Asymmetric shocks and international risk sharing in the European Monetary Union and the European Union

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Abstract

In this paper we measure the effectiveness of international risk sharing taking place in the Eurozone (EMU) and the European Union (EU) over the most recent period of 1999–2014. We find that on average as much as 75% of shocks have been left unsmoothed during 1999–2014 in the EMU and the EU. Only 6–8% of shocks have been attenuated through the factor income channel and 20–25% of shocks have been smoothed out through the saving channel, predominantly through government saving. Our research shows that risk sharing patterns have not changed considerably after 2008. Importantly, the most recent experience from the period starting with the outbreak of the global financial crisis of 2008+ casts doubt on the ability of international financial markets to smooth large shocks between the euro area countries and back convergence among Eurozone members. A critical discussion about the financial sector’s linkages with the real sector and its influence on economic growth and financial stability of European economies complements the empirical analysis of this paper, providing arguments explaining the relatively low effectiveness of the factor income channel in smoothing asymmetric shocks in the euro area.

Keywords: shock absorption, financial markets integration, risk sharing, consumption smoothing, models with panel data

JEL: C33, E01, F21, F32, F36

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1. Introduction

The advantages and disadvantages of currency unification were subject to in-depth analysis in the economic literature concerning the subject of optimal currency areas. Monetary union members derive benefits from common currency mainly at the microeconomic level. Unification brings benefits such as reduction of transaction costs in the banking system, elimination of trade and capital movement impediments and development of financial markets. It also allows more price transparency and better price arbitrage, which puts competitive pressure on market entities. It reduces exchange rate and relative price uncertainty,\(^1\) increases intra-union trade and offers advantages of a larger single currency domain.

Unfortunately currency unions are not costless ventures. The costs of a currency union emerge chiefly on the macroeconomic level and are strictly associated with the appearance of asymmetric shocks. Here, asymmetric shocks are defined as demand or supply shocks affecting a specific region or regions within the common currency area. Supply shocks spring from e.g. wage or production component price changes, or fiscal and common monetary policy. Demand shocks may ensue due to e.g. shifts in investment and demand, consumer preferences, macroeconomic or fiscal policy changes.

Since asymmetric shocks within the currency union cannot be blunted via the national exchange rate policy, i.e. via nominal exchange rate fluctuations, the costs of common currency are strictly related to the real exchange rate changes that occur among the currency union members. Real exchange rate is defined as: \( q = \frac{s p^*}{p} \), where \( p \) and \( p^* \) stands respectively for domestic and foreign price level, \( s \) denotes nominal exchange rate. By taking log-differences of \( p \) and \( q \) and setting \( s \) as a constant, the following equality is obtained: \( d\log(q) = d\log(p^*) - d\log(p) \). The extent of \( d\log(q) \) fluctuations across regions is regarded as a measure of costs arising in the common currency area. Both Keynesian and modern classical economists agree that “the need for real exchange rate adjustment depends on the size and frequency of changes in demand and supply conditions among the prospective member countries (asymmetric shocks) and the cost of alternative mechanisms of real adjustment to real economic shocks” (Vaubel 1990, pp. 936–938). In other words, the monetary union is the less costly, the greater the extent of trade (openness), the degree of labour mobility, the real wage flexibility, the system of risk sharing through fiscal transfers, the integration of credit and capital markets and the higher the correlation of shocks and business cycles among countries.

The focus of this paper is on how asymmetric shocks are attenuated through international risk sharing channels in the Eurozone and the European Union. The term “risk sharing” refers to international income insurance and consumption smoothing over time in presence of shocks to domestic income. The concept of international risk sharing through portfolio diversification has been first raised, i.a. by Mundell (1973); hence the international risk sharing concept originates from the Mundell II research stream (McKinnon 2008). The particular attention of this vein of research focused on the effect of financial markets integration within a monetary union. It was expected that the adoption of a single currency would significantly increase international risk sharing across currency union members through cross-ownership of productive assets, securing its smooth functioning. Also, financial markets integration would result in lower interest rates and bring about increase in foreign direct investment inflows, support economic development and lead to greater synchronization of

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\(^{1}\) It is debatable whether lower variance of price changes leads to overall gain or loss of welfare. The crucial assumption in this respect is that of risk-aversion of individuals.
business cycles. Practice has shown, however, that instead of foreign direct investment it is portfolio capital inflows that were dominant, which reinforced asymmetric shocks and caused them to spread rather than smooth out.

The subject of international risk sharing has been explored in detail, among others, in publications of Asdrubali, Sørensen, Yosha (1996), Arreaza, Sørensen, Yosha (1998), Sørensen, Yosha (1998), Marinheiro (2005), Kalemli-Ozcan, Sørensen, Yosha (2004), and Konopczak (2009). This paper is a continuation of the research conducted in the above studies.

Six years after the outbreak of the global financial crisis we attempt to measure the effectiveness of international risk sharing taking place in the EMU and the EU over the most recent period of 1999–2014. Our research shows that risk sharing patterns have not changed considerably after 2008 in the EMU and the EU. We find that on average as much as 75–76% of shocks were left unsmoothed in 1999–2014. As much as 20–25% of shocks have been attenuated through the saving channel, chiefly through the net saving of national governments. More specifically, it is the government saving that accounts for the entire smoothing effect of the saving channel in the EMU and the EU during the 1999–2014 period.

Importantly, shock smoothing through financial markets is found to be relatively low; only 6–8% of shocks have been attenuated through the factor income channel in the EMU and the EU23 during the period in question. When analysing the ability of financial markets to smooth out occurring asymmetric shocks in the current EMU and EU, we present a critical analysis of the financial sector linkages with the real sector and its influence on economic growth and financial stability of European economies.

The current debate on the Eurozone is concerned with costs and difficulties member states are facing in the early phase of EMU’s existence rather than on gains from monetary unification. At present, the EMU is concerned with fiscal and banking sector stability and low economic growth. The recent global financial crisis of 2008+ has been a major shock threatening the stability of the Eurozone. Before the outbreak of the global financial crisis of 2008+ it was expected that financial markets would facilitate gradual convergence of interest rates on member states’ government debt and contribute to increased international risk sharing within the EMU. Financial markets’ smoothing potential was supposed to grow with increased integration of financial markets in the Eurozone (Kalemli-Ozcan, Sørensen, Yosha 2004).

However, the global financial crisis of 2008+ has shown that financial markets and the banking sector can themselves be subject to shock and/or can generate asymmetric shocks with significant effect on the real sector of the economy. The global crisis of 2008+ has originated in the US banking sector and it has spread all over the world through integrated financial markets hitting strongly the EMU and EU economies. Instead of smoothing asymmetric shocks, integrated financial markets have actually generated shocks and reinforced them. This experience casts doubt on the ability of international financial markets to smooth large shocks between countries and back real convergence among the EMU members.

The global financial crisis constituted a significant negative shock to the EMU which affected its member countries with to a varying degree. The growing uncertainty on international financial markets in the wake of the crisis translated into high changeability of investor behaviour with an impact on the financial situation of the EMU individual economies, and contributing to fluctuations of countries’ GDP. Fluctuations of GDP were reinforced when the financial crisis encroached on the real sectors of Eurozone economies.
The 2008+ crisis has brought about a considerable deterioration of the fiscal position of Eurozone economies and has intensified divergence tendencies in income and productivity levels as well as competitiveness in the EMU, between ‘northern’, ‘southern’ and ‘eastern’ countries. These tendencies have started long before 2008, and due to the adverse effect of the 2008+ crisis they are expected to persist at least in the near future.

The global financial crisis has hardest hit the banking sectors and real sectors of some EMU economies such as Ireland, Greece, Portugal, Spain and Italy. Since the financial sectors of these countries required significant recapitalization after 2008, their ability to use fiscal policy to mitigate the impact of the financial crisis was significantly reduced. Some non-EMU countries like the UK, Sweden or Poland, could partly adjust to the crisis through the pursuit of their own independent monetary policies and exchange rate depreciation, however, the EMU members hardest hit by the global crisis could not devalue the euro. Instead, they were forced to use the already restrained fiscal policies and pursue internal devaluation as a response to the crisis. Higher estimated shares of shocks left unsmoothed in the EMU than those between non-EMU member countries as presented in this paper confirm the general observation that the existing market mechanisms in the EMU did not allow for quick and effective adjustment to the adverse effects of the global financial crisis.

The paper is organized as follows. The first section of this paper introduces a theoretical discussion of economic divergence and convergence mechanisms in monetary unions. The overall convergence in competitiveness and economic structures between union members is crucial for the long-term stability of the EMU. This tendency determines the extent of occurring asymmetric shocks between monetary union members. The subsequent sections describe risk sharing channels in detail, and present the principle of perfect risk sharing between countries in a monetary union. Third, the existence of perfect risk sharing is revised and possible gains resulting from risk sharing activities are enumerated. Fourth, we perform an econometric analysis using the method proposed by Sørensen and Yoshia (1998) to measure the effectiveness of international risk sharing mechanisms in smoothing income and consumption in the EU. Results from pooled data of 23EU countries for the period of 1999–2014 are discussed in detail, validated and compared with results from related papers. Fifth, we complement the empirical analysis of international risk sharing in the EMU with the analysis of the EMU impact on international risk sharing in the euro area, and we discuss the international consumption correlation puzzle against the theory of international risk sharing. Finally, the last section extends the discussion of international risk sharing mechanisms to the study of the financial sector linkages with the real sector of the EMU and EU economies and its influence on economic growth and financial stability of European economies.

2. Divergence and convergence and the extent of asymmetric shocks

Essentially, the costs of a monetary union are greater in the long run if regions within the union diverge from each other in economic structures, and economic mechanisms that can smooth asymmetric shocks arising between regions are not effective. An assessment of the currency union’s optimality should take into account the current functioning of the monetary union, the ongoing and expected future changes in demographic and economic structure of the regions of the union and the potential of economic mechanisms to even out idiosyncrasies within the monetary union. A discussion
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of the question whether countries within the EMU will converge or diverge (in economic structures) from one another in the mid- to long term future has been subject to detailed analysis and discussion, e.g. in Bayoumi, Eichengreen (1992), Krugman (1993), Frankel, Rose (1996) and De Grauwe (2014). These four studies depict the most important economic mechanisms potentially playing a role in the EMU in the future (from the 1990s viewpoint).

In 1992, Bayoumi and Eichengreen assessed the advisability of the prospective currency union in Europe for the former 11 EC members. The paper analysed different aspects of demand and supply shocks occurring between the 11 EC countries. The results were compared with those for the United States (US), i.e. a common currency area referred to as a smoothly functioning monetary union (Bayoumi, Eichengreen 1992, pp. 194). The findings undoubtedly indicated that correlation coefficients of demand and supply shocks between anchor areas (respectively Germany for the EC and the Mid-East region for the US) and other regions in the union were significantly higher for the United States. Moreover, further results implied that underlying supply shocks in the EU were larger in magnitude than these in the US, whereas demand shocks were smaller though more uneven. Bayoumi and Eichengreen (1992) decompose demand and supply shocks in AS-AD diagram with respect to price and output changes. In short term, positive demand shocks influence output and the price rise; in long term they affect only the price level. Positive supply shocks trigger off price and output drop, small in short term, larger in long term. Thus, the conclusion of the above paper was not favourable to the European Community. Yet, it was then unfeasible to predict the further impact of the integration process on the European Monetary Union's advisability with respect to asymmetric disturbances. Bayoumi and Eichengreen predicted that the incidence and correlation of supply asymmetries in the EU will decline along with market integration. Demand shocks, however, were to increase and become less correlated as specialization process grew in strength (Bayoumi, Eichengreen 1992, pp. 223–224).

Presumably the most important arguments in favour of the divergence scenario prevailing in the forthcoming years in the EMU were provided by Krugman (1991; 1993) and Krugman and Venables (1993). The ‘Krugman’s’ view of further economic integration in the EMU is that one might expect the Eurozone to experience a significant surge in regional specialization, as the process of market integration advances. This would imply more region (country)-specific shocks within the confines of the EMU and an increased need for real exchange rate adjustment. The line of argument consists of two major points.

Firstly, it is likely that any reduction in transportation costs, elimination of trade or regulatory impediments leads to higher concentration of industry (Krugman 1993, pp. 244).

Secondly, suppose a region or a country with a specific industrial pattern suffers a negative demand shock and all factors of production are immobile. In this case, factor costs – first and foremost real wages – have to decrease to ensure adjustment. Diminishing factor costs tend to attract other industries to the region. Consequently, the lack of factor mobility under region-specific shocks leads to larger industrial diversification of the distressed region. This sets therefore limits on the divergence in growth of regions (or countries) within a monetary union. In turn, under full factor mobility, factor shifts do the whole adjustment instead of factor costs adjustment. This reasoning provides a serious implication for the EMU. Krugman suggests that increasing factor mobility in the EMU, with the exception of labour mobility, will not contribute to the industrial diversification of its members. Increased factor mobility will cause “greater disparity in regional growth rates, because with increased factor mobility

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2 Labour is an exception here. Cultural and language differences are very likely to continue to make European labour relatively immobile.
regions will tend to adjust to shocks by adding or shedding resources rather than by adding or shedding industries" (Krugman 1993, pp. 248).

By comparison, arguments in favour of the convergence scenario prevailing in the EMU emphasized the importance of intra-industry trade, formation of interregional clusters of economic activity as well as the growing importance of services sector and its local function.

In particular, the European Commission's report (Commission of the European Communities 1990, pp. 136−178, 235−249) stressed that the frequency of asymmetric shocks would decline since national borders would become insignificant in the future EMU and intra-industry trade would play more and more important part among member countries. Therefore, shocks to one industry would affect many countries in a very similar manner. Similarly, De Grauwe (2014, pp. 23−27) suggested that there exists a presumption in favour of the European Commission's view. He rebutted Krugman's conclusion arguing that though integration results in specialization, two further arguments make the divergence scenario more unlikely. First, economic integration in the EU will become blind to national borders as time passes by. Clusters of economic activity will encompass different countries, reducing asymmetries. Second, De Grauwe stressed the fact of growing importance of services in contemporary economies and indicated that services do not necessarily undergo a concentration process. Thus, concentration of economic activities may decline even though integration proceeds.

The aspect of the deepening of the scope of convergence of economies that form the common currency area is the essence of the monetary unions' endogeneity theory. In the 1990s, Frankel and Rose (1996) formulated the hypothesis that countries that did not meet the criteria for an optimum currency area ex ante could also create a monetary union. This is because when a country deals with a common currency its economic structures converge successively. Common area optimality criteria would be thus met ex post, although they are not fulfilled ex ante currency unification. Frankel and Rose (2000) suggest that accelerated growth of mutual trade exchange as a result of the elimination of transaction costs and the elimination of exchange rate fluctuations after the introduction of the single currency should encourage the gradual convergence of structures of integrating economies, and as a result higher intra-industry trade and stronger co-movement of national output (correlation of business cycles). Even if increased integration may determine growing industrial specialization as countries use their comparative advantages,³ in their view the first effect will dominate the second one and it is likely that economies converge as trade rises.

3. Main channels of risk sharing

In the absence of buffers to asymmetric shocks, a monetary union may become very costly. Essentially, there exist two macroeconomic approaches that define the existence of such buffers. The earlier strand originates from the Mundell's Optimal Currency Areas theory.⁴ Mundell (1961) first raised the question of how would the entities lubricated by a common currency deal with demand shocks in the absence of the nominal exchange rate adjustment. Vaubel (1988, pp. 230−243) summarized the main characteristics which reduce the extent of real exchange rate

³ There is a tacit assumption that countries specialize in different industries. Otherwise Frankel and Rose's (1997) argument with respect to specialization would be internally contradictory.
⁴ The theory of optimal currency was originally developed i.a. by Mundell (1961), McKinnon (1963) and Kenen (1969).
fluctuations (asymmetries) between currency union members. Vaubel points out factor mobility, wage flexibility, fiscal integration and openness as main stabilizers. The above factors received much attention in the past forty years and have been subject to in-depth economic analysis. Therefore, this research shall not be further elaborated on here.

The other, relatively new strand of the literature is framed as intranational or international risk sharing. It originates from the discussion on whether member countries within a common currency area converge or diverge (in economic structures) from each other, and what (macroeconomic) costs are associated with the functioning of a common currency area. Consequently, this strand of literature analyses whether arising asymmetries between member states can be dampened effectively, i.e. what degree of income and consumption smoothing takes place between member states. International risk sharing serves as stabilizer of economic conditions “channelling income from prospering regions to regions in distress (…), and helps to attenuate asymmetries (…) producing a more even economic development across all regions” (von Hagen 2000, pp. 273). The fiscal policy and its ability to mitigate the impact of arising asymmetric shocks, financial markets development and integration, and their possible role in smoothing or reinforcing asymmetric shocks, and intertemporal saving and dissaving are subject to analysis in this strand of literature.

Sørensen and Yosha (1998) define four main channels facilitating the adjustment to asymmetric shocks, i.e.: factor income, international transfers, saving and dissaving and capital depreciation. This method was proposed by Sørensen and Yosha (1998). Asdrubali et al. (1996) introduced a less detailed division including capital market (sum of effects of factor income, capital depreciation and corporate saving and dissaving smoothing), federal government/transfers (international transfer smoothing) and credit market smoothing (personal and government saving and dissaving).

First, asymmetric shocks can be attenuated through factor income flows i.e. through cross-ownership of productive assets on bond and equity markets. Since individuals prefer to have a relatively steady amount of consumption over time, they will hedge against risk by purchasing bonds, stocks and derivative instruments that embody claims on assets and revenue of other businesses. It is characteristic to factor income channel that the insurance against a country-specific shock through cross-ownership of productive assets is effectuated ex ante the shock’s appearance. Through claims on foreign assets purchased prior to the shock’s appearance this channel smoothes domestic consumption fluctuations in the fastest way out of all international risk sharing channels. This channel provides temporary insurance against domestic output fluctuations and can thus be efficient only if shocks to domestic GDP are of temporary nature.

There is irrefutable evidence that there exists negative correlation between the degree of portfolio diversification and its revenue variance. In effect, individuals can lower some economic risk resulting from fluctuations in the volume of goods and services they consume by diversifying their securities portfolios. In the case of interregional or intranational asymmetric shocks, domestic portfolios holders cannot insure themselves against regional or domestic market risk. Further risk elimination is yet viable, but on the international level. Since countries’ business cycles are characterized by different degrees of correlation, domestic market risk resulting from domestic output fluctuations may only be smoothed by revenue streams from foreign assets that co-move with foreign income.

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5 For the issue of risk-sharing, economic literature uses ‘international risk sharing’ and ‘intranational risk sharing’ basically as synonyms; both regarding international income and consumption smoothing. Both terms are used here interchangeably.
Second, international transfers may also contribute to risk sharing among countries. This is a significant mechanism of intranational risk sharing, especially if market mechanisms do not provide sufficient smoothing alone. The attenuation of cross-country output fluctuations is effectuated in this channel through fiscal policies under mutual insurance of regions under a common state policy.\(^6\) The aim of the public insurance system under mutual insurance is to redistribute income across regions or states in order to dampen the impact of asymmetric shocks. This dampening takes a variety of forms, depending on the fiscal policies’ centralization level. Basically, risk sharing can be effectuated with fiscal mechanisms through horizontal redistribution among sub-central governments or through budgetary transfers from the central government. The mutually insured system is based on transfers that are redistributed either horizontally between states of a country, or by the central government where central government’s funds are financed from regions’ tax receipts. If temporary disturbances arise – most of them are demand shocks – then tax proceeds from prosperous regions serve as shock dampers in distressed regions, increasing aggregate demand in distressed and reducing aggregate demand in prosperous regions respectively. The redistributive policy, if not sensibly implemented, may reduce the distressed area’s incentive to adjust to the shock and cause serious social and economic problems in the long run. More specifically, in the case of negative productivity shock, possible transfers from the central budget to the region in distress restore the demand for products of this region. This leads to income and price increase and, most importantly, hampers the adjustment process to the shock. If the fiscal transfer mechanism were not available, there would be overall pressure on real wages to fall in order to restore the former output level (von Hagen 2000, pp. 272–280).

Third, saving (and dissaving), i.e. inter-temporal consumption smoothing may contribute to the dampening of asymmetric shocks. Households, corporations and governments may contribute to this channel. Households can smooth their consumption by saving and investing during prosperity and cutting back consumption at the same time in order to be able to smooth their spending pattern when current income decreases during economic downturn. In this way, residents shift consumption between the present and the future. Also, corporations may contribute to smoothing as they increase or decrease retained earnings in response to profitability shocks. In the case of a negative shock, for example dividends as well as wages, and input and output prices are not subject to changes in the short run. In order to maintain the dividends unchanged, companies must increase their payout ratios by reducing profits or resorting to external financing. As a result, companies stabilize their shareholders’ income and add to smoothing of asymmetric shocks. Finally national or regional governments may also save and dissave, acting in a counter-cyclical way to smooth the impact of asymmetric shocks. The self-insurance against asymmetric shocks implies that governments of regions struck by recession, acting in a counter-cyclical way, will increase their budget deficits by raising expenditure to overcome distress. Necessary funds are obtained through national or international credit markets to finance temporary deficit. The government’s counter-cyclical measures in response to negative asymmetric shocks may facilitate and accelerate economic recovery. The pursuit of governmental budgetary policies serving the self-insurance purpose may be hampered significantly by at least two factors. First, individuals foreseeing the prospective tax increase may evade taxes by reducing future consumption. Second, governments may be unable to run budget deficits in the presence of high public debt. High

\(^6\) Public insurance systems may be essentially grouped into self-insured and mutually insured with respect to risk sharing. The latter system refers to the international transfers risk sharing channel; the former is a component of the saving and dissaving risk sharing channel (von Hagen 2000, pp. 277–280).
debt may not allow the government to smooth asymmetric shocks thus eliminating the fiscal channel when it is most needed. As a rule, larger countries may rely more on relatively more effective fiscal stabilizers when shocks occur. Smaller countries with relatively less effective fiscal buffers depend more on private saving (von Hagen 2000, pp. 277–280).

Generally speaking, risk sharing through credit markets is effectuated by households, corporations or governments ex post shock’s appearance. If shocks to domestic output are persistent it is credit markets, and not capital markets that provide consumption smoothing over time.

Last, capital depreciation allowance may even out asymmetric shocks. The rate of capital depreciation is set by the authorities. It is the rate individuals or businesses can claim on purchases of depreciable assets when paying their federal income taxes. The higher the allowance the more can individuals deduct from tax-payments and therefore more can be invested. For example, in times of economic recession, authorities may set the depreciation rate higher to speed-up economic revival. They must, however, relinquish income from tax payments in the amount of the former and the present (higher) capital depreciation rate.

In conclusion, one of the important characteristics of factor income and international transfers risk sharing channels is that they depend on cross-border flows of capital. By contrast, saving and dissaving and capital depreciation are channels that provide consumption smoothing domestically. Insurance against shocks to domestic output takes place ex ante shocks in the case of factor income and possibly saving and dissaving channels. Therefore these channels provide immediate smoothing to occurring shocks. The remaining two mechanisms, capital depreciation and international transfers provide smoothing ex post shock occurrence.

4. Perfect risk sharing – theory and practice

Perfect risk sharing describes a state where domestic consumption is fully insured against country-specific shocks. In other words, changes in domestic consumption $\Delta C^D$ should not be affected by shocks affecting domestic output. This is because domestic consumption is insured internationally. As a result of this insurance, changes in domestic consumption should be closely related to changes in international (world) consumption $\Delta C^W$ and international output $\Delta Y^D$.

If perfect risk sharing is attained, then domestic consumption will be closely correlated with the world consumption pattern, despite the presence of domestic output fluctuations stemming from economic shocks with asymmetric impact on regional economies. Three conditions describe this pattern (Olivei 2000; Sørensen, Yosha 1998, pp. 216–217):

\[
\text{cor}(\Delta C_d, \Delta C_w) = k_d
\]

\[
\text{cor}(\Delta Y_d, \Delta Y_w) < \text{cor}(\Delta C_d, \Delta C_w)
\]

\[
\text{cor}(\Delta C_d, \Delta Y_d) < \text{cor}(\Delta C_d, \Delta Y_w)
\]

where $\Delta C_d$ and $\Delta C_w$ stand for changes in domestic and world (per capita) consumption levels respectively, $\Delta Y_w$ and $\Delta Y_d$ denote changes in world and domestic output levels, cor indicates the coefficient of correlation, and $k_d$ is a given country’s specific constant which is close to 1 when full risk sharing is effectuated.
Equation (1) implies perfect (or full) risk sharing definition. It states that domestic consumption grows linearly with global consumption with a country-specific ratio of $k_d$. In the ideal state of perfect risk sharing, $k_d$, the ratio should equal one. Conditions (2) and (3) are crucial predictions of the complete markets model. Condition (2) implies that if risk is effectively shared internationally then domestic and world consumption will be closely correlated. This condition results partly from condition (1) for the ideal case when $k_d$ equal 1. At the same time, domestic and foreign outputs will exhibit smaller correlation than that between domestic and foreign consumption. Empirical studies show that this relation is in fact violated, and the phenomenon describing this violation is called international consumption correlation puzzle (Backus, Kehoe, Kydland 1992; Obstfeld, Rogoff 2001). As to condition (3), it indicates that in the case of complete risk sharing, domestic consumption will tightly co-move with global output changes. There are two silent assumptions behind (1)–(3) that are worth mentioning. First, the global consumption co-moves with the global output, and so $\text{cor}(\Delta C_w, \Delta Y_w)$ is high. In other words, world's consumption cannot be insured against fluctuations in global output. Second, the variance of the global output is smaller than the variance of the domestic output: $\text{var}(\Delta Y_w) < \text{var}(\Delta Y_d)$. When perfect international risk sharing takes place, domestic consumption will strictly co-move with the global output. As a result, the variance of domestic output will decrease with the presence of international risk sharing, thereby increasing the overall utility of the risk-averse economy.

If world financial markets were complete, all risk sharing to domestic consumption would be provided by financial markets. Perfect capital mobility implies no restrictions on international capital flows. Completeness of financial markets means that individuals can insure themselves against all asymmetric shocks by purchasing adequate securities. Unless financial markets are complete, perfect insurance is not feasible. Finally, tradability of output means that consumption smoothing of goods or services is viable only if these are tradable, i.e. they can also be consumed by foreigners. However, when financial markets are incomplete and they cannot provide full risk sharing, other mechanisms such as international transfers, saving and dissaving and capital depreciation may also contribute to domestic consumption smoothing.

Perfect consumption risk sharing through financial markets is feasible if three assumptions are fulfilled: there is perfect capital mobility, financial markets are complete and output is tradable (Olivei 2000). In fact none of these assumptions holds in practice. First, capital is not perfectly mobile on the world capital markets. Even diminutive transaction costs discourage individuals from diversifying their portfolios, if profits from risk sharing are negligible. Second, financial markets are far from being complete. At present, one cannot e.g. insure oneself against labour income fluctuations. Finally, private and government services are indeed non-tradable goods. Their consumption cannot be traded internationally and so their consumption pattern does not follow the global consumption changes. For these reasons one would expect international risk sharing to offer limited insurance against arising asymmetric shocks.

5. Potential gains from risk sharing and home bias

What can explain the low degree of risk sharing among the OECD countries? In the world with full information, perfect capital mobility, complete financial markets, tradability of output and no transaction costs, all individuals would insure themselves against income fluctuations by holding
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...diversified world portfolios (Kaleml-Ozcan, Sørensen, Yoshia 2004, pp. 8). Full risk sharing is not feasible unless all assumptions hold. For developed, financially open economies, financial markets fulfill the majority of perfect risk sharing prerequisites. As to developing economies, costs of access to financial markets and hedging against country-specific shocks are relatively higher due to a lower degree of the openness of these economies and development of their financial markets. As a result, risk sharing patterns in those countries should be relatively weaker than that in developed economies.

There exist several reasons for which perfect risk sharing is not pursued through financial markets, even in developed economies. The most prominent causes for this are limitations of access to financial markets, relative costs of hedging, home bias and welfare gains from international portfolio diversification or barriers to international investment.

First, access to financial markets and costs of hedging are strictly related to wealth and size. Specifically, households and small companies would spend a relatively greater proportion of their time and bear higher relative costs of hedging than large or multinational companies that have their specialized units perform hedging strategies. Also, the size of company matters. Larger companies have access to a wider market and their production is more diversified. Due to greater diversification, and the resulting lower variability of expected income from production larger companies can perform hedging more effectively than small companies.

Second, international asset-trading is determined to a large extent by geographical proximity. This phenomenon is called home (equity and bond) bias and is also observed in developed economies. It results from the fact that the distance between countries is positively correlated with the degree of informational asymmetries. These hamper risk sharing activities since investors are reluctant to invest capital on the markets where they do not possess informational advantage.

Tesar and Werner (1992) found there was a significant home bias towards domestic securities despite apparent gains from risk sharing in the 1980s. Authors suggest that investors are consistently more optimistic about returns on domestic assets than on the foreign ones. German investors, for example, “think that the expected return is 420 basis points higher in Germany than the world market portfolio would indicate” (Tesar, Werner 1992, pp. 14–15). For Japan, the US and the UK the differences amounted to 353, 65 and 267 bias points respectively.

Tesar and Werner (1994) showed that international portfolio allocation decisions are not consistent with the CAPM model and argue that the composition of the portfolio of foreign securities in the developed countries reflects factors other than risk diversification. They point to trade linkages, language, and geographical proximity being more important to investors than portfolio optimization motives.

Huberman (2000) suggests that institutional barriers to cross-border investments, systematic differences in hedging needs and systematic differences in perceived returns distribution may explain home equity bias existence. He assigns systematic differences in hedging needs to consumption pattern differences or asset portfolios held and not traded. Systematic differences in perceived returns distribution are motivated by self-assessed ability to make predictions about the future situation on the respective market. “The familiarity of perceived competence (higher for domestic assets) tends to narrow the spread of return distributions and increase its expected value.” Moreover, individuals prefer assets they are more familiar with. Finally, asset returns and their risks are negatively correlated with language differences.

Schoenmaker and Bosch (2008, pp. 94–99) show that the home bias in bond and equity markets decreased steadily between 1997 and 2004. They estimate that the highest home equity and bond
biases were present in southern EMU countries, i.e. Greece, Italy and Spain, and the lowest in the Netherlands and the United Kingdom. While German and US home equity biases were the lowest across the examined countries, bond home biases in these countries were relatively high. Interestingly, although home equity and bond biases declined on average in the Eurozone countries when treated separately, regional bias towards EMU equities and bonds in turn increased during that time. This is strong evidence speaking in favour of regional home equity and debt bias.

Pagano and von Thadden (2004, pp. 2–17) point to the fact that the Eurozone’s debt market has quickly become highly integrated and that European bond investors quickly started to regard the common debt market as their home market. In consequence, each country’s home bond bias in the EMU evolved into euro-area home bias.

Last but not least, another issue may be of great significance as to international risk sharing. Welfare gains from risk sharing should be the predominant factor leading to risk sharing activities. If welfare gains were negligible in comparison with costs of insurance against disturbances to output, risk sharing would not be a wide-spread phenomenon. Yet, a significant portion of economic literature, including Kalemli-Ozcan, Sørensen, Yoshua (2004) or Athanasoulis, Shiller, van Wincoop (1999) suggested that the welfare gain from international risk sharing is non-negligible. An interesting analysis performed on the historical OECD GDP data from 1955–1990 by Athanasoulis, Shiller and van Wincoop (1999) suggests that these gains can in fact be considerable. They show that the probability that per capita GDP for the best performing OECD country rises by 30%, 50%, 70%, or 100% relative to that of the worst performing country over a 30-year horizon amounts to 99.99%, 99.9%, 61%, and 13%, respectively.

If welfare gains are indeed significant, why are they not fully exploited? It is again informational asymmetries, incompleteness of financial markets and non-tradability of output and transaction costs that determine this state of affairs.

6. Decomposition of cross-sectional variance of shocks to GDP

As stated above, if perfect risk sharing is effectuated, domestic consumption should not be affected by shocks altering domestic output. Instead, changes in domestic consumption should be closely related to changes in international (world) consumption $\Delta C^W$ and international output $\Delta Y^F$. If world financial markets were complete, all risk sharing to domestic consumption would be provided by financial markets. Since in reality financial markets do not provide full risk sharing, it is other mechanisms that can help to attenuate at least part of the arising shocks.

Below we present the method proposed by Asdrubali, Sørensen and Yoshua (1996), which measures the extent of risk sharing taking place between countries and additionally classifies risk sharing into four channels through which domestic consumption smoothing can be effectuated. The four channels facilitating adjustment to asymmetric shocks are factor income, international transfers, saving and dissaving and capital depreciation. Definitions of these channels are established with the help of the following tautology:

$$ GDP = \frac{GDP}{GNI} \cdot \frac{GNI}{NI} \cdot \frac{NI}{DNI} \cdot \frac{DNI}{(PC + GC)} \cdot (PC + GC) \quad (4) $$
where GDP, GNI, NI, DNI, PC and GC stand for per capita gross domestic product, gross national income, national income, disposable national income, private consumption and government consumption, respectively.

We provide a detailed decomposition of GDP into the 4 modelled integrated economic account aggregates in Table 1. With this information the functioning of each risk channel can be related to a specific macroeconomic aggregate. This information will be used in the next part of the paper when the results on each channel’s risk sharing effectiveness are discussed in detail.

The effectiveness of factor income flows in asymmetric shock smoothing is measured by the difference between GDP and GNI. Risk sharing through capital depreciation is measured by the difference between GNI and NI, international transfers risk sharing by the difference between NI and DNI, and saving and dissaving by the difference between DNI and PC + GC.

Each channel’s contribution to domestic consumption smoothing (or equivalently, attenuating shocks to domestic GDP) can be measured by means of cross-sectional variance decomposition of GDP. By showing the cross-sectional variance decomposition below, we provide intuition for the way international risk sharing is estimated by means of panel estimation methods proposed in the following part of this paper. Equally, by doing this we present the base estimation method for each channel’s risk sharing effectiveness.

The cross-sectional variance decomposition is calculated as follows (see also Sørensen, Yosha 1998, pp. 220–223). Equation (4) holds for each country $i$, at a given time $t$, i.e.:

$$GDP_{i,t} = \frac{GDP_{i,t}}{GNI_{i,t}} : \frac{GNI_{i,t}}{NI_{i,t}} : \frac{NI_{i,t}}{DNI_{i,t}} : \frac{DNI_{i,t}}{(PC_{i,t} + GC_{i,t})} : (PC_{i,t} + GC_{i,t})$$

(5)

By applying natural logarithms, taking the time difference of all variables in (5), subtracting the cross sectional mean, multiplying by Δln(GDP) and taking the cross sectional expectations we arrive at the following equation:

$$\text{var}[\Delta \ln(GDP_{i,t})] = \text{cov}[\Delta \ln(GDP_{i,t}) \cdot \Delta \ln(GNI_{i,t}) \cdot \Delta \ln(GDP_{i,t})] + \text{cov}[\Delta \ln(GNI_{i,t}) - \Delta \ln(NI_{i,t}) \cdot \Delta \ln(GDP_{i,t})] + \text{cov}[\Delta \ln(NI_{i,t}) - \Delta \ln(DNI_{i,t}) \cdot \Delta \ln(GDP_{i,t})] + \text{cov}[\Delta \ln(DNI_{i,t}) - \Delta \ln(GC_{i,t} + PC_{i,t}) \cdot \Delta \ln(GDP_{i,t})] + \text{cov}[\Delta \ln(GC_{i,t} + PC_{i,t}) \cdot \Delta \ln(GDP_{i,t})]$$

(6)

where $\Delta \ln(GDP_{i,t}) = \ln(GDP_{i,t}) - \ln(GDP_{i,t-1})$ denotes the change in natural logarithm of annual GDP of the $i$-th country, between time $t$ and $t - 1$. 

$$\text{var}[\Delta \ln(GDP_{i})] = \frac{1}{I} \sum_{i=1}^{I} \left[ \left( \Delta \ln(GDP_{i,t}) - \frac{1}{I} \sum_{i=1}^{I} \Delta \ln(GDP_{i,t}) \right)^2 \right]$$

(7)

where $I$ denotes the number of countries in the cross section, and e.g.:
\[
\text{cov} [ \Delta \ln(GDP_i) - \Delta \ln(GNI_i), \Delta \ln(GDP_i) ] =
\frac{1}{\sum I_i} \left[ \Delta \ln(GDP_{i,t}) - \frac{1}{I_i} \sum \Delta \ln(GDP_{i,t}) \right] \left[ \Delta \ln(GDP_{i,t}) - \Delta \ln(GNI_i) - \frac{1}{I_i} \sum \Delta \ln(GDP_{i,t}) - \Delta \ln(GNI_i) \right]
\]

The variance and covariance formulas presented above are cross-section, i.e. they are computed over all countries \( i = 1, ..., I \) within the sample. By dividing both sides of (6) by \( \text{var}[\Delta \ln(GDP_i)] \), we obtain 5 cross-section (slope) coefficients denoted by \( \beta \). For example, \( \beta_{FI} \) is defined as:

\[
\beta_{FI} = \frac{\text{cov} [ \Delta \ln(GDP_i) - \Delta \ln(GNI_i), \Delta \ln(GDP_i) ]}{\text{var}[\Delta \ln(GDP_i)]}
\]

Essentially, \( \beta \) slope coefficients denote the extent of shocks absorbed by the respective risk sharing channel: factor income – \( \beta_{FI} \), capital depreciation flows – \( \beta_{CD} \), international transfers – \( \beta_{IT} \), saving and dissaving – \( \beta_S, \beta_{un} \). measures the percentage of shocks left unsmoothed. In terms of national accounting statistics, factor income is measured by the difference between GDP and GNP, capital depreciation by the difference between GNI and NI, international transfers by the difference between NI and DNI, and saving and dissaving by the difference between DNI and PC + GC. The following condition holds for \( \beta \) estimates:

\[
\beta_{FI} + \beta_{CD} + \beta_{IT} + \beta_S + \beta_{un} = 1
\]

The concept of cross-sectional variance decomposition according to (7) was basis to numerous analyses on international risk sharing. This paper also follows this approach. We apply panel data estimation techniques, which are described in the following paragraphs, in order to assess the extent of international risk sharing effectuated in the EMU and the EU. The estimation method applied in this paper is based on the decomposition of GDP into integrated economic account aggregates. However, this method does not account for the role of net international investment position and its components. Assessment of the role of net international investment position and its components in international risk sharing would require an application of a different estimation method or methodology assessing each examined country separately, due to highly diverse international investment positions of member countries. Balli, Kalemli-Ozcan, and Sørensen (2011) attempt at quantifying this effect and estimate that the effect of capital gains on international risk sharing is still inconsiderable (about 6%) though increasing in importance.

The general form of panel estimation method through which the risk sharing effects will be estimated in the 2 models presented below is represented by equations (11)–(15):

\[
\Delta \ln(GDP_{i,t}) - \Delta \ln(GNI_{i,t}) = \alpha_{FI,t} + \gamma_{FI,t} + \beta_{FI} \Delta \ln(GDP_{i,t}) + u_{FI,i,t}
\]

\[
\Delta \ln(GNI_{i,t}) - \Delta \ln(NI_{i,t}) = \alpha_{CD,t} + \gamma_{CD,t} + \beta_{CD} \Delta \ln(GDP_{i,t}) + u_{CD,i,t}
\]

\[
\Delta \ln(NI_{i,t}) - \Delta \ln(DNI_{i,t}) = \alpha_{IT,t} + \gamma_{IT,t} + \beta_{IT} \Delta \ln(GDP_{i,t}) + u_{IT,i,t}
\]
\[ \Delta \ln(DNI_{i,t}) - \Delta \ln(GC_{i,t} + PC_{i,t}) = \alpha_{S,t} + \gamma'_{s,t} + \beta_0 \Delta \ln(GDP_{i,t}) + u_{S,i,t} \]  
\[ \Delta \ln(GC_{i,t} + PC_{i,t}) = \alpha_{UN,t} + \gamma_{UN,t} + \beta_{UN} \Delta \ln(GDP_{i,t}) + u_{UN,i,t} \]  

where e.g. \( \Delta \ln(GDP_{i,t}) \) denotes change in the natural logarithm of the annual GDP per capita of the \( i \)-th country between year \( t - 1 \) and \( t \); \( \gamma'_{s,t} \) and \( \alpha_{S,t} \) denote entity and time fixed effects in each regression. \( \alpha_{S,t} \) captures the time effect associated with GDP fluctuations of the entire group of countries in the panel each year; \( \gamma'_{s,t} \) (added only in the second set of panel regressions) accounts for entity-specific effects that do not change over time but are specific to each country. \( u_{S,i,t} \) is the regression error term characteristic to each regression.

We estimate the set of regressions (11)–(15) using two different panel regression models. The first model – model (1) – follows the estimation approach of Sørensen and Yosh (1998). This model provides the baseline results for this paper. Model (2) follows the estimation approach of Konopczak (2009). It complements the estimation results obtained from model (1) and allows the comparison of obtained results from both models.

The first estimation method – model (1) – accounts for time fixed effects \( \alpha_{S,t} \), but does not include entity fixed effects \( \gamma'_{s,t} \). In other words, the set of regressions (11)–(15) is estimated with time fixed effects \( \alpha_{S,t} \) and the entity fixed effects \( \gamma'_{s,t} \) are omitted. Time fixed effects are meant to capture the impact of output developments in the chosen group of countries on the path of the dependent variable.

In this estimation method we further assume that each regression error term \( u_{S,i,t} \) follows the AR(1) process, where the autocorrelation term \( \rho \) is the same for all entities and regressions. Furthermore, the variance of the error term is assumed to be country-specific in each regression. Through this assumption we mean to capture the differences in the variability of GDP growth rates between relatively small and large countries in the examined group of countries. Smaller countries are expected to be characterized by greater variability of GDP than large countries. More formally, it follows that:

\[ u_{S,i,t} \mid X_{i,t} = \rho u_{S,i,t-1} + \varepsilon_{S,i,t} \]  
\[ E[\varepsilon_{S,i,t} \varepsilon_{S,j,t}] = \sigma^2_{\varepsilon,S} \]  
\[ E[\varepsilon_{S,i,t} \varepsilon_{S,j,t}] = 0 \]

where (11)–(13) are equation-specific and only \( \rho \) is common to equations (11)–(15). \( \varepsilon_{S,i,t} \) is an idiosyncrating residual, \( \sigma^2_{\varepsilon,S} \) denotes variance of \( \varepsilon_{S,i,t} \) for entity \( i \), \( X_{i,t} \) stands for independent variables, \( \alpha_{S,t} \) for time fixed effects, \( \gamma'_{s,t} \) for entity fixed effects, \( j \) and \( i \) refer to entities, \( s \) and \( t \) denote time periods, \( j \neq i \) and \( j \neq s \). When testing for significance of panel regression estimates later in this text we further assume that residuals are normally distributed with a mean and variance as stated above. The procedure estimates equations (11)–(15) simultaneously using the two-step Generalized Least Squares approach. Later in the text this procedure will be referred to as model (1).
For this reason, we apply the panel regression approach with fixed effects only, especially when models (1) and (2) are estimated for the EU8 and the EMU16 groups of countries.

In order to assess whether perfect risk sharing is attained it is necessary to inspect the value of the $\beta_{UN}$ coefficient. $\beta_{UN}$ captures the share of shocks to GDP that are left smoothed. If $\beta_{UN} = 0$, then all shocks to domestic output are dampened through the risk sharing mechanisms and perfect risk sharing is attained. $\beta_{UN} = 1$, denotes a state where domestic consumption strictly co-moves with domestic output and no risk sharing takes place.

The coefficient $\beta_{UN} > 0$ does not necessarily mean that risk is not optimally shared. An optimal or efficient risk sharing should be distinguished from the case of $\beta_{UN} = 0$, where perfect risk sharing takes

7 The model is found to be robust with respect to including country dummies. The results are available upon request.
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place. In the case of perfect risk sharing, where $\beta_{UN} = 0$, the remaining $\beta$ coefficients add up to 1. When $\beta_{UN} > 0$ then the remaining coefficients add up to less than 1. Suppose that $\beta_{UN} > 1$, this would imply that shocks to GDP have been reinforced by the four risk sharing channels all together.

Complementing the results obtained from the main panel regression analysis, we provide estimates of risk sharing effectuated through different channels across time within a given group of countries. In order to estimate the effectiveness of each channel risk sharing across time within a given group of countries we resort to the estimation method proposed by Kalemli-Ozcan, Sørensen and Yosh (2004). The effect of each channel’s smoothing effect at a given date $t$ is directly captured by the $\beta_{it}$ estimate. We run the following Ordinary Least Squares (OLS) regressions independently of each other:

\[
\Delta \ln(GDP_{it}) - \Delta \ln(GDP_{i-1}) - \Delta \ln(GNI_{it}) = \\
\alpha_{Ft,i} + \beta_{Ft,i} \Delta \ln(GDP_{i-1}) + \Delta \ln(GDP_{it}) + \varepsilon_{Ft,i} \tag{21}
\]

\[
\Delta \ln(GNI_{it}) - \Delta \ln(GNI_{i-1}) - \Delta \ln(NI_{it}) = \\
\alpha_{CDt,i} + \beta_{CDt,i} \Delta \ln(GDP_{i-1}) + \Delta \ln(GDP_{it}) + \varepsilon_{CDt,i} \tag{22}
\]

\[
\Delta \ln(NI_{it}) - \Delta \ln(NI_{i-1}) - \Delta \ln(DNI_{it}) = \\
\alpha_{ITt,i} + \beta_{ITt,i} \Delta \ln(GDP_{i-1}) + \Delta \ln(GDP_{it}) + \varepsilon_{ITt,i} \tag{23}
\]

\[
\Delta \ln(DNI_{it}) - \Delta \ln(DNI_{i-1}) - \Delta \ln(GC_{it} + PC_{it}) = \\
\alpha_{St,i} + \beta_{St,i} \Delta \ln(GDP_{i-1}) + \Delta \ln(GDP_{it}) + \varepsilon_{St,i} \tag{24}
\]

\[
\Delta \ln(GC_{it} + PC_{it}) - \Delta \ln(GC_{i-1} + PC_{i-1}) = \\
\alpha_{UNt,i} + \beta_{UNt,i} \Delta \ln(GDP_{i-1}) + \Delta \ln(GDP_{it}) + \varepsilon_{UNt,i} \tag{25}
\]

where $\Delta \ln(GDP_{it})$ denotes the change in the natural logarithm of the annual GDP of the $i$-th country between year $t-1$ and $t$. $\Delta \ln(GDP_{i-1})$ denotes the change in the natural logarithm of the annual GDP of the respective group of countries between years $t-1$ and $t$. $\beta_{it}$ is the OLS regression coefficient capturing the extent of risk sharing effectuated through the respective channel at time $t$. $\varepsilon_{it}$ is the OLS regression error term. The number of observations for each regression is equal to the number of countries within the chosen group of countries. The $\beta_{it}$ estimate refers to $\Delta \ln(GDP_{i})$, which depends on the number of countries in the examined group for which the risk sharing effect $\beta_{it}$ is estimated.

7. Data

The underlying data are from the European Commission’s AMECO database. The dataset covers the period of 1998–2014. The examined GDP, GNI, DNI, NI, PC, and GC time series are EUR/ECU per capita values at current prices deflated by the price deflator of total consumption.

Three sets of countries are distinguished in this paper: the EU8, the EMU16 and the EU23. The main attention of this paper is directed at the EMU16 and the EU23 groups of countries. The EMU16
group is representative to the European Monetary Union and the EU23 is representative to the European Union within its current confines.

Additionally to the EMU16 and the EU23, we provide calculations for the EU8 group consisting of eight countries, which have been European Economic Community members since 1973. We chose to consider this group of countries for they have been subject to analysis in former papers on international risk sharing by Arreaza, Sørensen, Yosha (1998), Sørensen and Yosha (1998), and Marinheiro (2005).

The EMU16 group consists of the following countries: Austria, Belgium, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Netherlands, Portugal, Slovakia, Slovenia, and Spain.

The EU23 group is composed of Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

The EU8 group consists of eight countries, which have been European Economic Community members since 1973: Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, and United Kingdom.

The relatively smallest countries – Cyprus, Luxembourg, Malta and the newest members of the EU – Bulgaria and Romania – were not included in the analysis. Results for the EMU16 and the EU23 groups of countries are compared with results obtained by Marinheiro (2005), Kalemli-Ozcan, Sørensen, Yosha (2004) and Konopczak (2009).


In Table 2 the estimated percentages of shocks to GDP smoothed by each risk sharing channel are presented for 4 different time periods. The examined time periods are: the entire 1999−2014 sample, as well as the 1999−2007 and 2008−2014 sub-periods, where 2008−2014 covers observations starting with the outbreak of the global financial crisis only.

In each time period the obtained results are presented for 3 different groups of countries: the EU8, the EMU16 and the EU23. As already mentioned, our analysis focuses on the EMU16 and the EU23 groups of countries.

Estimated contributions to cross-country risk sharing of each of four risk sharing channels – factor income $\beta_{FI}$; capital depreciation $\beta_{CD}$; international transfers $\beta_{IT}$; intertemporal saving and dissaving $\beta_S$ – are presented in the respective rows of Table 2. Estimates in Table 2 have been obtained by means of model 1, characterized by equations (11)–(15). All four channels have been characterized in detail in the previous section of this paper.

The interpretation of $\beta > 0$ is the percentage of shocks smoothed out by the given risk sharing channel; for $\beta < 0$, it is the percentage of shocks reinforced by the given risk sharing channel. All the below presented estimates have been obtained by means of model (1). Together with percentages of shocks to GDP attenuated through each channel, $\beta_{UN}$ estimates are presented in the last row of the same table. $\beta_{UN}$ captures the percentage of shocks left unsmoothed.

First, we analyze percentages of shocks to GDP left unsmoothed in the selected time periods and country subsets presented in Table 2. $\beta_{UN}$ coefficients for the EMU16 and the EU23 groups depicted in Table 2 range from 0.66 to 0.8 across the 1999−2007 and 2008−2014 sub-periods. The amount of
shocks left unsmoothed amounted to 78% in the EMU16 and 80% in the EU23 in 1999–2007. Then, in 2008–2014, 71% of shocks were not attenuated in the EMU16 group and 66% in the EU23 group.

The share of shocks dampened in the EMU16 and the EU23 groups went up by roughly 10% after the outbreak of the global financial crisis of 2008+, meaning increased but still very moderate shock smoothing effectuated through all risk sharing channels. We argue that the observed slump in $\beta_{UN}$ by roughly 10 percentage points in the EMU16 and the EU23 is due to a considerable symmetric effect the global financial crisis had on the GDP of the EMU and EU economies.

Throughout the entire 1999–2014 time period 76% of shocks were left unsmoothed in the EMU16 and 75% in the EU23. Risk sharing in these two groups of countries was relatively low over the period in question and these results show clearly that perfect risk sharing was not observed in the EMU and the EU. The relatively more favourable estimate of $\beta_{UN}$ for the EU8 with roughly half of the shocks attenuated ($\beta_{UN} + 52\%$) is still far from perfect risk sharing.

A closer visual inspection of Table 2 leads to an important observation that differences between percentages of shocks left unsmoothed ($\beta_{UN}$) in the EU8, the EMU16 and the EU23 groups of countries actually result from a relatively lower effectiveness of the saving channel in the EMU16 and the EU23 as compared to the EU8 group.

Interestingly, $\beta_{UN}$ estimates obtained in this research do not differ significantly from results obtained in related studies based on earlier time periods and similar groups of countries. Similar results were obtained, i.a. by Arreaza, Sørensen, Yosha (1998), Sørensen, Yosha (1998), Marinheiro (2005) and Konopczak (2009). $\beta_{UN}$ values from different papers are presented in the last row of Table 3. Accordingly, as for the EU8 group, in step with our results concerning the EU8 countries in 1999–2014 ($\beta_{UN} = 0.52$), Arreaza, Sørensen, Yosha (1998), Sørensen, Yosha (1998) and Marinheiro (2005) estimate that 56–58% of shocks were left unsmoothed in the EU8 and the EU8* groups of countries within different 20-year time horizons bounded by years 1971 and 1999. As to our estimates for the EMU16 and EU23 sub-samples of countries, where 75–76% of shocks were left unsmoothed during the 1999–2014 period, comparable results have been obtained by Marinheiro (2005) and Konopczak (2009). Their $\beta_{UN}$ estimates range from 60% to 76% for the EMU and the EU11 groups of countries in 1996–2007 and 1980–1999, respectively.

Staying with the issue of $\beta_{UN}$ estimates, in Figure 1 we present yet another analysis, now based on estimates from regression (25). These estimates show the percentages of shocks left unsmoothed in each time period for the two examined groups of countries: the EMU16 and the EU23. This estimation method differs with respect to model (1) as presented in the previous section. Exponential smoothing has been applied to results generated by the set of equations (21)–(25). For these reasons, results obtained from model (1) and (2) may differ for some time periods.

The visual inspection of Figure 1 leads to the conclusion that the percentages of shocks left unsmoothed in the European Union (EU23) and European Monetary Union (EMU16) have been similar over the entire 1999–2014 period. In particular, we observe a gradual increase in percentage of shocks left unsmoothed in the EMU and the EU, from 60% in 2000 to over 90% in 2005. This rise was followed by a subsequent decline to 60% in 2010, and the regressive rise up to 90% in 2013.

We conclude that there is no evident trend in the $\beta_{UN}$ time series between 1999 and 2014. By and large, the amount of shocks left unsmoothed has fluctuated between 60% and 90% during the most recent two decades in the EMU16 and the EU23. The estimates of shocks left unsmoothed depicted in Figure 1 and presented in Table 2 show that the EMU16 and the EU23 are far from the state of perfect risk sharing.
Second, knowing the extent of risk sharing realized over the 1999–2014 period, captured by the 
\((1 - \beta_{UN})\) estimate, we now turn to the analysis of the effectiveness of different risk sharing channels 
in attenuating the occurring shocks to GDP.

We observe that the contribution of the factor income (cross-ownership of productive assets) 
channel to risk sharing is relatively small across all selected time periods and country sub-samples in our 
data set. The smoothing effect of the factor income channel is represented by \(\beta_{FI}\) estimates in Table 2.

The first row in the first column of Table 2 indicates that on average 6–8% of shocks to GDP were 
smoothed through cross-border ownership of productive assets in the EMU16 and the EU23 in 1999–2014.

Importantly, percentages of shocks to GDP smoothed through factor income flows were relatively 
stable between 1999–2007 and 2008–2014 sub-samples in the EMU16 and the EU23. During the 
1999–2007 period, \(\beta_{FI}\) was on average at 4% in the EMU16 and at 7% in the EU23 group. The highest 
contribution of this channel to smoothing of cross-country GDP fluctuations in the EMU16 and 
the EU23 sub-samples was observed after the outbreak of the global financial crisis of 2008–2009. 
\(\beta_{FI}\) estimates in Table 2 show that during 2008–2014 on average 12% of cross-country GDP variation was 
attenuated through the factor income channel in the EMU16 and 11% in the EU23.

\(\beta_{FI}\) values obtained in this paper are higher by an average of 10 percentage points than those from 
the related studies by Arreaza, Sørensen, Yoshia (1998), Sørensen, Yoshia (1998) or Marinheiro (2005). The 
results from the related papers are presented in the first row of Table 3, marked as \(\beta_{FF}\). In particular, 
earlier studies based on 20-year-long time periods ending in 1990, 1993 or 1999 indicate that factor 
income had no smoothing effect or even reinforced (\(\beta_{FI} < 0\)) the occurring shocks to GDP. Reported 
\(\beta_{FI}\) coefficients from these studies are equal to or smaller than 0.

We relate the results from earlier papers with our estimates of the \(\beta_{FI}\) over the 1999–2014 period 
presented in Table 2 through the analysis of factor income smoothing presented in Kalemli-Ozcan, 
Sørensen and Yoshia (2004, pp. 30). The authors pointed to expected growing significance of the factor 
income channel in smoothing shocks to GDP in the EMU, stemming from increased financial markets 
integration in Europe. Kalemli-Ozcan, Sørensen and Yoshia (2004) show that in the early 1990s, when 
several political and economic occurrences triggered off considerable shocks to EU13 economies 
(counterpart to our EMU16 group), factor income flows had a dis-smoothing effect on GDP fluctuations 
(\(\beta_{FI} < 0\)). Specifically, the contribution of factor income flows to cross-country risk sharing for the 
group of EU13 countries – treated as a proxy for the EMU16 group in this paper – fluctuated around 
0 in 1970–1985, and was negative during the 1985–1995 period. Afterwards, in the late 1990s, the extent 
of smoothing via factor income flows has sharply increased and reached the level of over 10% around 
the year 2000. This effect is roughly of the same value as our estimates obtained from the data set for 
the EMU16 over 1999–2007 presented in Table 2, it amounts to 6–8%.

The result of Kalemli-Ozcan, Sørensen and Yoshia (2004) is also consistent with the annual estimates 
of \(\beta_{FI}\) presented in Figure 2, obtained by means of regressions (21)–(25). Similarly to Kalemli-Ozcan, 
Sørensen and Yoshia (2004), \(\beta_{FI}\) are at about 10% in 1999 and fluctuate around this value between 2001 
and 2008. Interestingly, we observe an upsurge in the percentage of shocks to GDP smoothed through 
factor income in 2009–2011, both in the EMU16 and the EU23, and a subsequent significant fall of 
this effect down to approximately 0% in 2013. On average, the percentage of shocks to GDP smoothed 
through factor income was at around 8% in the EMU16 and the EU23.

As far as the results for 2009–2011 in Figure 2 are concerned, we argue that the observed rise in \(\beta_{FI}\) 
in the EMU16 and the EU23 is most likely due to the significant symmetric effect the global financial
crisis had on the GDP of the EMU and EU economies. The global financial crisis actually originated in the financial sector and spread through financial markets leading to a deep recession in all the EMU and all but one (Poland) EU countries.

Overall, the relatively minor smoothing effect of factor income in the examined time period of 1999–2014 may be determined, i.a. by the following factors already discussed in the previous section of this paper: (1) still relatively low integration of financial markets in the EU and the EMU, (2) persisting home bias in domestic investor decisions, and/or (3) the aim of portfolio diversification in the EMU and the EU during 1999–2014 not necessarily being consumption smoothing.

Third, we turn to the analysis of the factor depreciation channel. We find that shocks to GDP have been actually reinforced by the capital depreciation allowance channel during 1999–2014. All obtained $\beta_{CD}$ estimates are presented in the second row of Table 2. The smoothing effect of the capital depreciation allowance channel was on average at -7% in the EMU16 and -8% in the EU23 over the entire period subject to analysis. The percentage of shocks reinforced by this channel in the EMU and the EU increased from -1% and -4% in 1999–2007 to -14% and -15% in 2008–2014, respectively. It is likely that the global financial crisis has reinforced the dis-smoothing pattern of this risk sharing channel.

Apparently, the rate of capital depreciation set by the authorities might have been altered pro-cyclically, rather than counter-cyclically at least in 2008–2014. Provided that this presumption is correct, the EU authorities did not set the depreciation rate counter-cyclically higher to speed-up economic revival in times of economic recession finding it particularly difficult to relinquish income from tax payments in times of economic distress. The likely reason for this phenomenon taking place in the EMU16 or the EU23 in recent years was high average level of public debt and persisting budgetary deficits run by their member countries. High deficit countries are usually restricted in their countercyclical budgetary interventions due to high public debt levels and this might have been the case for the EMU16 and the EU23 at least over 2008–2014.

Fourth, we observe that the contribution of international transfers ($\beta_{CD}$) to cross-country risk sharing was insignificant both in the EMU16 group and the EU23 in 1999–2014. Detailed $\beta_{CD}$ results are presented in the third row of Table 2. All obtained $\beta_{CD}$ estimates range from 0% to 5% for the two groups of countries.

Of course, some forms of horizontal redistribution of income across the EMU16 and EU23 countries through the EU budget may have contributed to the dampening of asymmetric shocks during 1999–2014. However, given the size of the current EU budget – amounting to about 1% of the EU28 countries’ GDP only (EUR 144 bn in 2013), where roughly 50% of the budget is absorbed by the agricultural sector – this redistribution cannot serve as a relevant instrument of macroeconomic policy aimed at macroeconomic stabilization and redistribution of income. The current potential of this channel to smooth asymmetric shocks in the EMU is thus very limited. The importance of this channel is likely to increase over time in the prospective EMU together with further coordination and possible centralization of member countries’ budgetary policies (Molle 2014, pp. 88–101).

Finally, we turn to the saving (and dissaving) channel. This risk sharing channel has by far the highest contribution to shock smoothing across all groups of countries. Detailed estimates regarding this channel are presented in the last but one row of Table 2. Results from our data set show that this channel’s smoothing effect was highest in the EU8 group, and amounted to 47% in 1999–2014. As for the EMU16 and the EU23 groups, accordingly 25% and 20% of occurring shocks to GDP were attenuated through this channel.
Importantly, increased risk sharing through this channel was observed in all three groups of countries after the outbreak of the global financial crisis. Our $\beta_s$ estimates for the EMU16 and the EU23 groups show increased risk sharing through the savings channel rising from 17–19% in 1999–2007 to 29–38% in 2008–2014. In the EU8 group the rise in $\beta_s$ estimates between the two sub-periods was even more pronounced: $\beta_s$ rose from 22% in 1999–2007 to 78% in 2008–2014.

The largest importance of the saving and dissaving channel out of all risk sharing channels in smoothing shocks to GDP is also documented by Arrea, Sørensen, Yosha (1998), Sørensen, Yosha (1998), Kalemli-Ozcan, Sørensen, Yosha (2004), Marinheiro (2005) and Konopczak (2009) in the case of the EU8 and the EMU16. $\beta_s$ estimates from these papers are presented in the fourth row of Table 3 together with our estimates from model (1).

In short, our results are similar to estimates presented in the selected papers. Particularly, $\beta_s$ estimates from related studies for the EU8 and the EU8* groups range from 24% to 54%, whereas our estimate for the EU8 group reaches 51%. Similarly, the saving and dissaving channel’s smoothing effect estimated by Konopczak (2009) for the period of 1996–2007 is at the 27% level, while estimates from model (1) range from 25% to 29%.

Last but not least, we decompose the smoothing effect of the saving and dissaving channel into personal $\beta_{SP}$ and government $\beta_{SG}$ saving. Results are presented in Table 7.

As far as results in Table 7 are concerned, the sum of personal ($\beta_{SP}$) and government ($\beta_{SG}$) saving smoothing effects should be equal to the respective $\beta_s$ estimate presented in Table 2. This equality, however, is not achieved in this particular case, for two reasons. For one thing, due to the lack of data for Croatia, Estonia, Greece and Lithuania, we run the estimation procedure for the EMU13* and the EU19* groups of countries, rather than the EMU16 and the EU23. We also disregard the EU8 group in this estimation due to a relatively small number of observations in the sample. For another thing, the estimation procedure applied for the sake of the saving channel’s decomposition involves the extension of model (1) resulting in the change of the model structure. Because of the two conditions, $\beta_{SP}$ and $\beta_{SG}$ estimates presented in Table 7 are roughly similar but not equal to the respective $\beta_s$ estimates in Table 2.

We estimate the modified model (1) with 6 (rather than 5) underlying regressions, where equation (14) is replaced by the following two equations:

$$\Delta \ln(DNI_{i,t}) - \Delta \ln(DNI_{i,t} - GOV_{i,t}) = \alpha_{SG,i} + \gamma_{SG,i} + \beta_{SG} \Delta \ln(GDP_{i,t}) + u_{SG,i,t}$$

$$\Delta \ln(DNI_{i,t} - GOV_{i,t}) - \Delta \ln(GC_{i,t} + PC_{i,t}) = \alpha_{SP,i} + \gamma_{SP,i} + \beta_{SP} \Delta \ln(GDP_{i,t}) + u_{SP,i,t}$$

where $GOV$ denotes net government and the corresponding estimate is $\beta_{SG}$. $\beta_{SP}$ is the estimate of personal saving’s contribution to cross-country consumption smoothing.

The method makes use of the following relationships between national accounts: net saving = net private sector saving + net government saving, and $C + G + \text{net saving} = NI$.

An alternative estimation method presented in Marinheiro (2005, pp. 201–203) involves estimation of one single panel equation:

$$\Delta \ln(DNI_{i,t}) - \Delta \ln(DNI_{i,t} + X_{i,t}) = \alpha_{X,i} + \gamma_{X,i} + \beta_X \Delta \ln(GDP_{i,t}) + u_{X,i,t}$$

where $X$ is either net private sector saving or net government saving.
The $\beta_{SG}$ and $\beta_{SP}$ results obtained by means of this method are presented in Table 8 in order to validate results presented in Table 7, obtained from model (1). The estimates are found to be consistent with the $\beta_{S}$ results obtained from model (2) in Table 3 (model (2)) estimates are validation of results obtained from model (1)). The conclusions from the analysis of Table 8 are similar to those derived from Table 7, despite differences in the strength of the estimated effects between model (1) and model (2). First, private saving does not contribute to smoothing of shocks or even reinforces them. Second, government saving accounts for the entire/bulk of smoothing provided through the saving in the EMU13*/EU19*.

There are three important observations that can be made on the basis of results presented in Table 7. First, the $\beta_{SP}$ estimate of 0% depicted in the second row of Table 7 for the period of 1999−2014 shows that the net private saving channel has contributed nothing to cross-country consumption smoothing in the EU19* group. Worse still, the net private saving channel has actually reinforced the appearing shocks to GDP in the EMU13* group. $\beta_{SP}$ estimate shown in the first row of Table 7 implies that on average 7% of shocks have been reinforced in the EMU13* group in 1999−2014.

Second, it is the net government saving that accounts for the entire smoothing effect of the saving channel in the EMU13* and the EU19* in 1999−2014. Specifically, 39% of shocks to GDP have been smoothed out in the EMU13* group and 34% of shocks in the EU19* group through the government saving channel.

Third, on the one hand, we observe an upsurge in smoothing through government saving from 19−20% in 1999−2007 to 48−54% in 2008−2014 in the EMU16 and the EU23. This effect is attributed to national governments increasing their budgetary deficits after 2008, counteracting the adverse effect of the global financial crisis on the real sectors of national economies. On the other hand, the smoothing effect of the private saving channel has deteriorated from 0% over the 1999−2007 period to -4% and -12% over the 2008−2014 period in the EU19* and the EMU13*, respectively. This effect may be attributed to individuals visibly reducing their consumption after the outbreak of the financial crisis of 2008+.

Finally, we underpin the analysis of the saving channel's effectiveness with the conclusion that the above-presented results are similar to the results obtained by Sørensen and Yosha (1998, pp. 231−232). In their paper the authors find that net personal saving had no contribution to cross-country risk sharing in the group of 13 OECD countries. On the contrary, net government saving accounted for the bulk of the smoothing effect provided through the saving channel.

9. Validation of baseline results

In order to validate our baseline estimates, we replicate the results displayed in Table 2 by means of model (2). The estimation procedure applied in model (2), discussed in detail in the earlier section, has been applied by Konopczak (2009). Model (2) estimates are presented in Table 4 for detailed visual inspection by the reader. In short, there are no significant differences between estimates presented in Tables 2 and 4. Visible, but still acceptable differences between the estimated smoothing effect of the saving and dissaving channel exist and these also affect the estimates of percentages of shocks left unsmoothed by the two methods. We confine ourselves to the conclusion that estimates obtained by means of model (2) do not significantly differ from those presented in Table 2, obtained from our benchmark model (1). Model (2) results will thus not be further discussed.
Next, results obtained from model (1) are validated using Hodrick-Prescott de-trended panel data. The purpose of this validation is to ensure that the estimates obtained from model (1) are not biased by the existence of permanent shocks or existing heterogeneity of long-term trends across the examined countries. The robustness check of model (1) using Hodrick-Prescott de-trended data is presented in Table 9. Since the obtained results presented in Table 9 are similar to those presented in Table 2 for the EMU16 and the EU23 groups, we conclude that the benchmark model (1) is robust against the impact of permanent shocks or existence of heterogeneous trends across the examined countries.

In addition to the comparison of model results obtained through model (1) and model (2), we also compare selected results obtained in this paper for the period of 1999–2014 with the results from studies conducted by Arreaza, Sørensen, Yosha (1998), Sørensen, Yosha (1998), Marinheiro (2005), Kalemli-Ozcan, Sørensen, Yosha (2004) and Konopczak (2009). We juxtapose these calculations in order to inspect whether our results differ considerably from those obtained in the related studies on the same topic. Unfortunately, direct comparison of estimates from different papers on the same topic is not feasible since sub-samples of countries, time periods, estimation methods and data vary across papers. We juxtapose selected results obtained by different authors in Table 3, for possibly most similar groups of countries and time periods. While on the left hand side of Table 3 we present results obtained for the group of 8 EU countries, on the right hand side of the same table results obtained for the EMU or the EU11 countries are shown. Two important observations are taken from the visual inspection of Table 3.

We present two results referring to different time periods from the same study of Sørensen and Yosha (1998) on the left-hand side of Table 3. Also, two results from Marinheiro (2005) are presented in the right-hand side of the same table. The comparison of results within these studies clearly indicates that there exist significant differences in estimates within the examined studies for different time periods. The differences are both in percentages of shocks left unsmoothed and in the effectiveness of each risk sharing channel in shock smoothing. This observation from Table 3 suggests that the estimation may significantly vary over different time horizons, especially when the examined periods in the panel are relatively short. Also, our paper estimates of each channel's smoothing effectiveness presented in Table 2 vary, some even significantly, between 1999−2007 and 2008−2014. On average, however, the majority of estimates presented remain relatively stable over the 1999–2014 period.

Second, keeping in mind the differences in the sub-samples of countries, time periods, as well as estimation methods across papers we conclude from the visual inspection of Table 3 that the reported percentage of shocks left unsmoothed within the presented 20 to 30 year horizons is similar across different papers. The estimates of percentages of shocks left unsmoothed approach 60 for the EU8 and EU8* sub-samples, irrespective of the time period.

Similarly, the estimates of shocks left unsmoothed in the EMU or the EU11 groups range from 60–75% across all examined papers, irrespective of the underlying time period. We note however that the estimates of risk sharing effectuated through the four channels vary significantly across studies and it is the intertemporal saving and dissaving channel that has the largest estimated contribution to shock absorption across different groups of EU countries in the studies in question.
10. The international consumption correlations puzzle

In their paper Backus, Kehoe and Kydland (1992) documented an important discrepancy between the real business cycle theory and empirical data, coined as the international consumption correlations puzzle. The authors pointed to the fact that the correlation of output growth rates across countries is higher than the correlation of consumption growth rates. This empirical finding is not accounted for by the international risk sharing theory.

Specifically, when risk is effectively shared internationally then domestic and world consumption will be closely correlated. At the same time, domestic and foreign outputs will exhibit smaller correlation than domestic and foreign consumption. This state has been described by conditions (1)–(3) in the earlier section of this article. Even if only some degree of risk sharing is realized, one would still expect domestic consumption growth rate to be more closely correlated with the world consumption growth rate than domestic output growth rate with the world consumption growth rate. However, empirical studies show that this relation is in fact violated, and the phenomenon describing this violation is called international consumption correlations puzzle.

We document the existence of the international consumption correlation phenomenon in Table 10 by juxtaposing the average correlations of growth rates or Hodrick-Prescott de-trended and normalized time series of countries’ GDP, GNI, DNI, NI and C + G with the EU23 and the EMU16 time series for the period of 1999–2014. Correlations reported in Table 10 are simple averages of the countries’ correlations with the group’s respective aggregate series.

For both the EMU16 and the EU23 we document that the average correlation of the countries’ GDP growth rates with the group’s aggregate GDP growth rate is at 80–82%. This is significantly more than the correlation of countries’ consumption growth rates with the respective group’s consumption growth rate – 59–69%. The remaining correlations of GNI, DNI, and NI are also considerably bigger than reported consumption correlations.

These results are fully consistent with the international consumption correlations puzzle while the international risk sharing theory cannot account for the correlation of output growth rates being higher than the correlation of consumption growth rates. Moreover, bigger correlations of GDP than those of GNI, or a bigger correlation of GNI than that of DNI, or of DNI than that of NI are also inconsistent with the international risk sharing effectuated through any of the international risk sharing channels.

Different explanations have been proposed to provide justification for the existence of the international consumption correlations puzzle. Sørensen and Yosha (1998, pp. 231) favour the explanation that low country consumption correlations are still in line with theoretical considerations when countries are subject to idiosyncratic taste shocks. Obstfeld and Rogoff (2001, pp. 371–372) observe that international risk sharing does not require consumption correlations to be greater than output correlations. Since only output less investment and government consumption is solely shared by individuals, it is the correlation of consumption that should be greater than the correlation of output net of investment and government consumption. Their findings from the 1973–1992 period for France, Germany, Italy, Japan, UK and the US confirm this hypothesis.
11. The effect of the EMU on risk sharing

We complement our empirical analysis of international risk sharing in the EMU with a comparison of estimation results from model (1) for the EMU16 with estimates for non-EMU countries, i.e. the countries that are not members of the EMU16, but are included in the EU23. The purpose of this analysis is to explore whether the effect of the Eurozone on international risk sharing has been significant in the most recent period.

Estimation results for the EMU16 and non-EMU groups are presented in Table 6. The visual inspection of estimates for the entire 1999–2014 sample leads to the conclusion that roughly the same share of shocks was left unsmoothed during this period in both groups of countries: 76% in the EMU16 and 69% in the non-EMU group. Over time, the percentages of shocks left unsmoothed have decreased both in the EMU16 and non-EMU groups. During the 1999–2007 period 78% of shocks have been left unsmoothed in the EMU16 and 71% in the non-EMU group. After 2008 the share of shocks not attenuated diminished to 71% in the EMU16 and to 56% in the non-EMU group. In other words, risk sharing has particularly improved in the non-EMU group, and the estimate of shocks left unsmoothed in the 2008–2014 period is significantly smaller than that in the EMU16.

There are at least two important factors that determined this result. First, estimation results for the non-EMU group should be treated with certain reserve. It is worth nothing that there exists greater uncertainty about \( \beta \) estimates for the non-EMU group due to relatively small number of observations in the estimation sample.

Second, it is likely that the weaker smoothing effect observed in the EMU16, especially during the 2008–2014 period, can in fact be attributed to the effect of the EMU on international risk sharing. The global financial crisis has hardest hit the banking sectors and the real sectors of some EMU economies such as Ireland, Greece, Spain and Portugal. Since financial sectors of these countries required significant recapitalization after 2008, the ability to use fiscal policy to mitigate the impact of the financial crisis was significantly reduced in these countries. While some non-EMU countries, i.a. Denmark, the UK or Poland,\(^8\) could partly adjust to the crisis through the pursuit of their own independent monetary policies and exchange rate depreciation. The EMU members hardest hit by the global crisis could not devaluate the euro. Instead, they were forced to use already restrained fiscal policies and pursue internal devaluation as a response to the crisis. It is likely that because of this fact, the estimated share of shocks left unsmoothed in the non-EMU group is smaller than that in the EMU16.

12. Financial markets development and international risk sharing

The method of cross-section variance decomposition of GDP assessing the extent of international risk sharing presented in the preceding sections of this paper has been first proposed by Asdrubali, Sørensen and Yoshia (1996). Since then it has been applied in many subsequent papers with the aim of assessing the extent of risk sharing effectuated in the US and the EU/EMU, i.a. in Arreaza, Sørensen, Yoshia (1998), Sørensen and Yoshia (1998), Kalemli-Ozcan, Sørensen, Yoshia (2004), Marinheiro (2005) and Konopczak (2009).

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\(^8\) For example, Poland’s experience after 2008 is that the PLN floating rate has facilitated adjustment to the external global shock affecting Poland and the EMU (Konopczak, Marczewski 2011, pp. 14–18; Brzoza-Brzezina, Makarski, Wesołowski 2012).
The unquestionable success of the above-presented method lies in its tractability and intuitive character. This method operates at a very high level of generality, requiring only data on the main macroeconomic aggregates in order to assess the extent of international risk sharing among countries. In this method GDP is decomposed into 5 major macroeconomic aggregates, i.e. GNI (gross national income), DNI (disposable national income), NI (national income), PC (private consumption) and GC (government consumption).

Although this decomposition is very tractable for modelling, a detailed analysis of constituent factors having impact on the performance of individual channels is not possible at this level of data disaggregation. In particular, the overall assessment of risk sharing effectuated through selected channels does not provide one with information as to what percentage of shocks to GDP is smoothed by households, private firms, financial institutions and government, and which particular mechanisms making up for each channel generate and which ones smooth the arising shocks.

Referring to the factor income channel, it is important to note that revenues from factor income, i.e. repayments and dividends from loans and investments are to a relatively large extent part of corporations and earnings of financial institutions. Conversely, they are to a small extent part of households’ earnings. Unlike for international companies and financial institutions, households’ access to financial markets is relatively constrained due to relatively small amounts of capital (as compared to large firms) at their disposal, the costs of access to financial markets, and time and knowledge barriers hindering the effective management of capital and thus consumption smoothing.

Revenues from factor income extracted from macroeconomic aggregates consist largely of debt equity and foreign direct investment receipts. The main factors determining factor income capital flows are exploitation of risk and return differentials, speculation and hedging. Accordingly, the purpose of these capital flows is not consumption smoothing of households, i.e. the majority of population within a country. In fact, the capital flows related to investment in debt and equity markets and foreign direct investment may reinforce or generate shocks to GDP, especially when their purpose is speculation.

Moreover, the primary income balance recognized in the current account balance of payments – attributed to factor income – does not reflect the full scale of their financial sector’s linkages. The adverse effect the global financial crisis had on the EMU economies through the financial sector is difficult to estimate. Possibly only a part of this effect is measured through defined risk sharing channels.

Linkages between large international companies, financial institutions and capital flows generated by them are bound to affect the assessment of a single country’s risk and lead to severe crisis in the real sector of the economy. When financial market conditions are stable, large portfolio and investment capital volumes – which largely come from the few highest developed and richest economies in the world – are diffused on international markets searching for highest return vs. risk ratio. Under stable market conditions factor income may absorb a fraction of shocks to domestic GDP. However, when market conditions are not stable, e.g. when investors lose confidence in a country or region economy, the portfolio and investment capital is immediately withdrawn. With well-developed financial markets, large volumes of capital may outflow within short time, which can financially destabilize any country or region in the world, leading to severe financial and real economic crisis or even insolvency.

The interconnectedness of the financial sector’s participants and the impact of the situation of the financial sector on the economy emerged fully after the outbreak of the global financial crisis of 2008+. It was largely through the credit derivatives markets and financial sectors’ exposure to housing markets
that the global financial crisis started in the US and the UK. Next, it spread over international financial markets, endangering the stability of many financial institutions and national economies, i.a. in the EMU and the EU (Marciniak 2010a, pp. 26−39).

The excessive size of the financial sector in many developed economies has been criticized by many economists, especially after the outbreak of the financial crisis. The criticism is based on the consideration that the financial sector should play an ancillary role with respect to the real sector of the economy, facilitating its more effective functioning. Instead, the global financial crisis serves as a well-suited example of a situation where highly developed financial system increases the volatility of economic growth in the economy and decreases the financial stability of the economy, being actually the source of an asymmetric shock rather than providing greater risk sharing.

Before the outbreak of the global financial crisis of 2008+ it was expected that financial markets would facilitate gradual convergence of interest-rates on member states’ government debt and contribute to increased risk sharing within the EMU. For one thing, financial markets’ smoothing potential was supposed to grow with increased integration of financial markets in the Eurozone (Kalemli-Ozcan, Sørensen, Yosha 2004). For another thing, as a result of markets’ integration, government bond yields in member countries gradually converged after monetary unification (Pagano, von Thadden 2004, pp. 18−26). This convergence, however, contributed to the delay of reforms and led to accumulation of economic problems as revealed after 2008.

Specifically, convergence in interest rates made countries running high budgetary deficits and gradually losing the competitive advantage within the EMU (i.a. Greece, Portugal, Italy and Spain) postpone necessary reforms. These countries could finance their budgetary deficits and public debts at lower cost than from outside of the Eurozone. As costs of debt financing declined due to the unification effect and exchange rate depreciation was no longer available to restore external equilibria between countries, current account deficits between northern and southern member states of the Eurozone became persistent. In fact, it is financial markets through convergence of interest-rates in the EMU that contributed to the delay in reforms in southern EMU economies, resulting in the continuation of the divergence trend between Eurozone economies.

The global financial crisis of 2008+ has reinforced divergence tendencies between Eurozone member states. Instead of asymmetric shock smoothing, financial markets through the banking sector have actually generated asymmetric shocks and spread them mainly through credit derivatives markets. It turned out that the banking sector can itself be subject to an asymmetric shock and can generate asymmetric shocks with significant effects on real sectors of economies. Before the outbreak of the global financial crisis yield disparities on national debt in the EMU had been relatively small and they had not reflected the risks associated with investments in treasury bonds of selected economies.

The global financial crisis spread through financial markets bringing about liquidity crisis in banking sectors throughout the EU leading to insolvency of several banks across the EMU. When the financial crisis hit the banking sector inter-bank markets dried out of liquidity. Banks withdrew from inter-bank lending or engaged only in short-term lending, fearing the counterparty bank borrowing liquidity may default anytime and at the same time rising reserves for deteriorating credit and derivative portfolios. Liquidity supply shortages on interbank markets resulted in increased bid-ask spreads of IBOR rates and spreads between IBOR rates and treasury bonds (Marciniak 2010b, pp. 122−139).

With the loss of confidence in banks, and decreased confidence in the financial credibility of the EMU’s peripheral economies (i.a. Greece, Portugal, Ireland or Spain), or CEE economies, portfolio and
Asymmetric shocks and international risk...

Asymmetric shocks and international risk...

Investment capital started to be withdrawn from these countries. As capital was massively withdrawn from lower rated or hardest hit countries, CDS spreads and yields on treasury bonds soared, reinforcing the crisis in these economies through the financial sector. Spreads between countries’ government bond yields increased sharply, rising the costs of debt servicing of the lower rated or hardest hit economies. Increased costs of current debt servicing and funds spent on the nationalization of selected private banks led to massive debt accumulation in many countries. Increased budgetary spending aimed at counteracting the severe recession in real sectors further increased government debts of many countries (Bąk 2015, pp. 54–56).

Growing uncertainty on international financial markets translated into high changeability of investor behaviour influencing financial situation and real sectors of individual economies, i.a. contributing to the fluctuations of the GDP of individual countries. The fluctuations of GDP were reinforced, when the financial crisis started to have impact on real sectors of economies. Next, the recession in the real sector translated into a sudden increase in unemployment, deterioration of financial situation of many firms or bankruptcies. This led to the deterioration of banks’ loan portfolios forcing banks to raise additional capital against increasing losses.

Deterioration of bank portfolios’ credit quality has brought about contraction of crediting on the part of the banking sector to firms and households. This had a particularly severe effect on the EMU economies, which are heavily reliant on banking sector crediting rather than crediting through capital markets as is the case in the US. This reliance can be derived from data presented in Table 5, where the US and the EMU financial market sizes are presented.

While the banking sector assets made 18.2% in 2007 and 22.9% in 2012 of the whole US financial market value, the value of banking sector assets in the EMU was 51.5% and 50.8%, respectively. The relatively large size of the banking sector in the EMU as compared to the US, measured as percentage of the financial markets size and percentage of GDP shows a particularly important role of the banking sector for the EMU economies.

The size of the financial market estimated as the sum of stock market capitalization, market value of debt securities and value of banking sector assets has visibly declined in the EMU between 2007 and 2012, mainly as a result of the crisis in the banking sector reflected by a considerable decline of banking sector assets. While banking sector assets measured as percentage of GDP increased in the US from 77% to 91% between 2007 and 2012, they fell from 287% in 2007 to 233% in 2012 in the EMU. This constituted a significant shock to the whole EMU economy. Due to a relatively low share of banking assets, and greater shares of stock and debt securities markets in the US financial market, the impact of the banking crisis on the US economy was less pronounced than in the case of the EMU.

The comparison in Table 5 leads to the question about the optimal size of the financial and banking sector for stability and long term growth of economy. This question has been addressed in IMF discussion note by Sahay et al. (2015) in which relations between the level of financial development (the level of financial markets and financial institutions’ development) and economic growth (1), economic growth volatility (2) and economic stability (3) were subject to research.

Firstly, the relation between financial development and economic growth generally depends on the country’s income level, institutional, regulatory and supervisory quality. On average, this relation is bell-shaped, i.e. economic growth increases with the level of financial development up until a certain optimal level. Afterwards, greater financial development brings about lower economic growth (Sahay et al. 2015, pp. 16). The above bell-shaped relation is determined by economic
processes taking place in the financial system and the real sector of the economy as the level of financial development changes.

When financial development increases from low levels, its impact on the pace of economic growth is positive. Increased financial markets development entails an increase in financial markets' depth and growing competition between financial institutions. Greater competition leads in turn to improved access to capital and lowers the cost of capital. Also, greater financial market development leads to better international risk-sharing opportunities, which has been discussed in detail in the preceding sections (Bukowski 2011, pp. 32–35). However, at a certain point of financial development its marginal increase has a negative effect on economic growth. Therefore, further increase in financial development lowers the pace of GDP growth. This negative effect is i.a. due to the increased frequency of boom and recession phases intensified by the (excessively) developed financial market and/or diversion of skilled labour from the productive sectors of the economy (Sahay et al. 2015, pp. 14–17).

Conversely, the relation between financial development and economic stability has an inverted bell-shape. For an initial low level of financial development, the rise in financial development reduces economic growth volatility. This effect is attributed to increased risk management and diversification opportunities of households and companies, which is invariably related to financial markets' depth and size. Above a certain level of financial development, an increase of financial development triggers increased volatility of economic growth. The change in the direction of the impact of financial integration on growth volatility is again determined by excessive growth of the financial sector, which increases the frequency of boom and recession phases and therefore the variability of GDP growth (Sahay et al. 2015, pp. 21–24).

Finally, Sahay et al. (2015) find that financial stability generally decreases with financial institutions' depth. Initially, at low levels of GDP per capita increased financial institutions' depth is beneficial. However, for higher income levels this relation becomes negative, i.e. financial stability decreases with greater financial institutions' depth. An exactly opposite relation was observed in the case of financial markets. Particularly, at low income levels greater depth of financial markets leads to lower financial stability. At a relatively low level of GDP per capita this relation changes the sign and so greater financial market depth leads to improved financial stability of the economy.

According to Sahay et al. (2015), with their levels of financial markets and financial institutions’ development the advanced economies achieve lower economic growth and experience increased volatility of economic growth as compared to lower, optimal level of financial development which e.g. characterizes the current financial development level of the Polish economy. The financial crisis which initially burst in the US and the UK spread through highly integrated and developed financial markets extending i.a. to the EMU countries. The contagion effect was the greater the tighter and the more advanced were the financial links between the US and UK financial institutions. The global financial crisis thus serves as a well-suited example of a situation where a highly developed financial system results in lower economic growth, its increased volatility and decreases the financial stability of the economy.

13. Concluding remarks

The costs of monetary union emerge chiefly at the macroeconomic level and are strictly associated with the appearance of asymmetric shocks. Whether asymmetric shocks increase or decrease in intensity
and strength in the Eurozone in the future depends on whether the disturbances within the EMU will grow in strength. We present the point of view by the Commission of the European Communities (1990) emphasizing the fact that the expected surge in intra-industry trade after monetary unification will reinforce economic convergence of union members. The opposing arguments mentioned by Krugman (1991; 1993) suggest that increased integration resulting from monetary unification will lead to divergence in economic structures within the EMU, leading to the state where economic shocks appear more frequently and possibly also grow in strength between its members. Should this scenario materialize in the long-run, in order to function smoothly, the EMU will have to rely more on various economic mechanisms attenuating arising asymmetric shocks.

The analysis of selected market mechanisms smoothing asymmetric shocks, referred to as international risk sharing, is subject to detailed analysis in this paper. International risk sharing is one of the most prominent economic mechanisms, apart from e.g. labour and factor mobility, or (real) wage (downward) flexibility, that may enable the adjustment to symmetric shocks in a monetary union. In this paper we measure the effectiveness of international risk sharing effectuated in the EMU and the EU over the most recent period of 1999–2014. Our research refers to previous papers on international risk sharing showing that risk sharing patterns have not changed considerably after 2008 in the EMU and the EU.

We find that on average 75–76% of shocks have been left unsmoothed during the period of 1999–2014 in the EMU and the EU (see Table 2). More precisely, the annual estimates of shocks left unsmoothed in the EMU and the EU vary between 60% and 90% and no clear trend over the 1999–2014 can be observed.

We also observe that the contribution of the factor income (cross-ownership of productive assets) channel to risk sharing was relatively small during 1999–2014. On average 6–8% of shocks to GDP have been smoothed through cross-border ownership of productive assets in the EMU and the EU. This estimate is by an average of 10 percentage points higher than estimates from related studies of Arreaza, Sørensen, Yoshia (1998), Sørensen, Yoshia (1998) or Marinheiro (2005). Nonetheless, this is considerably lower than the predicted levels of over 20% by Kalemli-Ozcan, Sørensen and Yoshia (2004). Importantly, since 2000 the contribution of this channel to shock smoothing in the EMU and EU has not changed significantly.

Finally, our results show that 25% of asymmetric shocks were smoothed through the saving channel in the Eurozone between 1999 and 2014. It is the net government saving that accounted for the entire smoothing effect of the saving channel both in the EMU and the EU. This channel’s contribution to cross-country risk sharing in the EMU has been the highest among all assessed risk sharing channels.

We conclude that the low degree of risk sharing effectuated among the Eurozone and the EU through the factor income channel can be attributed to limitations of access to financial markets, relative costs of hedging, home bias and barriers to international investment. Importantly, revenues from factor income, i.e. repayments and dividends from loans and investments are to a relatively large extent part of corporations and financial institutions earnings, and do not necessarily have to smooth the consumption of households. In fact, the capital flows related to investment in debt and equity markets and foreign direct investment may reinforce or generate shocks to GDP, especially when their purpose is speculation.

Before the outbreak of the global financial crisis of 2008+ it was expected that financial markets would facilitate gradual convergence of interest-rates on member states’ government debt and contribute
to increased risk sharing within the EMU. Financial markets’ smoothing potential was supposed to grow with increased integration of financial markets in the Eurozone (Kalemli-Ozcan, Sørensen, Yosha 2004). The global financial crisis of 2008+ has, however, reinforced divergence tendencies between Eurozone member states. Instead of asymmetric shock smoothing, financial markets through the banking sector have actually generated asymmetric shocks and spread them mainly through credit derivatives markets. It turned out that the banking sector can itself be subject to asymmetric shock and can generate asymmetric shocks with significant effects on the real sectors of economies.

Actually, the size and depth of financial markets have a significant effect on the long-term growth, growth volatility and financial stability of the economy. In particular, immoderate financial development lowers the pace of GDP growth and increases the frequency of boom and recession phases intensified by the (excessively) developed financial markets. With their levels of financial markets and financial institutions’ development the advanced economies including the US and the EMU achieve lower economic growth and experience increased volatility of economic growth as compared to lower, optimal level of financial development which characterizes e.g. the current financial development level of the Polish economy, Sahay et al. (2015).

The excessive size of the financial sector in many developed economies has been criticized by many economists, especially after the outbreak of the financial crisis. The criticism is based on the consideration that the financial sector should play an ancillary role with respect to the real sector of the economy, facilitating its more effective functioning. Instead, the global financial crisis serves as a well-suited example of a situation where a highly developed financial system increases the volatility of economic growth and decreases the financial stability of the economy, being actually the source of an asymmetric shock rather than providing greater risk sharing.

References

Asymmetric shocks and international risk...


Commission of the European Communities (1990), One market, one money. An evaluation of the potential benefits and costs of forming an economic and monetary union, European Economy, 44.


Konopczak M. (2009), Efektywność kanału finansowego a wygładzanie konsumpcji w strefie euro i w Polsce, Bank i Kredyt, 40(1), 23–68.

Konopczak K., Marczewski K. (2011), Why so different from other CEECs – Poland’s cyclical divergence from the euro area during the recent financial crisis, Bank i Kredyt, 42(2), 7–30.


### Appendix

Table 1  
Economic accounts of the total economy

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>GNI</th>
<th>NI</th>
<th>DNI</th>
<th>PG + CG</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) taxes, less subsidies on production and imports (net, receivable from abroad)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(+) compensation of employees (net, receivable from abroad)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(+) property income (net, receivable from abroad)</td>
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<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>(+) taxes, less subsidies on production and imports (net, receivable from abroad)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(+) compensation of employees (net, receivable from abroad)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>(+) property income (net, receivable from abroad)</td>
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<tr>
<td></td>
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<td></td>
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</tr>
<tr>
<td>(−) consumption of fixed capital</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(−) current taxes on income, wealth, etc. (net receivable from abroad)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(−) social contributions and benefits and other current transfers (net, receivable from abroad)</td>
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<tr>
<td></td>
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<tr>
<td>(−) net saving</td>
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<tr>
<td>PG + CG</td>
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Table 2  
Channels of income and consumption smoothing. Baseline results (model 1), in %

<table>
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</thead>
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<td>EMU16</td>
<td>EU23</td>
</tr>
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<td>8***</td>
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<tr>
<td>Capital depreciation ($\beta_{CD}$)</td>
<td>-3*</td>
<td>-7***</td>
<td>-8***</td>
</tr>
<tr>
<td>International transfers ($\beta_{IT}$)</td>
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<td>0</td>
<td>5***</td>
</tr>
<tr>
<td>Saving ($\beta_S$)</td>
<td>47***</td>
<td>25***</td>
<td>20***</td>
</tr>
<tr>
<td>Not smoothed ($\beta_{UN}$)</td>
<td>52***</td>
<td>76***</td>
<td>75***</td>
</tr>
</tbody>
</table>

Notes:
Model (1) – panel of regressions with time fixed effects, autocorrelation of error term identical across countries and equations, state specific variance of error terms. Estimates may not add up to 100 due to rounding.

*** coefficient's significance level at 0.01,
** coefficient's significance level at 0.05,
* coefficient's significance level at 0.1.

Negative $\beta$ estimates referring to any of the four risk sharing channels imply that the occurring shocks to GDP have been actually reinforced by the channel.

### Table 3
Comparison of obtained results with related studies

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<td><strong>1971−1993</strong></td>
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<td>EU8</td>
<td>EU8*</td>
<td>EU8</td>
<td>EU11</td>
<td>EU11</td>
<td>EMU*</td>
<td>EMU</td>
<td>EMU</td>
<td>EMU</td>
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<tr>
<td>Factor income ($\beta_{FI}$)</td>
<td>-1</td>
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<td>3</td>
<td>-4</td>
<td>-7</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td>12</td>
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<td>Capital depreciation ($\beta_{CD}$)</td>
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<td>-8</td>
<td>-11</td>
<td>-3</td>
<td>-12</td>
<td>-14</td>
<td>-</td>
<td>-</td>
<td>-7</td>
<td>-14</td>
</tr>
<tr>
<td>International transfers ($\beta_{IT}$)</td>
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<td>0</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>-</td>
<td>-6</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Saving ($\beta_{S}$)</td>
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<td>24</td>
<td>54</td>
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<td>54</td>
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<td>27</td>
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<td>Not smoothed ($\beta_{UN}$)</td>
<td>56</td>
<td>57</td>
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<td>58</td>
<td>52</td>
<td>60</td>
<td>70</td>
<td>-</td>
<td>76</td>
<td>76</td>
<td>71</td>
</tr>
</tbody>
</table>

**Notes:**
Results from (Konopczak 2009) are regression results from panel estimation with fixed entity and time effects. Entries with “−” denote cases where estimates are not available due to the estimation method applied in the paper in question.

### Table 4
Channels of income and consumption smoothing. Complementary results (model (2)), in %

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>EU8</td>
<td>EMU16</td>
<td>EU23</td>
</tr>
<tr>
<td>Factor income ($\beta_{FI}$)</td>
<td>0</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Capital depreciation ($\beta_{CD}$)</td>
<td>-6***</td>
<td>-9***</td>
<td>-8***</td>
</tr>
<tr>
<td>International transfers ($\beta_{IT}$)</td>
<td>-1</td>
<td>2***</td>
<td>2***</td>
</tr>
<tr>
<td>Saving ($\beta_{S}$)</td>
<td>51***</td>
<td>23***</td>
<td>17***</td>
</tr>
<tr>
<td>Not smoothed ($\beta_{UN}$)</td>
<td>56***</td>
<td>74***</td>
<td>78***</td>
</tr>
</tbody>
</table>

**Notes:**
Model (2) – panel of regressions with time fixed effects. Estimates may not add up to 100 due to rounding.
*** coefficient’s significance level at 0.01,
** coefficient’s significance level at 0.05,
* coefficient’s significance level at 0.1.
Negative $\beta$ estimates referring to any of the four risk sharing channels imply that the occurring shocks to GDP have been actually reinforced by the channel.

Table 5
Selected measures of financial market size, 2007 and 2012, bn USD

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capitalization of stock markets</td>
<td>19,922.3</td>
<td>15,640.7</td>
<td>10,040.1</td>
<td>4,586.6</td>
</tr>
<tr>
<td>Market value of debt securities</td>
<td>30,324.2</td>
<td>33,700.9</td>
<td>23,004.2</td>
<td>24,976.2</td>
</tr>
<tr>
<td>– public</td>
<td>6,595.9</td>
<td>12,874.7</td>
<td>7,606.4</td>
<td>8,872.2</td>
</tr>
<tr>
<td>– private</td>
<td>23,728.3</td>
<td>20,826.2</td>
<td>15,397.8</td>
<td>16,104.0</td>
</tr>
<tr>
<td>Banking sector assets</td>
<td>11,194.1</td>
<td>14,634.9</td>
<td>35,097.1</td>
<td>30,529.6</td>
</tr>
<tr>
<td>Financial market size</td>
<td>61,440.6</td>
<td>63,976.5</td>
<td>68,141.5</td>
<td>60,092.5</td>
</tr>
<tr>
<td>Financial market capitalization (% of GDP)</td>
<td>424</td>
<td>396</td>
<td>558</td>
<td>458</td>
</tr>
<tr>
<td>Banking sector assets (% of GDP)</td>
<td>77</td>
<td>91</td>
<td>287</td>
<td>233</td>
</tr>
</tbody>
</table>


Table 6
Channels of income and consumption smoothing. The effect of EMU on international risk sharing.
Results from model (1), in %

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EMU16 non-EMU</td>
<td>EMU16 non-EMU</td>
<td>EMU16 non-EMU</td>
</tr>
<tr>
<td>Factor income ($\beta_{FI}$)</td>
<td>6***</td>
<td>5</td>
<td>4***</td>
</tr>
<tr>
<td>Capital depreciation ($\beta_{CD}$)</td>
<td>-7***</td>
<td>-11***</td>
<td>-1</td>
</tr>
<tr>
<td>International transfers ($\beta_{IT}$)</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Saving ($\beta_{S}$)</td>
<td>25***</td>
<td>36***</td>
<td>19***</td>
</tr>
<tr>
<td>Not smoothed ($\beta_{UN}$)</td>
<td>76***</td>
<td>69***</td>
<td>78***</td>
</tr>
</tbody>
</table>

Notes: model (1) – panel of regressions with time fixed effects, autocorrelation of error term identical across countries and equations, state specific variance of error terms. Estimates may not add up to 100 due to rounding.
*** coefficient's significance level at 0.01,
** coefficient's significance level at 0.05,
* coefficient's significance level at 0.1.
Negative $\beta$ estimates referring to any of the four risk sharing channels imply that the occurring shocks to GDP have been actually reinforced by the channel.

### Table 7
Channels of income and consumption smoothing. Assessment of private and government saving contribution to risk sharing. Results from modified model (1), in %

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>EU13*</td>
<td>EU19*</td>
<td>EU13*</td>
</tr>
<tr>
<td>Government saving ($\beta_{SG}$)</td>
<td>39***</td>
<td>34***</td>
<td>19***</td>
</tr>
<tr>
<td>Private saving ($\beta_{SP}$)</td>
<td>-7</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Notes: model (1) – panel of regressions with time fixed effects, autocorrelation of error term identical across countries and equations, state specific variance of error terms. Estimates may not add up to 100 due to rounding.

*** coefficient's significance level at 0.01,
** coefficient's significance level at 0.05,
* coefficient's significance level at 0.1.

Negative $\beta$ estimates referring to any of the four risk sharing channels imply that the occurring shocks to GDP have been actually reinforced by the channel.


### Table 8
Channels of income and consumption smoothing. Assessment of private and government saving contribution to risk sharing. Results from modified model (2), in %

<table>
<thead>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>EU13*</td>
<td>EU19*</td>
<td>EU13*</td>
</tr>
<tr>
<td>Government saving ($\beta_{SG}$)</td>
<td>27***</td>
<td>13***</td>
<td>33***</td>
</tr>
<tr>
<td>Private saving ($\beta_{SP}$)</td>
<td>-8**</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Notes: Model (2) – panel of regressions with time fixed effects. Estimates may not add up to 100 due to rounding.

*** coefficient's significance level at 0.01,
** coefficient's significance level at 0.05,
* coefficient's significance level at 0.1.

Negative $\beta$ estimates referring to any of the four risk sharing channels imply that the occurring shocks to GDP have been actually reinforced by the channel.

Table 9
Channels of income and consumption smoothing. Results from model (1) using Hodrick-Prescott filtered data, in %

<table>
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</thead>
<tbody>
<tr>
<td></td>
<td>EU8</td>
<td>EMU16</td>
<td>EU23</td>
</tr>
<tr>
<td>Factor income ($\beta_{FI}$)</td>
<td>0</td>
<td>9***</td>
<td>9***</td>
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<tr>
<td>Capital depreciation ($\beta_{CD}$)</td>
<td>-7***</td>
<td>-10***</td>
<td>-11***</td>
</tr>
<tr>
<td>International transfers ($\beta_{IT}$)</td>
<td>0</td>
<td>2**</td>
<td>3***</td>
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<tr>
<td>Saving ($\beta_S$)</td>
<td>67***</td>
<td>24***</td>
<td>25***</td>
</tr>
<tr>
<td>Not smoothed ($\beta_{UN}$)</td>
<td>40***</td>
<td>75***</td>
<td>74</td>
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</tbody>
</table>

Notes:
Model (1) – panel of regressions with time fixed effects, autocorrelation of error term identical across countries and equations, state specific variance of error terms. Results above serve as robustness check of estimation results in model (1). Underlying data have been de-trended using the Hodrick-Prescott filter and normalized. Estimates may not add up to 100 due to rounding.

*** coefficient’s significance level at 0.01,
** coefficient’s significance level at 0.05,
* coefficient’s significance level at 0.1.
Negative $\beta$ estimates referring to any of the four risk sharing channels imply that the occurring shocks to GDP have been actually reinforced by the channel.


Table 10
Average correlations of GDP, GNP, DNI, NI and C + G of countries with group’s corresponding aggregate series, 1999−2014

<table>
<thead>
<tr>
<th></th>
<th>EU23</th>
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<tbody>
<tr>
<td></td>
<td>differenced log of series (1-year)</td>
<td>HP-filtered</td>
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<tr>
<td>GDP</td>
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<td>0.81</td>
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<tr>
<td>GNP</td>
<td>0.76</td>
<td>0.79</td>
</tr>
<tr>
<td>DNI</td>
<td>0.75</td>
<td>0.78</td>
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<tr>
<td>NI</td>
<td>0.75</td>
<td>0.79</td>
</tr>
<tr>
<td>C + G</td>
<td>0.59</td>
<td>0.68</td>
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Table 11
Groups of countries

<table>
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<tr>
<th>EU23</th>
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<th>EU8*</th>
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<th>EMU</th>
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Note: Cyprus, Luxembourg, Malta, Bulgaria and Romania not included in the analysis.
Figure 1
Percentage of shocks left unsmoothed in the EMU16 and the EU23 over 1999–2014

![Graph showing percentage of shocks left unsmoothed in EMU16 and EU23 over 1999–2014]

Notes: time series of $\beta$ estimates have been smoothed using exponential smoothing, with damping factor of 0.5. Estimates obtained from equation (20).

Figure 2
Percentage of shocks smoothed through the factor income channel in the EMU16 and the EU23 over 1999–2014

![Graph showing percentage of shocks smoothed through factor income channel in EMU16 and EU23 over 1999–2014]

Notes: time series of $\beta$ estimates have been smoothed using exponential smoothing, with a damping factor of 0.5. Estimates obtained from equation (16). Negative $\beta$ estimates imply that the occurring shocks to GDP have been reinforced by the channel.