. HH: household savings; Sav. GVT: government savings; Depr: capital depreciation; Other inc.: residual income; FDI: foreign direct investment flows; COE: compensation of employees.

Partage du risque en Europe : nouveaux résultats empiriques sur le canal des marchés financiers

RÉSUMÉ

Ce papier évalue l'efficacité des mécanismes de partage du risque en Europe en désagrégeant les sous composantes des revenus de facteurs afin de déterminer dans quelle mesure l'intégration financière et la diversification internationale des investissements renforcent ou atténuent le partage du risque. Pour ce faire, nous comparons les périodes antérieure et postérieure à la crise de 2008 pour un échantillon de pays européens. Notre étude va au-delà des travaux précédents en prenant pleinement en compte l'hétérogénéité du panel (dans les dimensions temporelles et individuelles) au moyen de nouvelles méthodes économétriques. Nos résultats montrent que les revenus financiers sont devenus un canal essentiel du partage du risque au cours des dernières années et qu'une plus forte intégration des marchés des actions et des obligations semble améliorer significativement le partage du risque à long terme.

Mots-clés : zone euro, partage du risque, intégration financière, dépendance en coupe transversale

1. Introduction

Since the 2010 debt crisis in Europe, a consensus has emerged to develop stabilisation mechanisms within the euro area to improve its ability to absorb asymmetric shocks. Two main channels are currently studied.

The first channel relies on private sector cross-border investments, with the objective of improving risk sharing in both the short and long term. Firstly, the development of the Banking Union – as well as other initiatives aimed at boosting cross-border banking investments – would be beneficial to better diversify the sources of income. Secondly, the current initiatives to develop the Capital Markets Union will ease cross-border investments in bonds and equity. They help to strengthen risk sharing since the holder is directly impacted by losses and gains in foreign financial markets.

The second adjustment channel is related to the creation of public stabilisation tools such as a euro area budget or a European Unemployment Stabilization Fund as recently argued by European Leaders.[1] Some stakeholders, however, insist that transfers should be temporary. In this case, the long-term impact of this channel would be limited. In light of the criteria established by Mundell (1961) to characterise an optimal currency area, some international institutions (e.g. the IMF and the European Commission[2]) and academic authors have stressed the need for the euro area to develop alternative stabilisation mechanisms to deal with idiosyncratic shocks.

This paper proposes to estimate the degree of risk sharing in Europe using a new methodology which has not been used so far to study in detail the capital markets channel. We adopt the approach proposed by Demyanyk et al. (2008) and Balli et al. (2014), by breaking down factor income flows into their sub-components, drawn from the balance of payments, in order to analyse the effect of diversified financial ownership through portfolio income flows (debt and equity), foreign direct investments (FDI), other investment income and other primary income. We expand this approach on several points.

The first contribution of the paper is to assess whether the risk sharing channels depend on the degree of financial integration in the euro area. This issue has an important policy

[1] See the Franco-German declaration of Meseberg in June 2018.
[2] See for instance the *Euro Area: IMF Staff Concluding Statement of the 2017 Article IV Mission* and the *Reflection paper of the European Commission on the deepening of the EMU* (2017).

implication. Indeed, risk sharing measures consist in disconnecting final consumption fluctuations from GDP fluctuations, i.e. smoothing consumption after a domestic income shock. From a theoretical point of view, cross-border risk sharing in a monetary union helps dampen the impact of an idiosyncratic shock affecting a single country, in the context of a centralised monetary policy. Nevertheless, risk sharing mechanisms among EU countries have long been considered as less efficient than among US states. In particular, numerous studies claim that capital market smoothing is much stronger in the United States than in Europe (Afonso and Furceri, 2008; Furceri and Zdzienicka, 2015; Alcidi et al., 2017; Cimadomo et al., 2018). Consequently, it is often claimed that strengthening the integration of capital markets within the EU would reinforce risk sharing mechanisms. However, the sudden stops phenomena, which occurred in the wake of the 2008 financial crisis and sovereign debt crisis, might call into question the idea that greater financial integration may be viewed as a way of activating risk sharing channels during recessions. Our paper shows that, beyond the temporary massive capital outflows, greater integration in bond, equity and FDI markets has increased risk sharing in the euro area after 2008.

Secondly, we enrich the current approaches by accounting for possible heterogeneous effects across countries and years to avoid biased estimations, as this aspect is overlooked in the bulk of the literature (to the best of our knowledge Fukely et al. (2018) is the only paper that addresses this issue). We assume that the reaction of consumption to idiosyncratic shocks can be heterogeneous, at least because European countries have heterogeneous economic structures. In this case, the hypothesis of homogeneous slope coefficients, which has not been challenged so far when studying capital market channels, appears to be too restrictive and can be tested. We conclude in favour of heterogeneous reactions by detecting cross-correlations in the panel of countries and accordingly use an estimator that captures such heterogeneities. Another aspect which has to be reflected in the model is that GDP shocks are likely to be persistent over time, hampering the absorption of idiosyncratic income shocks over time. We therefore estimate error-correction models of risk sharing and show that the absorption channels can be different in the short and long term.

Finally, the use of quarterly data offers a novel empirical perspective on risk sharing, which is well suited to potentially volatile financial flows in the balance of payment and to high frequency risk related to capital markets. This means that, ideally, in order to know whether a country is engaged in high or low risk sharing, we would need to measure the channels at frequencies corresponding to the horizons of investors in financial markets (daily or weekly). Nevertheless, data do not exist at these frequencies for the variables used in the equations above,

and as a consequence we have no choice but to work with aggregated data stemming from the balance of payments. Since aggregation implies information losses about what is happening at higher frequencies, we use quarterly data, the highest available frequency for the balance of payment.

The main findings of the paper are the following. Firstly, FDI and portfolio investments contribute to smoothing shocks, respectively in the short and long term. Secondly, since 2008, savings has been a strong risk sharing channel in the euro area due to the behaviour of governments and households. Thirdly, the role of financial integration (equity and bond markets) in improving the degree of shock smoothing is evidenced in the years following the 2008 financial crisis.

The remainder of the paper is organised as follows. Section 2 presents a bird's eye review of the literature on risk sharing and financial integration. In Section 3, we lay out the accounting while Section 4 presents the econometric framework. Section 5 contains the results. Finally, Section 6 concludes the paper.

2. Risk sharing and financial integration: a brief literature review

The literature previously focused on testing the full risk sharing hypothesis. As Yehoue (2005) puts it "under full risk sharing, the consumption of an economic agent (country) is not sensitive to the agent's idiosyncratic shocks, in particular, income shocks." This hypothesis was first tested at the individual level (Cochrane, 1991; Mace, 1991; Townsend, 1994; and Hayashi et al., 1996) using micro-data and was mostly rejected. The first study using macro-data conducted by Obstfeld (1994) also rejects full risk sharing. The author finds a coefficient below 1 for the G7 countries. Even if the full risk sharing hypothesis does not seem to hold, it remains interesting to study each channel of consumption smoothing following an income shock.

The first comprehensive empirical model to assess the risk sharing effects on consumption was introduced by Asdrubali et al. (1996), who study it among the federal states of the United States. They estimate the respective contributions of the main channels that enhance consumption smoothing, namely the credit channel (broken down between private and public savings), secondary income (i.e. international transfers), and primary income (international factor income flows). Their model relies on a cross-sectional variance decomposition of GDP to assess the effectiveness of risk sharing mechanisms.

Several empirical studies have attempted to assess the link between financial integration (fragmentation) and increased (decreased) risk sharing, and to determine the relative contribution of the factor income channel – represented by the difference between GDP and GNI. From both methodological and theoretical points of view, this implies defining financial integration and how to measure it: put differently, it means identifying the conditions under which financial markets are considered integrated.[3]

Foreign portfolio diversification, reflected in foreign asset (equity and debt) holdings, is the main proxy used to measure financial integration in risk sharing models. Quantity-based measures of financial integration have confirmed the negative effect of the home bias on risk sharing. Demaynyk et al. (2008) propose a measure of financial integration through foreign portfolio diversification, by investigating whether certain classes of assets provide more consumption smoothing. They build on the approaches proposed by Mélitz and Zumer (1999) and Sørensen et al. (2007), who rely on total foreign assets relative to GDP to measure integration. They find that, financial integration has increased since the introduction of the euro, albeit at a more moderate pace than for the United States, and increased holdings of foreign assets are associated with increased income risk sharing. More recently, Balli et al. (2014) show, by breaking down net factor income into interests, dividends and retained earnings, that (i) interest receipts and equity dividend payments have a large positive impact on risk sharing, and (ii) the domestic home bias towards asset holdings contribute negatively to risk sharing.

Another strand of the literature deals exclusively with home bias, capital gains and risk sharing. The main empirical finding of these studies is that the absorption of idiosyncratic shocks stems mainly from the cross-ownership of equity capital (Sørensen et al., 2007).

The role of banking integration and its determinants, seen as one of the main financial channels for the corporate sector and households, is also investigated in the literature. Hence, the greater availability of loans to households and the more diversified portfolios of banks can contribute to income risk sharing (Demyanyl et al., 2008). Kalemli-Ozcan et al. (2008) find a significant positive effect of cross-border banking integration on risk sharing. Income insurance has also been tackled by Balli et al. (2011), who highlighted that most risk sharing through income flows is due to net financial asset holdings, in line with the results of previous studies (see Bracke and Schmitz, 2011).

[3] For instance, Kalemli-Ozcan et al. (2008) define integration as a situation where all agents face the same set of rules, are treated equally and have equal access to financial products.

3. Accounting framework, data and econometric specification

Our work builds on the pioneering framework introduced by Asdrubali et al. (1996). The authors study the four main adjustment channels of asymmetric shocks on output by breaking down GDP as follows:

$$\mathrm{GDP} = \frac{\mathrm{GDP}}{\mathrm{GNI}} \cdot \frac{\mathrm{GNI}}{\mathrm{NNI}} \cdot \frac{\mathrm{NNI}}{\mathrm{NNDI}} \cdot \frac{\mathrm{NNDI}}{\mathrm{C}} \cdot \mathrm{C} \quad (1)$$

where GNI stands for gross national income, NNI is net national income, NNDI is net national domestic income.

We can further break down savings and factor income to obtain a more disaggregated view of the main smoothing channels.

3.1. Accounting framework for assessing risk sharing

Our paper aims at presenting a renewed analytical framework based on consistent accountability principles. The lack of data for some variables convinced us to build a mixed database. Most of the series are taken from international balance of payments databases and some are computed according to the equations arising from the GDP breakdown. This method enables us to make sure that the whole dataset is fully consistent with the breakdown (1). The variables below with a "hat" are calculated so as to have a consistent macroeconomic framework using seasonally adjusted nominal data. All the variables are subsequently expressed in real and per capita terms.

Since GDP and the total primary income balance are two variables of interest, we decide to determine GNI as the sum of GDP and net primary income. The difference between GDP and GNI then gives us the amount of factor income:

$$\widehat{GNI} = GDP + INC_{PR} \quad (2)$$

Depreciation is defined as the difference between GNI and NNI:

$$\widehat{DEPR} = NNI - \widehat{GNI}$$

and this implies

$$NNI = \widehat{GNI} - \widehat{DEPR} \quad (3)$$

We define current transfers – or secondary income – using NNI and NNDI as follows:

$$\widehat{INC_{SEC}} = NNDI - NNI$$

and thus

$$NNDI = NNI + \widehat{INC_{SEC}} \quad (4)$$

Net savings is defined as:

$$\widehat{SAVING_{NET}} = NNDI - C_{TOT} \quad (5)$$

3.2. Breakdown of primary income and net savings

Primary income is broken down to show the contributions of the FDI income balance (INC_{FDI}), the Portfolio income balance (INC_{PORT}), the Other investment balance (INC_{OINV}), Other primary income (INC_{OTHER}) and the Compensation of employees (COE). In Equation (2) we replace INC_{PR} as follows:

$$INC_{PR} = INC_{FDI} + INC_{PORT} + INC_{OINV} + INC_{OTHER} + COE \quad (6)$$

Other primary income (INC_{OTHER}) is a residual variable which enables equality between total primary income and its sub-components to be reached.

For net savings, we distinguish the role of households, non-financial corporations and governments in consumption smoothing. In Equation (5) we replace $SAVING_{NET}$ by:

$$\widehat{SAVING_{NET}} = \widehat{SAVING_{NET}^{HH}} + \widehat{SAVING_{NET}^{NFC}} + \widehat{SAVING_{NET}^{GOV}} + SAVING_{NET}^{OTHER} \quad (7)$$

The residual variable ($SAVING_{NET}^{OTHER}$) enables equality between total net savings and its sub-components to be reached. It includes both savings from other sectors (such as financial institutions) and measurement errors. This component cannot therefore be interpreted straightforward and we focus our analysis on the other three components of savings.

3.3. Measuring risk sharing

The variance of the GDP growth rate can be broken down in such a way as to make the contribution of each of its components apparent. The first equation below gives a measure of the share of unsmoothed GDP shock. It is based on a set of hypotheses and constraints specified in Asdrubali et al. (1996) and Sørensen and Yosha (1998). In case of perfect risk sharing, this coefficient should be zero while the sum of the other four coefficients should be equal to 1 (for a given country). In some cases, GDP shocks are amplified ($\beta>1$) or result in dis-smoothing ($\beta<0$). For a more detailed explanation of the implications and the underlying dynamics of the coefficients, see Balli and Sørensen (2011). The different coefficients of risk sharing are the following:

$$\beta_u = \frac{cov(\Delta \log GDP_t^i,\ \Delta \log C_t^i)}{Var(\Delta \log GDP_t^i)}$$

$$\beta_{fi} = \frac{cov(\Delta\log GDP_t^i, \Delta\log GDP_t^i - \Delta\log GNI_t^i)}{Var(\Delta\log GDP_t^i)}$$

$$\beta_d = \frac{cov(\Delta\log GDP_t^i, \Delta\log GNI_t^i - \Delta\log NNI_t^i)}{Var(\Delta\log GDP_t^i)}$$

$$\beta_{tr} = \frac{cov(\Delta\log GDP_t^i, \Delta\log NNI_t^i - \Delta\log NNDI_t^i)}{Var(\Delta\log GDP_t^i)}$$

$$\beta_s = \frac{cov(\Delta\log GDP_t^i, \Delta\log NNDI_t^i - \Delta\log C_t^i)}{Var(\Delta\log GDP_t^i)}$$

with $1\text{-}\beta_u = \beta_{fi} + \beta_d + \beta_{tr} + \beta_s$. The index *i* refers to a country and the index *t* refers to a given period.

Under the assumption of full risk sharing, GDP shocks do not propagate through its sub-components as counter-cyclical factors offset these deviations (see Furceri and Zdzienicka, 2015, for a thorough review). The existing literature already provides a comprehensive assessment of the functioning of each channel, which can be summarised as follows. Firstly, the international income channel, corresponding to the income flows recorded in the balance of payments, is the difference between GDP and GNI. For instance, investors in country A (hit by a negative income shock) can benefit from higher investment income in country B (which experiences an economic upturn) to offset the lower domestic income. However, this channel does not take into account the valuation effect on the stock of investment and β_{fi} only measures income flows. Secondly, depreciation is the difference between gross and net income (GNI – NNI). Although depreciation is not the main subject of our study and mainly depends on past investment decisions, it has to be included in the GDP breakdown. Thirdly, international transfers (i.e. current transfers) are the difference between NNI and NNDI. This factor corresponds to net international taxes and transfers to and from supranational governments. In the EU, this account includes transfers via the European Commission's budget (e.g. structural funds). However, assistance programmes during the euro crisis were recorded in the loans account of the financial account. Fourthly, national net savings is the difference between net disposable income and total consumption. This channel reflects the ability of agents – including the government – to reduce their savings or increase their borrowing in the financial markets to maintain their levels of consumption during downturns and to accumulate potential savings buffers during upturns. This channel is governed by intertemporal considerations and measures the smoothing of consumption through credit markets (or assistance programmes).

Counter-cyclicality can be assessed at each stage of the breakdown and the channels can be computed individually by estimating the following equations:

$$\Delta\log GDP_t^i - \Delta\log GNI_t^i = \mu_{fi,t} + \beta_{fi} \cdot \Delta\log GDP_t^i + u_{fi,t}^i \quad (8)$$

$$\Delta\log GNI_t^i - \Delta\log NNI_t^i = \mu_{d,t} + \beta_d \cdot \Delta\log GDP_t^i + u_{d,t}^i \quad (9)$$

$$\Delta\log NNI_t^i - \Delta\log NNDI_t^i = \mu_{tr,t} + \beta_{tr} \cdot \Delta\log GDP_t^i + u_{tr,t}^i \quad (10)$$

$$\Delta\log NNDI_t^i - \Delta\log C_t^i = \mu_{s,t} + \beta_s \cdot \Delta\log GDP_t^i + u_{s,t}^i \quad (11)$$

$$\Delta\log C_t^i = \mu_{u,t} + \beta_u \cdot \Delta\log GDP_t^i + u_{u,t}^i \quad (12)$$

4. Econometric specification and data

4.1. Limits of the standard approach

In the bulk of the literature a standard approach for estimating risk sharing is based on the hypothesis of market completeness. This implies that the agents are able to make an intertemporal trade-off of their wealth and consumption. A typical specification is:

$$\log C_t^i = \lambda_i \mu_t + \alpha_i + \delta_i t + \beta_i \cdot \log GDP_t^i + u_t^i \quad (13)$$

where μ_t is a common risk, $\lambda_i > 0$ is a loading factor, α_i refers to idiosyncratic country characteristics, $\delta_i t$ measures the degree of impatience and u_t^i is a measurement error on consumption. The risk sharing hypothesis can then be tested to determine the degree of smoothing by $H_0 : \beta_i = 0$.

The empirical studies usually test this hypothesis relying on several homogeneity assumptions which can bias the results. It is often assumed that all the countries have the same preferences and the same degree of impatience: $\mu_t = \bar{c}_t - \bar{y}_t$, $\lambda_i = 1$, $\delta_i = 0$ (Asdrubali et al., 1996; Crucini, 1999). In addition, many influential articles (Sørensen and Yosha, 2000; Kose et al., 2009), as well as recent studies on EU countries (Poncela et al., 2016; Ferrari and Picco, 2016) assume that $\beta_i = \beta$. Some studies opted for a temporal dummy δ_i to replace demeaning and implicitly take into account common shocks (Asdrubali et al., 1996; Sørensen and Yosha, 1998; Fratzscher and Imbs, 2009).

As shown by Fuleky et al. (2018) the standard models appear too restrictive and sources of heterogeneity need to be further investigated. Firstly, the smoothing channels can vary widely across countries and this affects the magnitude of the impact of income shocks on consumption. Secondly, variations in global and country-level consumptions may differ when risk aversion,

endowments and discount factors are heterogeneous (Obstfeld, 1989 and 1994) or because of heterogeneous consumption preferences. Thirdly, structural factors – such as the GDP composition or the inclusion in a global value chain – can also explain why aggregate shocks affect countries differently. Idiosyncratic fluctuations can be taken into account by applying specific coefficients to global income shocks whose effect is likely to differ between countries. In their study of the Feldstein-Horioka puzzle, Giannone and Lenza (2010) isolate idiosyncratic sources of fluctuations that allow countries to react with a specific sign and magnitude to global shocks after rejecting the homogeneity restriction. Once heterogeneous propagation is taken into account, they show that the savings retention coefficient is significantly lower.

4.2. Four models tested

We examine four alternative models (all variables are in log) following Fuleky et al. (2018) in order to introduce various sources of heterogeneity. We start with the most constrained model and then relax the constraints one by one.

In the fixed effects (FE) model, we "demean" both consumption and GDP by subtracting their cross-sectional means at each period and include fixed effects for each country α_i:

$$\Delta c_{it} - \overline{\Delta c}_t = \alpha_i + \boldsymbol{\beta}(\Delta y_{it} - \overline{\Delta y}_t) + \varepsilon_{it} \quad (14)$$

However, this first model imposes a strong constraint on the relation between the two demeaned variables by assuming that the extent of consumption smoothing is uniform. The cross-sectional demeaned (DEM) model relaxes this constraint by introducing a specific coefficient $\boldsymbol{\beta_i}$ for each country:

$$\Delta\, c_{it} - \Delta\bar{c}_t = \alpha_i + \boldsymbol{\beta_i}(\Delta y_{it} - \overline{\Delta y}_t) + \varepsilon_{it} \quad (15)$$

Two implicit homogeneity hypotheses still hold on the cross-sectional means: their coefficients are both assumed to be equal to unity. The hybrid (HYB) model (Pierucci and Ventura, 2010) relaxes the constraint on the cross-sectional mean of consumption, but the heterogeneous impact of income shocks is still neglected (Equation 16). Thus, the same common shock on consumption affects the countries to a different degree but the common income shock influences the β_i coefficient which is applied to a non-idiosyncratic term:

$$\Delta c_{it} = \alpha_i + \beta_i(\Delta y_{it} - \overline{\Delta y}_t) + \boldsymbol{\gamma_i}\overline{\boldsymbol{\Delta c_t}} + \varepsilon_{it} \quad (16)$$

The Common Correlated Effects (CCE) model (Pesaran, 2006) includes in addition a specific coefficient on the mean of GDP (Equation 17). This model deals with the three heterogeneity shortcomings and makes it possible to estimate coefficients based on

idiosyncratic fluctuations. It measures the impact of idiosyncratic shocks to income on idiosyncratic consumption (β_i) and the effect of common shocks on consumption (γ_i^c) and income (γ_i^y) as approximated by cross-sectional averages:[4]

$$\Delta c_{it} = \alpha_i + \beta_i \Delta y_{it} + \gamma_i^c \overline{\Delta c}_t + \boldsymbol{\gamma_i^y \overline{\Delta y}_t} + \varepsilon_{it} \quad (17)$$

4.3. Data

We estimate the above equations using quarterly data over the period 1999Q1-2016Q2 and we consider 14 members of the European Union based on data availability.[5] Appendices A and B contain, respectively, the list of the variables included in the initial database and those that we have computed. We use several sources: OECD-Quarterly National Accounts, IMF-Balance of Payments Statistics, Eurostat, and ECB-Statistical Data Warehouse. All the variables are converted into euros, expressed in real terms (using the GDP deflator), measured in per capita and log transformed. Population data are obtained from the OECD and Eurostat, and for some countries annual data are sometimes extrapolated, due to the incompleteness of quarterly data. Due to the lack of available data, we are unable to include some major countries in our pool, namely Austria, Belgium, Hungary and Poland. The financial integration data are extracted from the ECB financial integration database and include synthetic price-based and quantity-based indicators as well as sub-indicators by market (money, bond, equity and banking). The sample is divided into two parts, namely 2000Q1-2007Q4 and 2008Q1-2016Q2, to distinguish between the pre- and post-crisis periods.

4.4. Model selection

The consumption equation is estimated for each of the four models in order to detect the presence of unit roots, co-integration relationships or cross dependency and determine whether they accurately measure risk sharing.

In order to distinguish between short- and long-term risk sharing, we test for the presence of unit roots and co-integration relationships. CIPS tests (Pesaran, 2007) indicate that GDP and consumption in levels include unit roots. The null hypothesis on non-stationarity is rejected when the test is applied to the first difference of the variables (Table 1).

[4] Westerlund and Urbain (2015) show that such an approximation leads to a smaller bias compared with alternative approaches based on the estimation of common factors.

[5] The countries are: the Czech Republic, Germany, Denmark, Greece, Spain, Finland, France, Ireland, Italy, the Netherlands, Portugal, the United Kingdom, Romania and Sweden.

We test for the presence of similar patterns across countries using a cross-sectional independence test (Pesaran, 2004). If the null hypothesis of no dependence is rejected, common factors can be introduced to deal with co-movements between countries and the impact of idiosyncratic income fluctuations on idiosyncratic consumption can then be studied using the CCE estimator. The CD tests detect cross-sectional dependence for both series in almost all variables (Table 1).

Table 1. Cross-sectional and unit root tests for total consumption and GDP – 13 countries

2000-2007				
	Level		**Difference**	
	GDP	Consumption	GDP	Consumption
CD test	33.41*	7.40	29.84*	6.67*
CIPSc	-1.00	-1.94	-3.7*	-3.52*
CIPSc,t	-0.06	-0.49	0.01	-0.11
2008-2016				
	Level		**Difference**	
	GDP	Consumption	GDP	Consumption
CD test	29.66*	18.03*	35.49*	20.11*
CIPSc	-1.21	-0.78	-3.06*	-3.07*
CIPSc,t	0.12	0.15	-0.40	-0.20

Note: CD test of cross-sectional dependence is Pesaran (2004). We choose 2 lags. The test statistic follows a standard Gaussian distribution. The null hypothesis is no cross-sectional dependence. The CIPSc and CIPSc,t tests are panel unit roots under cross-sectional dependence by Pesaran (2007). CIPSc is the model with an intercept, CIPSc,t is the model with an intercept and trend. The 5% critical values are respectively -2.45 and -2.98.

* indicates statistical significance at the 5% level (rejection of the null hypothesis)

The properties of the four models are then investigated to see whether consumption and income are co-integrated and cross-sectional dependence is corrected. Tests are applied to the residuals – idiosyncratic consumption and income – of each model. We find that the CCE model is the only one for which cross-sectional dependence is controlled for, in the short and long term over both sub-periods (Table 2). The rejection of a unit root in the residuals of the long-term equation means that consumption, income and common factors are co-integrated. The CIPS statistics (Pesaran, 2007) indicate the existence of a co-integration relation between the variables for the CCE model over both sub-periods.

An ADL (1,1) CCE error correction model is estimated for each country to distinguish between short- and long-term risk sharing as follows:

$$c_{it} = \alpha_i + \beta_{1i}\, c_{it-1} + \beta_{2i}\, y_{it} + \beta_{3i} y_{it-1} + \gamma_{1i}^{c} \bar{c}_t + \gamma_{2i}^{c} \bar{c}_{t-1} + \boldsymbol{\gamma_{1i}^{y} \bar{y}_t} + \boldsymbol{\gamma_{2i}^{y} \bar{y}_{t-1}} + \varepsilon_{it} \quad (18)$$

The individual unsmoothing parameters on short and long terms and the speed of adjustment are:

$$\beta_i^{SR} = \beta_{2i}, \quad \beta_i^{LR} = \frac{\beta_{2i}+\beta_{3i}}{1-\beta_{1i}}, \qquad b_i = \beta_{1i} - 1$$

More generally, the risk sharing channels for each variable X can be estimated with the following ADL (1,1) CCE error correction model:

$$X_{it} = \alpha_i + \beta_{1i}\, X_{it-1} + \beta_{2i}\, y_{it} + \beta_{3i} y_{it-1} + \gamma_{1i}^{c}\bar{X}_t + \gamma_{2i}^{c}\bar{X}_{t-1} + \boldsymbol{\gamma_{1i}^{y}\bar{y}_t} + \boldsymbol{\gamma_{2i}^{y}\bar{y}_{t-1}} + \varepsilon_{it} \quad (19)$$

The panel coefficients are then calculated as the average of individual coefficients.

Table 2. Diagnostic tests on the residuals of the estimated models – 13 countries

2000-2007								
	Long-term				Short-term			
	FE	DEM	HYB	CCE	FE	DEM	HYB	CCE
CD	54.16*	55.83*	-2.58*	-4.09	27.43*	29.94*	-0.67	-4.03
CIPSc	-1.01	-2.07	-2.33	-2.88*				
2008-2016								
	Long-term				Short-term			
	FE	DEM	HYB	CCE	FE	DEM	HYB	CCE
CD	36.43*	27.27*	1.55	-0.06	38.04*	33.96*	1.84	0.84
CIPSc	-2.62*	-2.06	-1.72	-2.90*				

Note: see footnote, Table 1.

4.5. Measuring the impact of financial integration on risk sharing

The effect of the degree of financial integration on risk sharing can be measured by imposing a structure on the risk sharing coefficient as in Mélitz and Zumer (1999), Sørensen et al. (2007) and Demyanyk et al. (2008):

$$\kappa = \kappa_0 + \kappa_1(FIN_{it} - \overline{FIN_t})$$

FIN is a variable of financial integration and $\overline{FIN_t}$ is the cross-country average at time t. When the interaction term κ_1 is omitted, we implicitly assume that the coefficient κ measures risk sharing for a country with an average financial integration ($FIN_{it} = \overline{FIN_t}$). We estimate this equation for six financial integration indicators. More specifically, we consider the following ECM model based on the CCE estimator:

$$\hat{u}_{it} = c_{it} - \nu_i^1 \bar{c}_t - b_i - \rho_i^1(y_{it}) - \nu_i^2 \bar{y}_t - \rho_i^2 FIN_{it}\, y_{it} - \nu_i^3 \overline{FIN_t} \quad (20)$$

$$\Delta c_{it} = a_i + \gamma_i^1 \overline{\Delta c_t} - \mu_i \hat{u}_{it-1} + \beta_i(\Delta y_{it}) + \gamma_i^2 \overline{\Delta y_t} + \lambda_i(\Delta FIN_{it})(\Delta y_{it}) + (\gamma_i^3 \overline{\Delta FIN_t}) + \hat{\varepsilon}_{it} \quad (21)$$

The degree of risk sharing depends on the degree of financial integration (FIN) in the short term $\beta_i + \lambda_i \Delta FIN_{it}$ and in the long term $\rho_i^1 + \rho_i^2 FIN_{it}$.

5. Results

5.1. Estimate of the degree of unsmoothed shocks

We first estimate the degree of unsmoothing by regressing consumption on GDP. The coefficients in Table 3 show the extent to which consumption is impacted by a shock on GDP. The results vary widely and show that unnecessary constraints such as imposing identical coefficients on all countries (FE) or the same impact of common shocks (FE and DEM estimators) can lead to very different results when these constraints are relaxed (HYB and CCE estimators). Distinguishing between short- and long-term impacts is also useful. In most cases, a significant proportion of income shocks is not adjusted in the long term (between 12% and 95% remain unsmoothed), but shocks are better smoothed in the short term. Our findings that the results vary widely across estimators suggest that some conclusions obtained in the empirical literature under the slope homogeneity and with no distinction between short- and long-term effects are not necessarily robust.

We choose the CCE estimator since the tests on the estimated residuals in Table 2 show that it better captures heterogeneous behaviour amongst countries. The CCE estimator suggests a degree of unsmoothing around 31%-40% in the short term and as much as 34% to 49% in the long term. Risk sharing patterns changed a little after 2008 with a higher degree of unsmoothing. This finding contradicts the idea that the proportion of shocks to GDP that can be absorbed increases over time as the effects of the shocks dissipate. Conversely, sizable differences in consumption growth remain after countries' specific shocks. The literature documents several reasons why perfect risk sharing (a degree of unsmoothing close to zero) may not be pursued. One reason is the unequal access of firms to financial markets with an asymmetry between small and large companies (there is a minimum requirement size on firms' financial wealth which serves as collateral in loan operations; see Hoffmann and Shcherbakova-Stewen, 2011). A second explanation relates to the home bias hypothesis. Indeed, international portfolio allocation decisions depends on other factors than optimisation decisions – as assumed in the intertemporal models that are the backbones of the risk sharing model. Trade linkages, institutional differences, language differences, informational asymmetries on foreign assets, differences in perceived returns determine international asset trading (Huberman, 2000; Aviat

and Coeurdacier, 2007). A third argument is that welfare gains are not fully exploited due to transaction costs (Jack and Suri, 2014).

Table 3. Estimate of the degree of unsmoothing

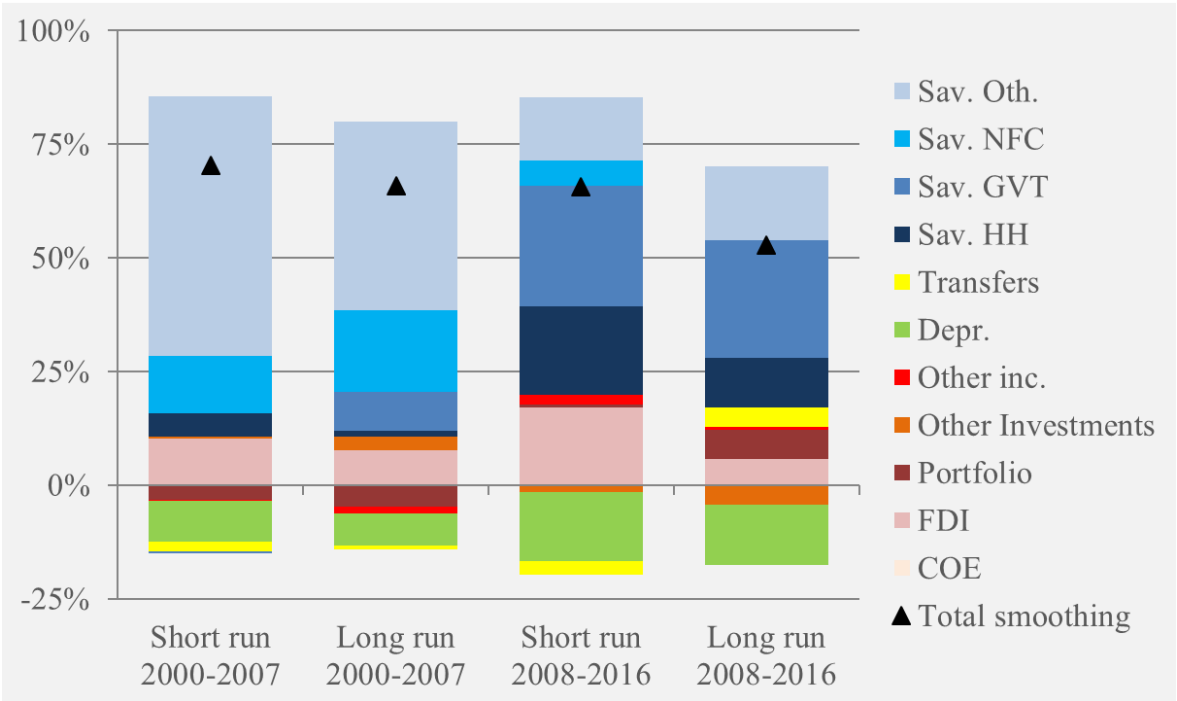
2000-2007							
Long-term				Short-term			
FE	DEM	HYB	CCE	FE	DEM	HYB	CCE
0.94* (66.49)	0.95* (96.49)	0.12* (4.33)	0.34* (9.56)	0.14* (3.24)	0.18* (5.57)	0.11* (5.84)	0.31* (9.96)
2008-2016							
Long-term				Short-term			
FE	DEM	HYB	CCE	FE	DEM	HYB	CCE
0.46* (6.08)	0.44* (26.10)	0.19* (10.66)	0.49* (20.03)	0.31* (3.93)	0.38* (18.34)	0.18* (8.04)	0.40* (12.3)7)

* indicates statistical significance at the 5% level.

5.2.Estimate of the smoothing channels

As regards the contributions of the different channels, Table 4 displays our results and Chart 1 shows graphically the share of each channel in total smoothing. Our main findings are the following.

Chart 1. Contribution of the channels of risk sharing



Note: Sav. Oth.: savings from other sectors and measurement errors; Sav. NFC: savings of non-financial corporations; Sav. HH: household savings; Sav. GVT: government savings; Depr: capital depreciation; Other inc.: residual income; FDI: foreign direct investment flows; COE: compensation of employees.

The proportion of shocks to GDP smoothed through government, household and non-financial corporations savings was relatively small before 2008 (most of the coefficients are statistically insignificant). Though the coefficient of "other savings" is significant, it is hard to interpret because this variable reflects both financial corporations' savings and the error terms of the regression. Up to the Great recession, international factor income was the main smoothing channel of cross-country GDP fluctuations. Interestingly, we find that portfolio flows reinforced the shocks (the short-term coefficient is significantly negative), while FDI attenuated them (with 8% of the shocks smoothed out in the short term and 11% in the long term).

Table 4. Channels of output smoothing - CCE estimator

	Long term		**Short term**		**Error correction**	
2000-2007	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**
Unsmoothed	0.34***	8.65	0.31***	8.39	-0.61***	-15.44
Savings	**0.69**		**0.78**			
Households	0.01	0.20	0.05	0.57	-0.87***	-20.89
Government	0.08	0.76	-0.01	-0.03	-0.93***	-20.29
NFC	0.18*	1.87	0.13	1.30	-1.02***	-23.52
Other	0.41***	3.81	0.60***	4.58	-1.03***	-24.04
Net intern. transf.	-0.01	-0.54	-0.02	-1.13	-0.89***	-19.96
Capital depreciation	-0.07**	-2.03	-0.09**	-2.85	-0.90***	-19.20
Int. Factor Income	**0.04**		**0.08**			
COE	-0.00	-0.08	-0.00	-0.37	-0.48***	-11.23
FDI	0.08***	3.64	0.11***	3.11	-0.69***	-13.91
Portfolio	-0.05***	-2.87	-0.03	-1.35	-0.86***	-17.76
Other investments	0.03**	2.64	0.00	0.45	-0.53***	-11.00
Other income	-0.01	-0.98	-0.00	-0.08	-1.04***	-24.81
	Long term		**Short term**		**Error correction**	
2008-2016	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**
Unsmoothed	0.49***	16.27	0.40***	11.36	-0.48***	-12.33
Savings	**0.55**		**0.77**			
Households	0.11**	2.27	0.23***	3.30	-0.83***	-18.20
Government	0.27***	3.78	0.31***	2.46	-0.93***	-20.04
NFC	0.00	0.02	0.07	0.71	-0.89***	-18.98
Other	0.17*	1.86	0.16	1.12	-0.70***	-16.46
Net intern. transf.	0.04***	2.82	-0.04	-1.29	-0.94***	-21.95
Capital depreciation	-0.14***	-3.01	-0.18***	-3.92	-0.93***	-21.12
Int. Factor Income	**0.09**		**0.21**			
COE	-0.00	-0.46	-0.00	-0.08	-0.37***	-9.14
FDI	0.06	1.32	0.20***	5.32	-0.67***	-15.92
Portfolio	0.07***	5.30	0.00	0.40	-0.82***	-17.91
Other investments	-0.04***	-6.56	-0.02***	-2.78	-0.43***	-10.08
Other income	0.00	0.58	0.02*	1.93	-1.10***	-31.34

The post-2008 period offers a slightly different picture. Firstly, government and household savings contributed to smoothing 38% of the shocks in the long term. The contribution of these channels is even higher in the short term (54% of smoothing for household and government savings combined). Although the savings channel contributed the most to shock smoothing, FDI and portfolio income also substantially reinforced risk sharing. Contrary to our observation for the period prior to 2008, portfolio income contributed to risk sharing (by about 7% in the long term). The effectiveness of FDI income in reducing the discrepancies in consumption growth due to asymmetric shocks is also assessed. FDI income acted as a stabilising channel after 2008, with a short-term coefficient suggesting as much as 20% of shock smoothing.

5.3. Does the degree of financial integration reinforce risk-sharing mechanisms?

To investigate the effects of financial integration on risk sharing, we estimate Equations (20) and (21). The financial integration variables are taken from the ECB database and refer to integration in the following markets: money market, bond market, equity market and banking sector[6]. We also consider two composite variables of respectively quantity-based and price-based indicators of financial integration (see ECB, 2018). In Table 5, we document a positive effect of financial integration in strengthening the smoothing of the asymmetric shocks to GDP fluctuations. "Coeff. Beta" refers to the coefficient measuring the degree of unsmoothing defined as, respectively, the averages of the estimated coefficients β_i and ρ_i^1 in Equations (20) and (21). "Coeff. Beta added" refers to the marginal added contribution of financial integration to the degree of unsmoothing, i.e. coefficients λ_i and ρ_i^2 in Equations (20) and (21). The sign of the "Coeff. Beta added" coefficient tells us whether, for a given level of risk sharing, the interconnectedness of GDP fluctuations and financial integration strengthens risk sharing. A negative coefficient indicates higher risk sharing because financial integration reduces the degree of unsmoothing. This can be considered as a proxy for the financial unification marginal contribution to the smoothing of asymmetric shocks.

We observe that, since the Great recession, stronger integration of equity and bond markets and yield convergence (price-based financial integration) have reinforced the smoothing of asymmetric shocks. And this can be viewed as a permanent phenomenon (only the long-term coefficients are statistically significant). The integration of the banking sector has potentially contributed to amplifying the unsmoothing of asymmetric shocks. The reason may be that the sudden drying up of interbank lending has substantially reduced both banking sector integration

[6] We use the same definitions and indicators as the ECB in its reports on financial integration in the EU.

and other investment income after 2008. Moreover, the correlation between business and financial cycles has increased and the asymmetric negative shocks to real GDP are associated with polarisation effects in the banking sector (tighter access to credit loans for some countries).

Table 5. Unsmoothing with financial integration variables – CCE estimator

2000-2007	**Long term**				**Short term**			
	Coeff. Beta	***T-stat Beta***	**Coeff. Beta added**	***T-stat Beta added***	**Coeff. Beta**	***T-stat Beta***	**Coeff. Beta added**	***T-stat Beta added***
Price-based	0.31***	*3.50*	0.00	*0.02*	0.30***	*9.66*	1.32	*1.52*
Quantity-based	0.34***	*8.44*	0.00	*0.12*	0.27***	*6.92*	2.79	*1.41*
Money market	0.29***	*4.59*	0.08	*1.16*	0.33***	*8.93*	0.62***	*2.61*
Bond market	0.25**	*2.28*	0.10	*0.61*	0.31***	*9.92*	-0.18	*-0.30*
Equity market	0.51***	*7.31*	-0.15	*-1.60*	0.35***	*11.15*	-1.61***	*-3.01*
Banking sector	0.31***	*4.24*	0.03	*0.31*	0.31***	*8.77*	-0.85	*-1.24*
2008-2016	**Long term**				**Short term**			
	Coeff. Beta	***T-stat Beta***	**Coeff. Beta added**	***T-stat Beta added***	**Coeff. Beta**	**T-stat Beta**	**Coeff. Beta added**	***T-stat Beta added***
Price-based	0.58***	*8.66*	-0.26*	*-1.90*	0.38***	10.95	0.06	*0.17*
Quantity-based	0.40***	*11.63*	0.00	*0.27*	0.35***	10.44	-1.24	*-1.12*
Money market	0.57***	*9.08*	-0.15	*-1.29*	0.39***	11.69	-0.11	*-0.49*
Bond market	0.58***	*12.98*	-0.37***	*-3.64*	0.38***	10.49	0.28	*1.14*
Equity market	0.74***	*12.45*	-0.42***	*-4.44*	0.39***	12.29	-0.02	*-0.10*
Banking sector	0.32***	*4.43*	0.27**	*2.08*	0.37***	11.54	-0.03	*-0.14*

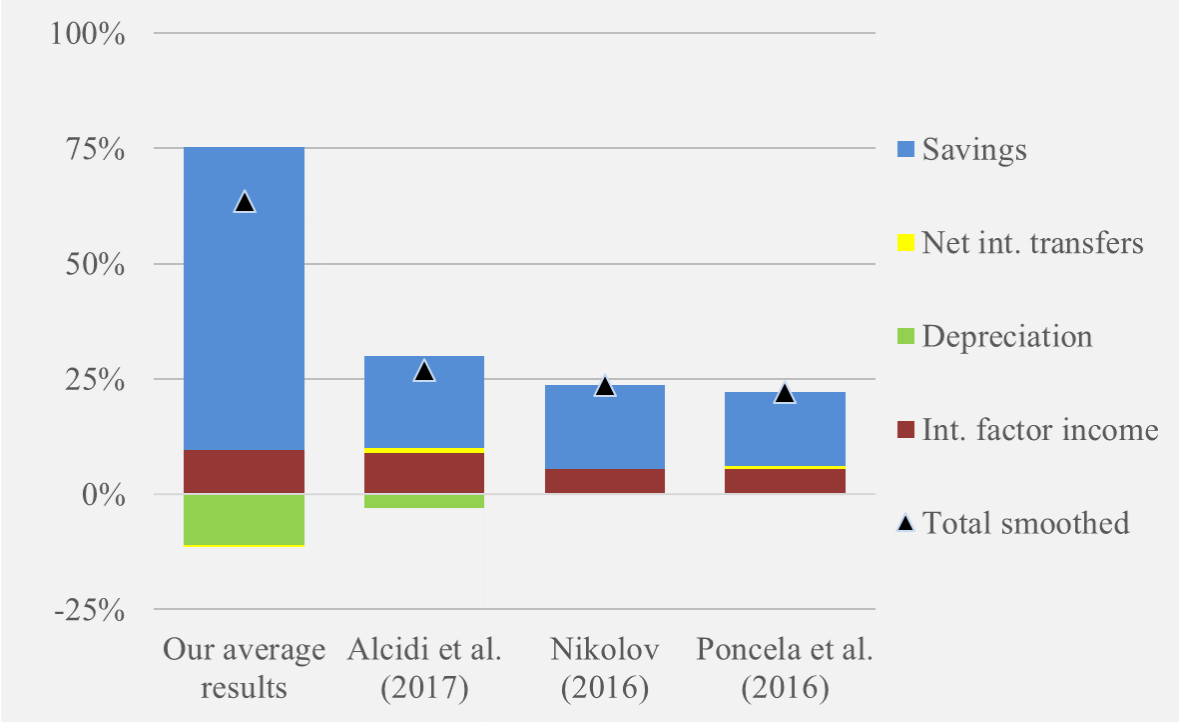
5.4. Discussion

The results of our estimations distinguish markedly themselves from recent studies on the risk-sharing channels in Europe. Chart 2 shows that, on average, we find a much larger degree of risk-sharing in Europe than in estimations of Nikolov (2016), Poncela et al. (2016), Alcidi et al. (2017), and Cimadamo et al. (2018). Their studies find quite consistently that between 75% and 80% of a country-specific shock remains unsmoothed while our results range from 30% to 47%. However our results are consistent with those of Fukely et al. (2018) using the same CCE model for high income countries for 1990-2014.

The large gap in results can be explained by two apparent caveats of precedent studies. First, they do not take into account the heterogeneity of responses to common shocks which is a major factor of bias. Second, former studies do not distinguish between short and long term risk sharing which can also bias the results when a cointegration relation is ignored. As shown above our tests led us to conclude that our results would have been biased if not correcting those two

biases. Another source of explanation is the difference of samples. We use quarterly data – as the European Commission (Nikolov, 2016) – while most study use annual ones which allows us to better observe short-term risk sharing. Moreover the time periods and countries included are also slightly different. On that point our country selection seems relevant since it includes all major countries that encountered difficulties during the crisis as well as major current account surplus economies. This allows us to capture well the impact of common shocks in the sample averages $\bar{c}_t$ and $\bar{y}_t$ and also to observe precisely the impact of crisis assistance on risk sharing after 2008 via lending flows.

Chart 2. Comparison of the channels of risk sharing with previous studies on EU countries



Note. Our average results are calculated as the mean of the results shown in Chart 1. Our sample: 13 EU countries on 2000Q1-20146Q2. Alcidi et al. (2017): sample of euro area countries on 1998-2013. Nikolov (2016): 13 EU countries on 2000Q4-2015Q4. Poncela et al. (2016): EU countries on 1999-2014.

When we look more precisely to the sub-channels of risk-sharing, it appears that our estimations are quite close to the previous studies as regards International factor income. However, those studies seem to underestimate the savings channel which according to our results contribute to smooth most of country-specific shocks – as we noted above the lion's share of this smoothing is due to public sector since 2008. We also find that depreciation contributes to dis-smoothing as in Alcidi et al. (2017) but with a larger magnitude.[7]

[7] In Nikolov (2016) and Poncela et al. (2016), depreciation is likely to contribute to a reduction of the savings channel since these studies does not disentangle this channel by using only gross incomes.

6. Conclusions

Risk sharing in Europe is two-faceted. On the one hand, in order to deepen economic and monetary union, euro area members are considering creating mutual funds from which countries could be compensated for adverse asymmetric shocks to their GDP. On the other, a far-reaching mutualisation of risks can be achieved through financial markets by developing a genuine Capital Markets Union in Europe.

This paper examines the second approach and builds on the vast literature on risk sharing through factor income. This approach relies on the identification of channels that contribute to smoothing, at the aggregate level, the idiosyncratic negative shocks that countries experience during recessions. We have proposed new empirical evidence of risk sharing in Europe based on a finer disaggregation of the usual channels. This has rarely been done but such a breakdown provides us with interesting information. For instance, we can learn about the institutional sectors that bear the adjustment of negative shocks.

We find that, in Europe, savings is a major smoothing channel of the asymmetric shocks to GDP. Until 2008, non-financial corporations played a major role by adjusting their savings in response to GDP fluctuations. Since then, cross-border consumption smoothing has mostly occurred through variations in household and government savings. Another advantage of our breakdown is that it confirms the fact that, sometimes, the channel related to international factor income can be destabilising. For instance, we find that other investment income can, in the short term, amplify the sizes of the differences in consumption growth between countries. However, capital income has mostly contributed to stabilising consumption following shocks to GDP. The role of FDI income is particularly strong in both sub-periods and portfolio income has become the main stabiliser in the long term. Furthermore, estimates show that higher integration of bond and equity markets should contribute to improving risk sharing in Europe.

Our results are obtained under the assumption of potential heterogeneous reactions of countries' consumption to common shocks to GDP. As we have seen, ignoring this hypothesis can substantially affect the estimates of the degree of risk sharing. In case of heterogeneity, average-based estimates are more robust. In addition, differences in reactions to shocks can also emerge across time, which suggests distinguishing between short-term and long-term effects. Consequently, we provide new and more robust evidence that further financial integration should contribute to improving the shock adjustment capacity in Europe via capital income.

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Appendices

APPENDIX A. List of exogenous variables (included in the initial database)

GDP = Gross domestic product

INC_{PR} = Primary income balance

COE = Compensation of employees

INC_{FDI} = FDI income balance

INC_{PORT} = Portfolio income balance

INC_{OINV} = Other investment balance

NNI = Net national income

NNDI = Net national disposable income

C_{TOT} = Final consumption expenditures (total economy)

NCT = Net capital transfer (second section of the balance of payment)

GCF = Gross capital formation

OTHERS = Acquisitions minus disposals of non-financial non-produced assets

$NNDI^{HH}$ = Net national disposable income of households

C^{HH} = Final consumption expenditures of households

I^{HH} = Total investment of households (mostly real estate)

$SAVING_{GROSS}$ = Gross savings of NFCs

CF_{GROSS} = Gross capital formation

T = Government revenue

G = Government expenditure

POP = Population

DEFL = GDP deflator

APPENDIX B. Computed variables (endogenous variables)

1. We determine GNI depending on GDP and primary income balance:

$$\widehat{GNI} = GDP + INC_{PR}$$

2. The consumption of fixed capital (or capital depreciation - DEPR) is the difference between the calculated GNI and NNI (Net national income):

$$\widehat{DEPR} = \widehat{GNI} - NNI$$

3. The secondary income balance is the difference between NNDI (Net national disposable income) and NNI:

$$\widehat{INC_{SEC}} = NNDI - NNI$$

4. Net savings is the difference between NNDI and final consumption expenditure of the total economy:

$$\widehat{SAVING}_{NET} = NNDI - C_{TOT}$$

5. Net lending of the total economy is the net savings of the total economy minus the net capital formation (CF_{GROSS} – DEPR), plus net capital transfers (NCT) and minus Others (acquisitions less disposals of non-financial non-produced assets):

$$\widehat{LENDING}_{NET} = \widehat{SAVING}_{NET} - \left(GCF - \widehat{DEPR}\right) + NCT - OTHERS$$

However, since the contribution of NCT and OTHERS to net lending is quite marginal in most cases, net lending can be proxied as follows:

$$\widehat{LENDING}_{NET} = \widehat{SAVING}_{NET} - \left(GCF - \widehat{DEPR}\right)$$

6. Net lending of financial corporations is calculated as follows (i.e. total net lending minus net lending of households, non-financial corporations and government):

$$\widehat{LENDING}_{NET}^{FCAO} = LENDING_{NET} - LENDING_{NET}^{HH} - LENDING_{NET}^{NFC} - LENDING_{NET}^{GOV}$$

However, when net lending is proxied as discussed above, the net lending of financial corporations also includes other components (NCT and Others).

7. Finally, the other primary income balance (INC_{OPI}) is a residual variable which is the difference between the total primary income balance and the balances of other sub-components of the primary income account:

$$\widehat{INC_{OPI}} = INC_{PR} - COE - INC_{FDI} - INC_{PORT} - INC_{OINV}$$