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A minimal moral hazard central stabilisation capacity for the EMU based on world trade

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Abstract

Recent debate has focused on the introduction of a central stabilisation capacity as a completing element of the Economic and Monetary Union. Its main objective would be to contribute cushioning country-specific economic shocks, especially when national fiscal stabilisers are run down. There are two main potential objections to such schemes proposed so far: first, they may lead to moral hazard, i.e. weaken the incentives for sound fiscal policies and structural reforms. Second, they may generate permanent transfers among countries. Here we present a scheme that is relatively free from moral hazard, because the transfers are based on changes in world trade in the various sectors. These changes can be considered as largely exogenous, hence independent from an individual government's policy; therefore, the scheme is better protected against manipulation. Our scheme works as follows: if a sector is hit by a bad shock at the world market level, then a country with an economic structure that is skewed towards this sector receives a (one-time) transfer from the other countries. The scheme is designed such that the transfers add up to zero each period, hence obviating the need for a borrowing capacity. We show that the transfers generated by our scheme tend to be countercyclical and larger when economies are less diversified. In addition, since transfers are based on temporary changes in world trade, the danger of permanent transfers from one set of countries to the other countries is effectively ruled out. Finally, we show that transfers are quite robust to revisions in the underlying export data.

JEL Codes: E32, E62, E63.

Keywords: EMU, central fiscal capacity, exports, moral hazard.

Non-technical summary

Recent debate about reforming the European Economic and Monetary Union (EMU) has focused on the introduction of a central stabilisation capacity, as also highlighted in the "Five Presidents' Report" (Juncker *et al*., 2015). The main objective of such a capacity would be to help cushioning country-specific economic shocks, especially when national fiscal stabilisers are hampered. Indeed, a stabilisation capacity may be particularly beneficial in the presence of asymmetric shocks that the ECB can by definition not address as monetary policy is formed on the basis of aggregate inflation developments in the Eurozone. At the same time, private insurance through cross-border capital flows remains limited, because asset holdings tend to be home-biased.

This paper proposes a novel 'export-based stabilisation capacity' (ESC) for the EMU that allows for cross-border transfers in response to exogenous changes in the world market conditions in the various export sectors. Our ESC works in a very simple and intuitive way: suppose that world trade in a specific sector fall, as reflected in total Eurozone export in that sector. Then, Eurozone members that are relatively more intensive in this sector receive a transfer from the members that are relatively less intensive in this sector.

The proposed ESC has a number of advantages. First, the transfers respond to exogenous developments in world trade, which are by definition outside the control of individual governments. As such, the scheme is relatively free from moral hazard, given that it would not weaken the incentives of governments to run virtuous fiscal policies and implement structural reforms. This, in turn, should help in reducing the political resistance to the introduction of the ESC. Second, since it is based on *changes* in world trade in individual sectors, the danger of permanent transfers from one set of countries to the other countries is mitigated: a new transfer can only be obtained in response to a *further* decline in world trade, while an expansion in the same sector leads to a transfer into the opposite direction. There is a natural bound to the accumulation of transfers, because world trade in a specific sector cannot fall below zero. Third, our scheme does not rely on a long-run process of convergence of economic structures before it can be implemented. Fourth, our scheme is designed such that each period all the cross-border transfers add up to zero, hence avoiding the need of issuing bonds to finance the scheme.

We perform a simulation of our ESC using OECD sectoral export data for all 19 eurozone countries, over the period 1996-2014. We find that the net transfer received by a country in a given period tends to be "counter-cyclical": it is more positive (or less negative) when the output gap, relative to the Eurozone average, is lower. The absolute magnitude of the transfers turns out to be larger if sectoral diversification is smaller. Over the full sample, cumulative transfers generally stabilise and they tend to return towards zero towards the end of the sample, thus suggesting that

the risk of permanent transfers is low under this scheme. This is also consequence of the design of the scheme: being based on *changes* in the world trade for each specific sector, transfers cannot be permanently positive (or negative) because shocks hitting the sectors in which a country is specialised will change sign at some point. We also show that the transfers are quite robust to the use of preliminary rather than ex-post data.

Of course, before our scheme can be made fully operational, practical obstacles would need to be overcome. Although we show the robustness of our scheme to data revisions, we still view the timely availability of the data that serve as input for the calculation of the transfers as the main practical obstacle. This is in particular the case for data on sectoral activity. However, when sufficient practical need is perceived for the timely availability of such data, governments and statistical agencies may invest more resources in achieving this objective. Another issue, not addressed in this paper, concerns the question how transfers received by governments should be put to best use. It could be politically appealing to earmark them for ameliorating the consequences of structural reforms or help in transforming the economy towards activities with a more prosperous future.

1. Introduction

The global economic and financial crisis that started in 2007 and the ensuing Eurozone debt crisis have shown the painful consequences of having an incomplete monetary union. In response to these developments, substantial effort has been made to improve the Eurozone's fiscal and financial architecture with the introduction of the European semester, a strengthening of the Stability and Growth Pact (through the "Six-pack" and the "Two-pack"), a "Fiscal Compact", and the introduction of the first elements of a banking union. Still, Europe's Economic and Monetary Union remains incomplete. As part of the process towards the completion of the EMU, further steps need to be taken to complete the financial union, including the completion of a banking union with a single deposit insurance scheme, while some forms of fiscal union are also deemed as needed. Indeed, in contrast to other monetary unions, the EMU lacks a central fiscal capacity which could help cushioning country-specific shocks. Fiscal policy remains decentralised, implying that the potential for macroeconomic stabilisation through area-wide fiscal policies remains under-exploited.

Discussions about fiscal centralisation already started some years ago. In a report in June 2012 the then President of the European Council, Van Rompuy (2012), identifies an integrated budgetary framework as one of four building blocks to consolidate the EMU. Shortly after, in December 2012, the "Four Presidents' Report" (Van Rompuy *et al*., 2012) discusses the gradual creation of a central fiscal capacity aimed at both promoting structural reforms and mitigating asymmetric shocks. Importantly, the capacity would be kept separate from the EU's multiannual financial framework. The "Five Presidents' Report" (Juncker *et al*., 2015) sketches the steps towards completion of the EMU, and more specifically also towards fiscal union as one of its main building blocks. It discusses the notion of a euro area stabilisation function with the guiding principles that it should not lead to permanent transfers, which would be avoided through the convergence of economic structures beforehand, and not undermine the incentives for sound fiscal policy.[1] The capacity is also not intended as a crisis management tool, but it is rather thought to improve the economic resilience to temporary shocks of the Eurozone and its individual members. Most recently, the European Commission (2017)'s reflection paper sketches the main concrete options for a macroeconomic stabilisation function for the euro area. One would be a scheme to protect investment in the case of a downturn. Another would be an unemployment reinsurance scheme to support national unemployment schemes. Importantly, the former scheme is generally

[1] A future central stabilisation capacity is more broadly discussed, for example, by ECB board member Cœuré (2016) and the President of the Dutch central bank (Knot, 2016) before the European Parliament. In their report, D'Alfonso and Stuchlik (2016) explore the potential options concerning a centralised fiscal capacity for the European Parliament. Recently, a motion was put to vote in the European Parliament which sets out a roadmap towards a budgetary capacity for the Eurozone (European Parliament, 2017). The case for enhanced fiscal risk sharing in the EMU is also made by a recent study of the IMF (Berger et al., 2018).

conceived as a mechanism to cushion area-wide (aggregate) shocks, while the latter would address country-specific (idiosyncratic) shocks.

This paper proposes a novel 'export-based stabilisation capacity' (ESC) that allows for cross-border transfers in response to exogenous changes in the world trade in the various sectors. A stabilisation capacity may be particularly beneficial in the presence of asymmetric shocks that the ECB can by definition not address as monetary policy is formed on the basis of aggregate inflation developments in the Eurozone,[2] while private insurance through cross-border capital flows remains limited, because asset holdings are notoriously home-biased. Our ESC works in a very simple and intuitive way: suppose that world trade in a specific sector falls, as reflected in total Eurozone export in that sector. Then, Eurozone members that are relatively more intensive in this sector receive a transfer from the members that are relatively less intensive in the same sector sector.

Our ESC has a number of advantages, which should enhance its political acceptability when compared with many existing proposals, although quite naturally, as is the case with any cross-border transfer scheme, the prospect of having to pay a transfer to other countries at some point may generate political resistance. First, the transfers respond to exogenous developments in the world market, which are by definition outside the control of individual governments. As such, the scheme is relatively free from moral hazard, given that it would not weaken the incentives of governments to run virtuous fiscal policies and implement structural reforms. Second, since it is based on temporary *changes* in world trade in individual sectors, the danger of permanent transfers from one set of countries to the other countries is mitigated: a new transfer can only be obtained in response to a *further* decline in the Eurozone exports in the sector, while an improvement in the same sector leads to a transfer into the opposite direction. There is a natural bound to the cumulation of transfers, because Eurozone exports in a specific sector cannot fall below zero. Third, our scheme does not need to rely on a long-run process of convergence of economic structures before it can be implemented. Fourth, our scheme is designed such that each period all the cross-border transfers add up to zero, hence avoiding the need of issuing bonds to finance the scheme. Fifth, the scheme is shown to be quite robust to revisions in the underlying export data. Sixth, because the transfer scheme is based on movements in total Eurozone exports in the various sectors, it does not rely on identifying the sources of the shocks underlying the changes in exports. Finally, it is important to realize that the transfers are not specifically earmarked for sectors in decline. They are intergovernmental and, hence, a net recipient government is free to determine its use, including the possibility to stimulate the transition of activity towards upcoming sectors.

[2] With perfectly flexible markets asymmetric shocks can be handled easily, because production factors move quickly to those parts of the union where undercapacity prevails. However, there is an abundance of evidence that European markets are highly rigid. In particular, labour mobility is low, both within, but even more so, across countries.

We perform a simulation of our ESC using OECD sectoral export data for all 19 Eurozone countries, over the period 1996-2014. This allows estimating how the transfers would have materialised over this period, if our ESC would have been in place. Our baseline scheme links the transfer associated with a given sector to the exports share of a country in that sector relative to its total exports share in the Eurozone. In the baseline scheme, the full (relative) income loss that a country experiences after a negative shock to the sectors in which it is relatively more specialised is fully compensated by a transfer from other EMU countries, i.e., the ones less affected by that shock. We then consider a number of variants to the baseline scheme. More specifically, we first assume that the transfer may be capped to a certain maximum on a period basis, followed by the case in which it is only based on labour income loss. Then, we impose that the transfer that a country pays after receiving a positive shock cannot be bigger than the increase in government revenues from the sector(s) hit by the shock. Next, we propose a scheme which takes into account historical trends in sectoral exports. Such a scheme would avoid transfers responding to structural changes driving sectoral activity at the world level. Finally, we consider transfers linked to the export share of a country in a sector relative to its GDP share in the Eurozone.

We find that the net transfer received by a country in a given period tends to be "counter-cyclical": it is more positive (or less negative) when the output gap, relative to the Eurozone average, is lower. The absolute magnitude of the transfers turns out to be larger if sectoral diversification is smaller. Over the full sample, cumulative transfers generally stabilise and they tend to return towards zero towards the end of the sample, thus suggesting that permanent transfers are ruled out under this scheme. This is also a consequence of the design of the scheme: being based on *changes* in the world trade for each specific sector, transfers cannot be permanently positive (or negative) because shocks hitting the sectors in which a country is specialised will change sign at some point. We also show that the transfers are quite robust to the use of preliminary rather than ex-post data.

To put our scheme into perspective, the transfers it generates tend to be non-negligible, but limited in (cumulative) magnitude and, therefore, more politically palatable than schemes that expose countries to the risk of large payments to other countries. Of course, it cannot address all idiosyncratic shocks. However, if needed it could be combined with auxiliary arrangements that address other sources of shocks, though probably at a greater moral hazard risk. As is the case for any scheme featuring in the public debate, also practical obstacles need to be overcome. The main obstacle is the timely availability of the data that serve as inputs for the calculation of the transfers. While we show that our results are robust to the use of non-revised sectoral export data, even these data become available with a lag. Yet, the purpose of this paper is not to provide a blueprint for a system that can be implemented right away. Rather, we aim at demonstrating that a scheme like

ours has the potential to generate plausible transfers with a number of desirable properties. As data provision becomes better and faster, practical implementation comes within sight. Viewed from a different angle: by exposing the data needs of the practical implementation of a plausible transfer scheme, we may help to encourage statistical agencies to work on fulfilling these data needs.

The remainder of this paper is organised as follows. Section 2 reviews the related literature. Section 3 lays out the design of our baseline ESC and its five proposed variants, which is followed by a discussion of the data sources in Section 4. Section 5 reports and discusses the transfers based on actual data. The robustness of the scheme is investigated in Section 6. Finally, Section 7 concludes the main body of this paper.

2. Literature review

2.1 Risk sharing channels in federations and across countries

Eventually, the need for a centralised stabilisation capacity in the Eurozone will be determined by the amount of cross-border risk sharing that already exists. Over the past two decades there has been a substantial amount of work, using a variety of empirical approaches, analysing the magnitude of risk sharing across countries and across regions. A large fraction of it focuses on inter-regional risk sharing in the US and other federal countries. However, there also exist a number of studies focusing on the Eurozone.

Risk sharing of asymmetric shocks in federations can take place through a variety of private and public channels. For example, individuals may hold equity stakes in companies from different regions. In their seminal contribution, Asdrubali *et al*. (1996) explore the importance of the various channels through which consumption risk sharing takes place among the states in the US. They demonstrate that there exists substantial risk sharing through cross-state asset holdings. Among the public channels, a federal tax-transfer scheme may be important. Von Hagen (1999) summarises the estimates in the early literature of the share of state-specific shocks insured through the federal tax-transfer system in the US. It ranges from 7 to 40% as found by Sala-i-Martin and Sachs (1991), although most of the estimates are on the order of 10 – 15%. Other countries for which insurance through the tax-transfer mechanism has been estimated are Canada, France, Germany, the United Kingdom and Italy. For Canada, this source of insurance is quite consistently estimated to be close to 15%, although more recent work by Balli *et al*. (2012) get to an estimate of 27%. The estimated degree of implicit insurance among German and French regions is 35-40% (e.g. see Pisani-Ferry *et al*., 1993, and Mélitz and Zumer, 1998), while for the United Kingdom it is around 20%. The lowest degree of implicit insurance seems to prevail in Italy, for which Obstfeld and Peri (1998)

arrive at an estimate of only 3%. An important complication of this line of research is that it is hard to distinguish pure insurance against asymmetric shocks from redistribution, which takes place at the same time if state incomes differ on average. Recent work by Poghosyan et al. (2016) for the US, Canada and Australia distinguishes between interregional fiscal transfers smoothing idiosyncratic versus permanent shocks. They find that 4 - 11% of the idiosyncratic shocks are smoothed (i.e., risk-sharing), as opposed to 13 - 24% of permanent shocks (i.e., redistribution).

The literature (for example, see Sorensen and Yosha, 1998, and, more recently, ECB, 2017, Chart B, p.4) suggests that cross-border consumption risk sharing through private asset holdings plays only a limited role in Europe. Nevertheless, there exists evidence that overall consumption risk sharing has increased over time. Cimadomo *et al.* (2017) estimate an increase from about 40% at the start of EMU to about 65% in 2015. Both increased financial integration and international official assistance contributed to this increase (see, also, Milano, 2017).[3] Farhi and Werning (2017) provide a rationale for this finding: they show theoretically that some degree of public intervention is helpful even in the presence of complete markets which would allow insurance against idiosyncrayic shocks. Therefore, they make a strong case for fiscal insurance as a necessary complement to risk sharing via private channels.

2.2 Analyses of proposed stabilisation schemes

The debate around a supranational automatic stabilisation mechanism for Europe dates back to the 1970s (see, e.g., Marjolin *et al.*, 1975) and re-emerged in the 1990s (see, e.g., Padoa-Schioppa *et al.*, 1987). However, as highlighted in Beblavý and Lenaerts (2017), proposals remained unexecuted for two main reasons. On the one hand, there was a common belief that market adjustment mechanisms alone would lead to macroeconomic stabilisation. On the other hand, the launch of the Economic and Monetary Union was expected to be accompanied by stronger business cycle synchronisation for Member States, and therefore by fewer and weaker asymmetric shocks (Allard *et al.*, 2013). The recent crisis suggested that business cycle convergence is far from achieved. In addition, if national fiscal buffers are run down completely, shocks remain unsmoothed or are even amplified. This evidence explains a renewed attention in the post-crisis debate on a centralised fiscal capacity which could help attenuating the effects of macroeconomic shocks in the euro area.

Recent proposals mainly build on schemes addressing either country-specific (i.e., idiosyncratic) shocks, or, aggregate shocks, i.e., shocks common to all members of the currency

[3] Hepp and von Hagen (2013) estimate an increase in the role of factor markets in interstate consumption risk smoothing in Germany between before and after its unification. However, risk sharing through the government sector continues to be important by smoothing around 10% of shocks after the unification.

union). As regards the first category, studies have typically focused on shocks hitting country-specific GDP, the output gap or employment. For example, Enderlein *et al*. (2013) propose a 'European fund' calibrated on country-specific output gaps: Member States would contribute to the fund when their cyclical position is better than the euro area average, and they would receive a net transfer when they are in a worse position. Another scheme recently proposed is the one by Furceri and Zdzienicka (2015), which focuses on country-specific GDP shocks. The authors simulate a supranational fiscal stabilisation mechanism for the euro area, financed by a gross contribution of 1½-2½% of countries' GNP. The scheme would imply transfers to countries hit by negative GDP shocks. The authors show that such a scheme could provide significant stabilisation for the euro area, comparable to the level of fiscal risk sharing observed in Germany and other federally organised countries. In general, the main criticism moved towards schemes based on the output gap is that the output gap is unobservable and subject to large revisions. Therefore, the implementation of such schemes 'in real time' may be problematic. Schemes based on GDP, on the other hand, are less likely to be subject to big revisions. However, the estimation of country-specific GDP shocks is not trivial and the outcomes would be subject to the deployed methodology.

Many of the current proposals have focused on a European unemployment insurance scheme. The main reason is that unemployment expenditure is the main category of public spending that moves automatically (although typically with a lag) with the business cycle. Therefore, a common unemployment insurance based on cross-country transfers could work well to reinforce national automatic stabilisation mechanisms. Several proposals for such a scheme were brought into the political debate.[4] For example, Dolls *et al*. (2016) model transfers based on household-level data for Eurozone economies and find that about 10% of the income fluctuations caused by transitions into and out of unemployment could be absorbed by means of a common unemployment insurance scheme. The main advantage of a scheme based on unemployment is that it would be strongly counter-cyclical. In addition, unemployment data are subject to small revisions. However, unemployment insurance schemes are especially prone to moral hazard considerations as unemployment spending depends on cyclical developments but also crucially on structural characteristics of labour markets, on which economic policy has a decisive influence.

Other recent studies have been developed around the idea of a euro area 'investment capacity' to provide discretionary fiscal stabilisation. The basic idea is that the scheme would finance national investment projects in downturns. This would help to avoid that countries cut public investment, thus reducing their growth potential, when faced with the need of fiscal consolidation. For example, the German Ministry of the Economy and the French Treasury developed proposals for a common budget for infrastructure and stabilisation as one of the main

[4] See Beblavý and Lenaerts (2017) for a survey and a comparative analysis of various schemes.

new elements of a reformed euro area fiscal framework (see Zettelmeyer, 2016; Bara *et al*., 2017). However, such schemes are typically designed to address aggregate shocks hitting the whole euro area, especially when monetary policy is constrained by the zero lower bound (see, e.g., IMF, 2016). In addition, they are geared towards economic convergence among Member States, on top of stabilisation needs. As such, they may not be not directly comparable with mechanisms designed to stabilise country-specific shocks.

In general, the main advantage of our proposal is that – being targeted on sectoral exports in the presence of shocks to world trade – the ESC is less subject to moral hazard compared to schemes based, e.g., on unemployment. In addition, export data tend to be less affected by revisions compared to the output gap. Finally, at least in its baseline version, our scheme would not need to be endowed with a borrowing capacity.

3. The design of our ESC

Von Hagen and Hammond (1995) list a number of desirable properties that a central stabilisation capacity should fulfill. First, insurance should be provided primarily against asymmetric shocks, because for these shocks the loss of an independent monetary policy is most important. Second, transfers should be based on serially uncorrelated shocks only. Transfers in response to persistent shocks might reduce policymakers' incentives to undertake politically-costly reforms to overcome the structural problems that form the source of the persistence of the shocks. Third, the scheme should be simple and automatic for it to be acceptable for the general public. Fourth, over time net transfers should be zero on average. Fifth, the scheme should be financially balanced at the supranational level. Finally, setting up such a scheme is only worthwhile if it is able to offset a substantial part of the asymmetric shocks.

The downside is that the larger is the scheme, the larger is the danger of moral hazard. Moral hazard can arise if the asymmetric shocks potentially justifying the scheme are imperfectly observable, even though they are exogenous. Imperfectly observable shocks imply that transfers need to be conditioned on other, observable variables, such as changes in unemployment and economic growth. These measures of economic activity can be improved through structural reforms of, for example, labour and product markets. Hence, making transfers conditional on these measures may disincentivize politicians to engage in politically-costly reforms. Beetsma and Bovenberg (2001) develop a model of cross-border insurance in which transfers are linked to an observable combination of an exogenous shock and a reform component. Reform is politically costly, but it also generates additional resources. However, the fact that the shock and the amount

of reform cannot be separately observed, leads to an underprovision of reform that may be so large that it is optimal to entirely refrain from setting up the insurance scheme.

To limit the potential for moral hazard, the cross-border transfers associated with a central stabilisation capacity should be conditioned on observables that are as much as possible beyond the control of the individual governments. The ESC we propose below conditions cross-border transfers on changes in world market conditions in the individual exporting sectors of the economy. In addition, the transfers add up to zero in each period.

3.1. Baseline scheme: equalising income shifts as a fraction of the value-added of exports

In the following, we present the main building blocks of our workhorse scheme, which compensates full (relative) income losses following shocks to exports. Suppose that there are j=1,..,S sectors trading on the world market. The euro area is formed by N countries. Denote by x_{ijt} the period-t value-added of exports by sector j in country i towards the rest of the world. One can write:

$$x_{ijt} = w_{ijt} x_{jt},$$

where x_{jt} is the total value-added of euro area exports of sector j products,[5] while w_{ijt} is country i's share in this total. Hence, w_{ijt} is country i's share in the value-added of total euro area exports of sector j. Now, consider the following decomposition:

$$\begin{aligned} x_{ijt} - x_{ij,t-1} &= w_{ijt} x_{jt} - w_{ij,t-1} x_{j,t-1} \\ &= (\Delta w_{ijt}) x_{j,t-1} + (\Delta w_{ijt})(\Delta x_{jt}) + w_{ij,t-1}(\Delta x_{jt}). \end{aligned} \quad (1)$$

The first component on the right-hand side of equation (1), $(\Delta w_{ijt})\ x_{j,t-1}$, could be negative because country i's productivity grows more slowly than the EMU-average productivity in this sector or because the quality of its products improves more slowly than the EMU average, thus resulting in $\Delta w_{ijt}<0$. The component could also be positive due to improvements in competitiveness relative to other EMU countries. These differences are likely to be at least partly the result of differences in government policies, business climate, investment behaviour, fiscal devalutions, etcetera, and would not justify any cross-border transfers, because they are determined by national choices. The

[5] Hence, this includes also the value-added of exports from EMU countries to other EMU countries. Double-counting is avoided by considering the value-added of exports instead of the total value of exports.

same is true for the second term on the right-hand side of (1), $(\Delta w_{ijt})(\Delta x_{jt})$. However, this term is only of a second-order magnitude and is, therefore, likely to be relatively small. Finally, the term $z_{ijt} \equiv w_{ij,t\text{-}1}(\Delta x_{jt})$, being mainly driven by changes in total Eurozone exports in sector j, is largely beyond the control of *national* policymakers.[6] Hence, if moral hazard is to be minimised, intra-European cross-border transfers could in principle be based on the component z_{ijt} in (1).

Of course, z_{ijt} is not perfectly insulated from potential moral hazard. While the weight $w_{ij,t\text{-}1}$ is given in period t, future weights can be affected by current policies. However, we expect future weights to be less relevant for current policies than movements in current weights, because of time-discounting and because of the chance that another government will be in office next period. Moreover, we will show below that in our ESC a lower weight $w_{ij,t\text{-}1}$ translates into a smaller incoming (or larger outgoing) transfer precisely when the total value-added of Eurozone exports in sector j shrinks. Because a country would generally prefer to limit the harm associated with a shrinking exports sector, the incentive to limit reforms to improve the structure of economy would be softened. Further, notice that transfers are a function of z_{ijt}, hence, for a given weight $w_{ij,t\text{-}1}$, they are a function of the *change* Δx_{jt}. Therefore, a given fall from x_{jt} to $x_{jt} < x_{j,t\text{-}1}$ causes a transfer only in year t and not in the following years. Further transfers require further shrinkages of the total value of exports in this sector.

The ESC requires some design choices. First, a choice needs to be made regarding the component of the income change beyond the government's direct control that is compensated by the transfer. Our baseline scheme aims at compensating the *full income loss* beyond the government's direct control, which would be a natural choice if all the capital compensation went to domestic inhabitants. An alternative, which we study below, is to compensate the loss (beyond the government's direct control) of labour income, which would be a natural choice if the shares in the companies producing in each country are perfectly spread over all the Eurozone inhabitants. Second, there is a "scaling" issue, because the Eurozone countries are all of a different size. A natural objective is that the change in the component of the value-added of exports that is beyond the direct control of the government, i.e. z_{ijt}, plus the transfer T_{ijt} implied by this change, is constant for each country as a *fraction* of its total value-added of exports,[7]

$$\frac{w_{kj,t-1}(\Delta x_{jt}) + T_{kjt}}{x_{k,t-1}} = \frac{w_{ij,t-1}(\Delta x_{jt}) + T_{ijt}}{x_{i,t-1}}, \ \forall k \neq i .$$

[6] Common policies at the EMU level may well have an effect on Δx_{jt}. For example, ECB policy could lead to a fall in the external value of the Euro, thereby boosting exports to the rest of the world. However, the influence of an *individual* government on Δx_{jt} would be very limited.

[7] An alternative objective, considered below, would be that the sum of the change in the component of the value-added of exports that is beyond the direct control of the government, plus the transfer associated with it, is constant as a fraction of each country's GDP.

Obviously, this implies that the sum over all sectors of the term $w_{ij,t-1}(\Delta x_{jt})+T_{ijt}$ as a share of the total value-added of a country's exports is the same for all countries. In other words, the component of the change in national income (including the transfer) beyond the direct control of the government as a share of a country's value-added of exports is the same for all countries under the above condition. Further, we want to impose that the aggregate transfers associated with sector *j* are zero in period *t*, i.e.

$$\sum_i T_{ijt} = 0 .$$

This restriction obviates the need for a central budget capacity to implement the transfer scheme. Imposing the above requirements, we can now calculate the transfers. Equal percentage net (i.e., including the transfers) effects for two countries *i* and *k* imply that

$$T_{kjt} = \frac{x_{k,t-1}}{x_{i,t-1}}\left\{\left[w_{ij,t-1} - \frac{x_{i,t-1}}{x_{k,t-1}} w_{kj,t-1}\right]\Delta x_{jt} + T_{ijt}\right\} = \left[\frac{x_{k,t-1}}{x_{i,t-1}} w_{ij,t-1} - w_{kj,t-1}\right]\Delta x_{jt} + \left[\frac{x_{k,t-1}}{x_{i,t-1}}\right] T_{ijt},\ k \neq i .$$

There are *N*-1 such equations. Using the restriction that the sum of the transfers be zero, we have:

$$\left[1 + \sum_{k \neq i}\left(\frac{x_{k,t-1}}{x_{i,t-1}}\right)\right] T_{ijt} = \sum_{k \neq i}\left[w_{kj,t-1} - \frac{x_{k,t-1}}{x_{i,t-1}} w_{ij,t-1}\right]\Delta x_{jt} .$$

Using the condition that the weights sum to one over the countries, we obtain:

$$T_{ijt} = \left[\frac{x_{i,t-1}}{x_{t-1}} - w_{ij,t-1}\right]\Delta x_{jt}$$

Hence, country *i*'s total transfer *from* the rest of the Eurozone is:

$$T_{it} = \sum_j \left[\frac{x_{i,t-1}}{x_{t-1}} - w_{ij,t-1}\right]\Delta x_{jt} \qquad (2)$$

Expression (2) has very simple intuitive interpretation. Recall that $x_{i,t-1}/x_{t-1}$ represents the share of country *i*'s exports in the total exports of the euro area, while $w_{ij,t-1} = x_{ij,t-1}/x_{j,t-1}$ represents

the share of country *i*'s exports in sector *j* in the total exports of the euro area in sector *j*. If the difference between the two is negative, it means that the country is relatively more exposed to a shock in sector *j* (say, the Netherlands in agriculture) than is the rest of the euro area. This implies that if there is, for instance, a *positive* shock in the total euro area export in agriculture ($\Delta x_{jt} > 0$), then the Netherlands will be relatively more positively affected than the other countries. In this case, the net transfer for the Netherlands (relative to this specific sector) would be negative according to (2), meaning that the country would be a contributor. The transfer would go to countries which are less exposed to agriculture (say, to Finland). Conversely, if a *negative* shock hits a sector which is relatively more important in a country (like the financial industry in Ireland), this country will receive a transfer from countries in which the sector is relatively less important (for instance, from Portugal).

The mechanism can be illustrated further with a simple numerical example: suppose that there are only two countries (e.g., Germany and Greece), with shares of total Eurozone exports of, respectively, 90% and 10%. Additionally, suppose that there is only one sector, say tourism (e.g. hotels and restaurants), and that Greece is relatively more specialised in that sector than is Germany (e.g., $w_{ij,t-1}$ = 20%). Suppose now that a negative shock hits the total euro area export for that sector (e.g., Δx_{jt} = - €1000 million). Then, given that Greece is relatively more exposed to that sector, it will receive a transfer from Germany, which would amount to $T_{GR,j,t}=(0.10 - 0.20)*(-1000)=$ + €100 million.

A potentially important aspect of (2) is that if country *i*'s policymakers are for some (potentially political) reason reluctant to reform a sector *j* in which the country is relatively specialized, then country *i*'s share in sector *j*'s exports $w_{ij,t-1}$ will fall in the future. Hence, by (2) future transfers received because of further declines in Eurozone exports of sector *j* will become smaller. Of course, transfers paid would also be smaller when Eurozone exports of sector *j* undergo a positive shock. However, we would expect (risk averse) governments to be mostly concerned with what happens under adverse shocks. Hence, because of the effect on the future evolution of $w_{ij,t-1}$ the transfer scheme may actually stimulate reform.

3.2. Baseline scheme with a cap on the annual transfer of a country

Generally, the transfer scheme should be designed so as not to be too burdensome on any country in any given year, no matter how favourable the cyclical conditions are in such country. However, given the sectoral heterogeneity of the Euro-area countries with respect to their exports, it may well be the case that, in certain situations, the transfers implied by the scheme would require a country

to contribute or receive in percent of its GDP such a large amount of funds that the political viability of the scheme is undermined. Hence, we also consider the case in which we introduce a cap in percent of GDP on the amount of transfers a country can contribute or receive in any given year. Our illustration below proposes a cap applied to the baseline scheme. The other schemes discussed later work similarly.

Denote by T_{it}^{uc} the uncapped transfer given by (2). Suppose that the cap on the transfers paid or received is a fraction $\bar{c}$ of GDP. Then, the capped transfers will be:

$$T_{it}^{c}=\begin{cases}\sum_j\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{ij,t-1}\right]\Delta x_{jt} & \text{if } \left|\sum_j\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{ij,t-1}\right]\Delta x_{jt}\right|\leq \bar{c}y_{it}\\ -\bar{c}y_{it} & \text{if } \sum_j\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{ij,t-1}\right]\Delta x_{jt}<-\bar{c}y_{it}\\ \bar{c}y_{it} & \text{if } \sum_j\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{ij,t-1}\right]\Delta x_{jt}>\bar{c}y_{it}\end{cases} \quad (3)$$

where y_{it} is real GDP of country i in period t. By applying this correction the sum of the transfers will generally no longer be zero. We calculate the sum of the "unexecuted" transfers as:

$$T_t^{unex}=\sum_{i:|T_{it}^{uc}|>\bar{c}y_{it}}\left[T_{it}^{uc}-T_{it}^{c}\right] \quad (4)$$

The summation is over all those cases in which $|T_{it}^{uc}| > \bar{c}y_{it}$. Notice that, if $T_{it}^{uc} > T_{it}^{c} = \bar{c}y_{it}$, the system "saves" money, because country i receives less than it would originally receive and the other countries, if effectively uncapped, pay into and receive out of the system according to (2), while if $T_{it}^{uc} < T_{it}^{c} = -\bar{c}y_{it}$, a shortage is added to the system. Hence, if $T_t^{unex} > 0$, there is an overall surplus in the system after applying the caps, and vice versa if $T_t^{unex} < 0$. We assume that the surpluses or the deficits are redistributed across the countries in proportion to their shares of the Euro-area GDP. Therefore, we have that the "eventual" transfer, T_{it}^{c*}, is:

$$T_{it}^{c*}=T_{it}^{c}+\frac{y_{it}}{y_t}T_t^{unex}. \quad (5)$$

where y_t is GDP of the Eurozone as a whole in period t. Note that the expression applies to both the case of $T_t^{unex}>0$, so that each country "gets a little extra" and the case of $T_t^{unex} < 0$, when each country gets a little less.

An alternative could be to do the reallocation among all the countries that are not subject to a cap. The complication is that, after the reallocation, the country could in theory violate the cap, after which a new round of reallocations would need to be performed.

3.3. Compensation for labour income loss

Suppose that asset holdings are perfectly diversified over all individuals in the Euro-area. Then, it is natural to assume that the ESC should cover unexpected changes in labour income only. Let p_{ijt} be the average productivity in sector j in country i measured as the value of production per worker expressed in Euros. Hence, the change in employment in sector j in country i associated with z_{ijt} equals $w_{ij,t-1}(\Delta x_{jt})\ /p_{ijt}$. Furthermore, let s_{ijt} be the average salary in sector j in country i. Then, expressed in Euros, the amount of labour income associated with z_{ijt} equals $w_{ij,t-1}\ (\Delta x_{jt})\ (s_{ijt}\ /p_{ijt})$. Notice that $lsh_{ijt} \equiv s_{ijt}/p_{ijt}$ is the *labour share* in value-added in country i in sector j.

Now, imposing equal net (i.e., after transfers) income effects as a share of exports for the two countries i and k implies:

$$\frac{w_{kj,t-1}(\Delta x_{jt})lsh_{kjt} + T_{kjt}}{x_{k,t-1}} = \frac{w_{ij,t-1}(\Delta x_{jt})lsh_{ijt} + T_{ijt}}{x_{i,t-1}},\ \forall k \neq i.$$

Hence,

$$T_{kjt} = \left[\frac{x_{k,t-1}}{x_{i,t-1}} w_{ij,t-1} lsh_{ijt} - w_{kj,t-1} lsh_{kjt}\right]\Delta x_{jt} + \left[\frac{x_{k,t-1}}{x_{i,t-1}}\right] T_{ijt},\ \forall k \neq i.$$

There are N-1 such equations. Using the restriction that the sum of the transfers be zero, we have:

$$\left[1 + \sum_{k\neq i}\left(\frac{x_{k,t-1}}{x_{i,t-1}}\right)\right] T_{ijt} = \sum_{k\neq i}\left[w_{kj,t-1} lsh_{kjt} - \frac{x_{k,t-1}}{x_{i,t-1}} w_{ij,t-1} lsh_{ijt}\right]\Delta x_{jt} \Rightarrow$$

$$T_{ijt} = \left[1 + \sum_{k\neq i}\left(\frac{x_{k,t-1}}{x_{i,t-1}}\right)\right]^{-1} \sum_{k\neq i}\left[w_{kj,t-1} lsh_{kjt} - \frac{x_{k,t-1}}{x_{i,t-1}} w_{ij,t-1} lsh_{ijt}\right]\Delta x_{jt}$$

The transfers are extremely easy to calculate. However, simplification of this expression is only possible in the simple case in which the labour shares of value-added in a given sector j are identical across the countries, i.e. $lsh_{jt} \equiv lsh_{ijt},\ \forall i$. In that case,

$$T_{ijt} = lsh_{jt}\left[\frac{x_{i,t-1}}{x_{t-1}} - w_{ij,t-1}\right]\Delta x_{jt} \qquad (2')$$

Hence, in this case, up to the proportionality factor lsh_{jt} for sector j, the transfers are the same as when the full income effect (beyond the government's direct control) from the shock is equalised across the countries.

3.4. Compensation for losses of tax revenues

According to the proposed ESC scheme, a country that experiences an improvement in the world trade of its relatively export-intensive sectors will have to make a net transfer that will benefit relatively less fortunate countries. However, the resources for making these transfers cannot easily be freed up: the extra revenues that were generated are spent on compensating the providers of labour and capital. Yet, these additional revenues also produce additional tax revenues to the government of the lucky country and these additional tax revenues can be used for transfers to unlucky countries that are confronted with a shortfall in tax revenues. The problem with conditioning transfers on tax revenues is that countries have different tax rates: to compensate an unlucky country with high labour and capital tax rates for a bad shock, it would need to receive a larger transfer than an unlucky country with low tax rates. Hence, it makes sense to base transfers on some common tax rate.

We consider here the baseline scheme. For the other variants of the scheme the compensation for losses of tax revenues works analogously. Let the common tax rate be τ_t. Then, in the absence of a cap on the transfers, the transfer received from the rest of the countries would be

$$T_{it} = \tau_t \sum_j \left[\frac{x_{i,t-1}}{x_{t-1}} - w_{ij,t-1}\right]\Delta x_{jt}\,, \qquad (6)$$

where τ_t could, for example, be the average or the lowest tax burden as a share of GDP across the countries.

3.5. Compensation based on shocks from trend growth

In all of the above versions of the scheme we have considered shocks to Eurozone exports in sector j to be the change in the value-added of exports in that sector from one year to the next. However, as exports tend to grow over time, such a change would be positive in most of the years, suggesting

that, while countries would not be net contributors or recipients overall, they would tend to be net contributors in the sectors they are most specialised in, and net recipients in the other sectors. Moreover, systematic differences in the growth rates of exports across the sectors might imply systematic transfer streams across countries if their sectoral export weights are stable over time.

These issues can be addressed by changing our definition of the shock in sector *j*, which is now defined as the difference of export in sector *j* relative to the sector's trend value. In this case the expected shock to exports in each individual sector is zero, given that shocks are defined as deviations from the sector-specific trend. By doing so, the expected value of transfers for all countries related to all sectors would be zero. Specifically, the formula for the transfers under such a scheme would then be:

$$T_{ijt} = \left[\frac{x_{i,t-1}}{x_{t-1}} - w_{ij,t-1}\right]\left(x_{jt} - x_{jt}^{*}\right), \tag{7}$$

where x_{jt}^{*} is the trend value of x_{jt}, i.e., $x_{jt}^{*}=x_{j,t-1}(1+g_{j}^{*})$, with g_{j}^{*} as the trend growth rate of euro area exports in sector *j*.

In the empirical application below (Section 5.5), we simulate the scheme including an estimate of g_j over windows of 4, 6 and 8 years prior to each year *t*.

3.6. Stabilisation based on equalising income shifts as a fraction of GDP

Finally, we assume that the change in the component of the value-added of exports that is beyond the direct control of the government plus the transfer implied by this change, is constant for each country as a *fraction* of its GDP:

$$\frac{w_{kj,t-1}(\Delta x_{jt}) + T_{kjt}}{y_{k,t-1}} = \frac{w_{ij,t-1}(\Delta x_{jt}) + T_{ijt}}{y_{i,t-1}}, \ \forall k \neq i.$$

Going through calculations analogous to those above and assuming that transfers are aimed at compensating all income loss, we obtain the following formula for the transfer to country *i*:

$$T_{it} = \sum_{j}\left[\frac{y_{i,t-1}}{y_{t-1}} - w_{ij,t-1}\right]\Delta x_{jt} \tag{8}$$

To interpret this formula, consider for example the case in which $w_{ij,t-1} > y_{i,t-1}/y_{t-1}$. In other words, country *i* is responsible for a large fraction of value added in sector *j* exports relative to its GDP share in the Eurozone. A fall in global sector *j* exports, i.e. $\Delta x_{jt} < 0$, implies that country *i* receives a positive transfer (associated with this sector). A potential issue with transfer scheme (8) may be the following. Suppose that the economy is relatively closed (typically, a relatively large economy). In that case, for many or all sectors *j* we have that $w_{ij,t-1} < y_{i,t-1}/y_{t-1}$. A contraction of the global trade would typically imply that $\Delta x_{jt} < 0$ for many or all sectors *j*. But that, in turn, implies that the country would basically always pay a net transfer when Eurozone exports fall. This is intuitive, because a more closed economy suffers less from a fall in Eurozone exports. Vice versa, for a relatively open economy.

4. The data

We obtain yearly data on $x_{ijt,}$ - i.e., the value added content of exports by country and by sector towards the rest of the world (including the other EMU countries) - from the OECD (2017b) Trade in Value Added (TiVA) database. The sample covers all the 19 countries currently in the Euro Area and runs from 1995 to 2014. Years 2012, 2013 and 2014 are currently published by the OECD as "nowcasts", thus are subject to revisions. The industrial sectors into which exports are subdivided correspond to those of the 3rd Revision of the International Standard Industrial Classification (ISIC Rev. 3). Using these data, we can calculate $x_{jt}=\sum_i x_{ijt}$, $x_t=\sum_j x_{jt}$ and $w_{ijt}=x_{ijt}/x_{jt}$. Overall, our dataset comprises 33 sectors, which are listed in Table 1.

Figure 1 depicts the annual growth rate of total Eurozone exports (yellow line) and of Eurozone exports by individual sector (not labelled for simplicity). The annual growth rate of total exports averages at 5.4% over the full sample. Export growth is generally positive, but several years are also characterized by negative growth rates. Most notably, the 2009 global economic and financial crisis exhibits a very severe fall of more than 15% in total exports, with some sectors dropping by as much as 35% in that year.

Table 1 reports also, for each sector and country, the country's average (over time) exports share in that sector's total Eurozone exports. At the bottom of the table we report, for each country, its share in total Eurozone exports. For each country, we have marked the three smallest (red) and the three largest (green) sectors in terms of Eurozone share. Obviously, given that Germany is the largest economy and the largest exporter, it is also the largest exporter of all countries in a substantial number of sectors. In some sectors, it is very dominant, such as "Electrical machinery

and apparatus n.e.c.", "Motor vehicles, trailers and semi-trailers" and "Electricity, gas and water supply". Hence, large negative shocks in these sectors could potentially lead to large transfers to Germany that need to be financed by all the other countries. This potential effect is mitigated by the fact that Germany is a relatively diversified economy over the various sectors and, in the case of our baseline, that the transfers are driven by the difference of Germany's share in total exports, which is high not only because of its size but also because of its openness, and its share in the exports of the specific sectors.

Data on nominal and real GDP of the EA19 countries are retrieved from the OECD (2017a) and from the World Bank (2017). The output gap is taken from the OECD (2017a). Using data on Gross Value Added and Compensation of Employees, by industry and country, from Eurostat's Spring 2017 vintage (Eurostat, 2017), we calculate the labour share of gross value added in sector *j* (lsh_{jt}) as:

$$lsh_{jt} = \sum_i \left[\frac{\frac{WL_{ijt}}{GVA_{ijt}} y_{it}}{\sum_i y_{it}} \right]$$

where WL_{ijt} is the total compensation of employees and GVA_{ijt} is gross value added in country *i*, sector *j* and year *t*. Hence, lsh_{jt} is a weighted average of the labour shares in sector *j* in the different countries. Data are available for years 1995-2009. For years 2010-2014, we set lsh_{jt} at its 2009 value.

The tax rate τ_t is the EA19 value for "Total receipts from taxes and social contributions (including imputed social contributions) after deduction of amounts assessed but unlikely to be collected" as a percentage of GDP. It is retrieved from Eurostat (2017) as well. The series is listed in Table A.2 of the Appendix.

Average revisions of export data over time are computed using different editions of the Ameco database (2017).

All data are annual, and expressed either in million US$ or percentages. US dollars were chosen consistently so as to avoid exchange rate complications.

5. Transfers calculated on the basis of actual data

In this section, we present the results for our baseline scheme (spelled out in Subsection 3.1) and of its variants (presented in Subsections 3.2 - 3.6) simulated over the period 1995-2014 based on the data described above. Results are shown starting in 1996, as equation (2) (and the following) include one lag.

5.1. Baseline scheme: equalising income shifts as a fraction of the value-added of exports

Figure 2 depicts, for each Eurozone country, the simulated annual transfer for year *t* as a share of GDP for the same year (red solid line, left scale). In addition, the figure plots the cumulative transfers (grey dotted line, right scale). The latter are calculated as $\sum_{\tau=1996}^{t} T_{i,\tau} / y_{it}$, i.e., the sum of transfers up to year *t* over GDP in year *t*. We choose to show transfers as fractions of GDP, as their relevance should not be determined by the scale of the economy per se.

Overall, the graphs suggest that, first, annual transfers tend to be counter-cyclical, i.e., they are generally positive (negative) during periods of growth below (above) potential. This is shown, for example, for Germany which is a big receiver of transfers in 2008-2009. Indeed, those years were characterised by large and negative shocks in those sectors – such as "Motor vehicles, trailers and semi-trailers", and "Machinery and equipment n.e.c" – in which that country is relatively more specialized.[8] Countries less exposed to those sectors, notably France and the Netherlands, would have needed to contribute to the scheme in those years.[9] As shown in Figure 2, however, over history Germany would have been a net contributor to the transfer scheme in most years, which explains why cumulatively transfers are around zero for this country at the end of the sample. Another example of counter-cyclicality is Finland, which would have received a large positive transfer in 2008 due to its exposure to the sectors of "Computer, electronic and optical products" and "Pulp, paper, paper products, printing and publishing", which declined very severely in that year.[10]

Second, transfers are on average small, amounting in most cases to less than 0.2% of GDP.[11] Third, transfers tend to be non-persistent, i.e., they tend to revert to zero or to switch sign after one or two years (e.g., Germany and France). This is a direct consequence of the design of the transfer scheme, whereby transfers depend on the *change* in exports for a given sector relative to other sectors, which cannot be permanently positive or negative. In these cases, cumulated transfers are also around zero at the end of the period. However, there are cases characterised by positive (or negative) transfers for several years consecutively. Typically, these are cases of countries

[8] The euro area shares of Germany's exports in "Motor vehicles, trailers and semi-trailers" and "Machinery and equipment n.e.c" are, respectively, 53.8% and 43.2% , which compares with an overall share - of total German exports over euro area exports - of 30.4% (see Table 1).

[9] It is important to realise that our transfer scheme does not exclude the possibility that countries, in some years, may have to make "pro-cyclical" transfers when their output gap is negative (e.g. France in 2009). In the end, transfers are triggered by *differences* in the amount of "luck" that countries experience in their exports. By definition, a scheme that aims at stabilising aggregate shocks cannot be annually balanced at the aggregate level. Obviously, a scheme of borrowing and lending to stabilise common shocks could be superimposed on our scheme. However, such a complementary scheme would raise other issues, such as the question which fraction of the common shocks it should smooth given that also the ECB is engaged in stabilising common shocks. We will not delve into these issues here.

[10] Finland's share of these sectors was on average 5.7% and 13.8%, compared to its exports share of 2.2% overall.

[11] However, in some years and countries transfers can be quite large. Examples are Finland in 2008 when the transfer is almost 1.7% of GDP, Ireland in 2009 with -3.8% of GDP, Cyprus with -2.5% in 1998 and 1.9% in 2013, Malta with -1.6% in 2008, and Luxembourg in several years, with peaks of -6.9% in 1999 and -6.3% in 2008.

(generally, small ones) heavily specialised in some sectors that have been hit by positive (or negative) shocks for several years in a row. For instance, the fast growth of the sector "Finance and insurance", in which Ireland, Luxembourg and Cyprus are heavily specialised, was in these countries the main determinant of several consecutive years of negative transfers.[12]

Figure 2 suggests that another three countries - Italy, Portugal and Greece - are characterized by cumulated transfers which have some tendency to increase over time. Again, this is related to their relative sectoral specialisation and the shocks hitting those sectors: they would have received positive transfers overall due to the relative performance of the sectors in which they are relatively less specialised, as it turns out that such sectors had a significantly higher growth than the ones in which the countries are more specialised (e.g., the sector "Textiles, textile products, leather and footwear" in Italy and Portugal). In particular, sectors such as the textile industry lost much of their relative importance over our sample period as compared to booming sectors such as "Finance and insurance". Because of the low growth of these sectors, the transfers that these countries would have to make to other countries are dominated by the transfers that they receive from other countries for the sectors in which they only have a small presence, in the case of Italy "Motor vehicles, trailers and semi-trailers" and "Electricity, gas and water supply", for example, in which it has shares in euro area exports of only 9% and 3%, respectively, and in the case of Portugal "Chemicals and chemical products" and "Machinery and equipment n.e.c", for example, for both of which it has a share in euro area exports of only 0.6%. Transfers for Greece are rather strongly and negatively affected by the sector "Transport and storage", in which it has a share of 5.5%, compared with its overall share in total euro area exports of 1.5%. However, this is more than compensated by the positive transfers due to almost all the other sectors in most years (especially "Motor vehicles, trailers and semi-trailers", "Machinery and equipment n.e.c", and "Chemicals and chemical products") in which it has low shares.

In general, we observe that the relatively large values for the annual and cumulative transfers tend to be concentrated among the small and highly open economies. A potential explanation is the smaller degree of diversification of their export sectors. To investigate this further, we calculate for each country the Herfindahl index for sectoral shares in the country's total value-added of exports as $H_{it} = \sum_j \left(w_{ij,t} / \sum_j w_{ij,t} \right)^2$, which we relate to the country's average over the sample years of the absolute values of its transfers. The idea is that if an economy is weakly diversified, it features some sectors with large export weights, which drive up the Herfindahl index,

[12] Ireland, Luxembourg and Cyprus have average shares of the euro-area total for this sector of, respectively, 13.1%, 16.9% and 1.6%; while their shares of total euro area exports are much lower, at 3.2%, 1% and 0.3%. In particular, transfers for Luxembourg are almost completely due to developments in this sector, which represents around 50% of its total exports, while Ireland was also hit by equally positive shocks (leading to negative transfers) in the chemical sector, where it exports 8% of the euro-area total.

because it is based on the sum of the quadratic values of the weights. Appendix A reports the figures for the index and the average absolute value of the transfers. Luxembourg, Latvia and Cyprus have relatively large Herfindahl values of 0.20, 0.18 and 0.11 respectively, while for many countries they are on the order of 0.04 – 0.05. The high cross-country correlation between the Herfindahl index and the average absolute transfer of 0.73 is strongly in line with the hypothesis that relatively large transfer sizes are closely related to a limited diversification of the economy. Figure 3 visualizes the strong relationship between the average value of the Herfindahl index over time for each country and the average absolute value of the transfer.

Figure 4, chart 1a, depicts the cross-country dispersion in the baseline transfers by reporting for each year the lowest and highest value across the sample countries, together with the 15th and 85th percentile in the distribution and the median.[13] It is shown that – as expected – the median transfer hovers around zero in all years. Generally, transfers are in the interval of +/- 1% of GDP, while the dispersion widens during the 2000 slowdown and the 2008-2009 recession.

Crucial for the transfer scheme's economic usefulness and political viability is the degree to which the transfers correlate with overall economic activity. As mentioned before, it is desirable that transfers are positive when the economy is doing relatively poorly and vice versa when it is doing relatively well. Table 2 reports the coefficient estimates of panel regressions of transfers on the actual output gap of each country, its lag and its deviation from the Eurozone average. Estimation is performed based on random effects generalized least squares. The negative coefficients reported in Table 2 suggest that a better "state of the economy" is associated with lower transfers. The relationship is highly significant for the output gap and its lag (Columns 1 and 2), and also close to 10% significance for the deviation of a country's output gap from the euro area average output gap for that year (Column 3).

5.2. Baseline scheme with a cap on the transfers

Above we saw that, while as a share of GDP transfers are mostly rather small, in some instances they can become quite substantial, in particular for some of the smaller Eurozone members. Here, we introduce a cap of 0.5% of GDP on the absolute values of the annual transfers. The transfers are now governed by expressions (3) – (5). Figure 5 depicts the annual and cumulative transfers in the presence of the cap for the four countries for which the cap is most relevant, i.e. Finland, Ireland, Luxembourg and Cyprus. In particular, Luxembourg hits the cap frequently, both as a net contributor and as a net recipient. Recall that the aggregate deficit resulting from the cap on payments and the surplus from the cap on receipts leads to some reallocation of resources. Hence,

[13] Luxembourg is excluded, for sake of exposition, as it experiences substantially larger transfers than any other country in most of the years.

the cap of 0.5% of GDP is not totally strict. However, Figure 5 shows that the eventual values of the transfers exceed the 0.5% of GDP cap by only minimal amounts (the same conclusion would hold, if all the sample countries were included in the figure). One reason is that the initial overall surpluses and deficits are shared by all the countries in the system. The other is that it is the small member states that initially exceed the cap, hence the deficit or surplus to be shared over all the countries in the system will be rather small in comparison to the Eurozone economy. Turning to the cumulative transfers, we observe that they are substantially more contained than before. Cumulative transfers reach maximum absolute values of around 3% of GDP, substantially smaller than in the baseline case. In fact in the case of Luxembourg, the cumulative transfer is roughly zero again at the end of the sample after reaching a peak of around -2.5% of GDP in 2009. Table 2 again reports the results of the regression of annual transfers as a share of GDP on measures of the state of the economy. Interestingly, we observe now that the regression coefficient on our state of the economy variable is always highly significant at the 1% level.

5.3. Transfers based on compensation of loss of labour income

This subsection explores transfers that are intended to compensate for the loss of labour income. Conceptually, this would be the more natural scheme to consider when there is no home bias in asset holdings in companies, i.e. all stakes in equity, corporate bonds and other corporate financing vehicles are perfectly evenly spread over the entire Eurozone. Transfers are now governed by expression (2'). The individual country figures with the annual and cumulative transfers in the absence of a cap are very similar to the baseline figures. This will also be the case for the other variants on the baseline scheme we consider below. Hence, for the sake of space, from now on we no longer show the charts for each individual country, but confine ourselves to summary charts.[14]

Figure 4 summarises the information in the individual country figures by showing the differences between the highest and lowest values for both the annual and cumulative transfers. While smaller than under the baseline, the spread in annual and cumulative transfers can still be large, i.e., in the order of the labour share in income times the dispersion under the baseline scheme. Introducing our 0.5% of GDP cap has again a substantial mitigating effect on annual and cumulative transfers. The estimated coefficients in Table 2 are essentially scaled down versions of the numbers under the baseline and they are in all instances negative and (highly) significant, except in the case of the relative output gap when the cap is absent.

[14] Results for individual countries are available upon request.

5.4. Transfers based on tax revenues

As we argued earlier, a country that has to pay a transfer has already spent necessary resources to compensate the production factors. Hence, these resources are not readily available to the government. However, the government obtains additional tax revenues, because of the taxes paid on the additional income that is generated in the case of a relatively favourable shock in the main export market(s). In this subsection we assume that the transfers are based on these additional tax revenues, i.e. they are calculated using expression (6). To make the scheme operational, we need to choose a tax rate τ_t. Tax rates differ across countries and, ideally, we would apply a country-specific tax rate. However, countries to which a low tax rate is applied experience relatively small transfers in absolute magnitude, and vice versa for countries to which a high tax rate is applied. With different tax rates applied to the different countries in the system, transfers no longer automatically add up to zero when aggregated across the countries. Therefore, we assume that in a given period *t* the same tax rate τ_t is applied to calculate each country's transfer. The tax rate could, for example, be equal to the minimum revenue-GDP ratio across the countries, which would ensure that the resources to pay a transfer are always available to the government. Here, we assume that the tax rate is equal to the Euro-area-19 total receipts from taxes and social contributions, including imputed social contributions and after deduction of amounts assessed but unlikely to be collected, as a percentage of Euro-area-19 GDP, as retrieved from Eurostat (2017). Table A.2 in Appendix A lists the annual value of common tax rate τ_t that we use to calculate the transfers. Figure 4 shows the differences between the lowest and the highest values for annual and cumulative transfers in the absence and in the presence of a 0.5% of GDP cap. In the absence of a cap, the figure is essentially proportional to the baseline figure (not entirely, because the tax rate fluctuates over time). We see that the maximum differences in annual and cumulative transfers can still be large, while, as before, these differences are substantially smaller in the presence of the cap. Again, as shown by the estimates in Table 2, the scheme is countercyclical. In particular, in the case of the cap the regressions of the transfers on the output gap, the lagged output gap and the output gap in deviation from the Eurozone average yield highly significant negative coefficients.

5.5. Compensation based on shocks from trend growth

In this subsection, we change our definition of the shock to exports in a sector, defining it as the deviation from a trend. The reason is that over time euro area exports of most sectors tend to grow because of the expansion of world trade. An analysis based on deviations from trends in the various

sectors may therefore be more appropriate.[15] For our simulation here, we assume the trend growth of exports in sector j to be represented by the average of the growth rates of exports in j in the previous four years (therefore, a four-year moving average). Hence, retaining the baseline scheme otherwise, transfers are here calculated as:

$$T_{ij}=\sum_j \left[\frac{x_{i,t-1}}{x_{t-1}}-w_{ij,t-1}\right]\left[x_{jt}-x_{jt-1}\left(1+\frac{g_{j,t-1}+g_{j,t-2}+g_{j,t-3}+g_{j,t-4}}{4}\right)\right]$$

where g_{jt} is the growth rate of Eurozone exports in sector j and year t. The transfers under this scheme have a high positive correlation with the baseline (0.80, see Table 3), but they are generally more counter-cyclical, with more negative, and generally significant, coefficients, especially for the version with the caps (see Table 2). As shown in Figure 4, annual transfers are more dispersed across countries. Like the annual transfers, the cumulated transfers are similar to the ones implied by the baseline. In particular, they do not revert to zero more quickly, suggesting that, at least over our sample period, the high cumulated transfers for some countries in certain years (in the baseline) are not due to our definition of the shock. Using a moving average of six or eight years – as opposed to only four – in order to calculate the trend growth gives essentially the same results in terms of transfers; the correlation with the moving average scheme based on four years being 0.97 for both schemes.

Obviously, it is important to realise that the length of the sample period is rather limited. As a result we observe that the years of negative deviations from the trend, 2008-2009 and 2012-2013, coincide with the years of negative growth in the baseline, implying that the results are inevitably rather similar to those under the baseline.

5.6. Compensation based on equalising income shifts as a fraction of GDP

In this subsection compensation is based on stabilisation of income shifts (including the transfers) as a share of GDP, according to expression (8). Figure 4 depicts the differences between the lowest and the highest values for annual and cumulative transfers in the absence and in the presence of a 0.5% of GDP cap. We observe that in the absence of a cap the maximum differences in annual transfers can reach up to around 17% of GDP, while the maximum difference in cumulative transfers reaches up to 70% of GDP. The introduction of a cap obviously reduces these spreads. Still we observe that the maximum spread in the annual transfers is 1% of GDP in the far majority

[15] An example concerns a shift of activity in the textile industry from Portugal to Asia coinciding with a trend expansion of the world market in textiles. Linking transfers to deviations from the trend avoids transfers from Portugal to other Eurozone countries purely as a result of the trend expansion of the sector.

of the years, indicating that at almost any moment there is at least one country at the lower-bound and another country at the upper-bound imposed on the transfer. Also, the maximum spread in cumulative transfers exhibits an upward trend over the sample period. In terms of its countercyclicality properties this scheme performs worse than the other schemes. The estimates reported in Table 2 are (negatively) significant only in the absence of the cap when the transfers are regressed on the output gap.

5.7. Summary

The preceding discussion of the various transfer schemes warrants a number of conclusions. First, the schemes are generally (strongly) counter-cyclical, except for the scheme based on income (including the transfer) stabilisation as a share of GDP. Second, the counter-cyclicality is weaker in the presence of caps than in their absence. Third, in the absence of a cap, annual transfers and cumulative transfers may reach large values which would probably undermine the political support of the scheme. This is in particular the case for the scheme based on stabilisation as a share of GDP. Finally, Table 3 reports the correlations of the annual transfers between each pair of schemes. We observe that the correlations of the transfers between the various schemes are generally highly positive.

6. Robustness

This section explores the robustness of the results discussed in the previous section for a number of relevant variations.

6.1. Data revisions

Data on exports are subject to substantial revisions over time, as better information becomes available and definitions and computation procedures change. As our transfer scheme would have to make use of real-time data for its implementation, it is important to assess whether it is sufficiently robust to data revisions. We have shown that the ESC, using ex-post data, has the property of being countercyclical; it is fundamental for it to maintain this property when real-time data is used.

The variables entering equation (2) with a lag constitute less of a problem and are likely to be relatively stable: the data they are based on would have probably already undergone at least a minor revision since their real-time publication; moreover, shares such as x_{it}/x_t and $w_{ijt}=x_{ijt}/x_{jt}$, are

generally more robust to revisions as both the numerator and the denominator tend to be revised in the same direction and with comparable proportions. Inspection of the data for subsequent vintages shows that large parts of the data revisions are common across all the countries in the sample. This is not surprising as changes in the common methodology of constructing figures, for example, will apply to all the sample countries. However, data for Δx_{jt} is particularly affected by revisions. Does this significantly affect the level of annual transfers? Figure 6, with data from the Ameco database (2017), shows the euro-area average absolute value of the difference between the values for exports as published in the winter 2017 edition of the database, and the real-time estimate, as a percentage of the real-time estimate. (Data for Malta and Cyprus are excluded from the average because the revisions are extremely large; the small size of the two economies justifies this choice of excluding them in order to avoid biases.) The figure shows that revisions generally increase with time, but stay below 10%, and are of around 5% on average.

We do not have any real-time data for exports by sector, but we utilise the above information about revisions for exports in general in order to conduct a counterfactual experiment in which we inspect the extent to which revisions of this size affect the transfers implied by our scheme. In this experiment each data point for x_{ijt} (export by country i, sector j, year t, from which all the variables needed for the transfers in (2) can be computed) is multiplied by a different random number taken from the uniform distribution between 0.9 and 1.1. Therefore, we assume that there are random revisions, which are uncorrelated across countries, sectors and years and range between -10% and +10% (with an average magnitude of +/-5%). As in general we should expect considerable correlation in the revisions across sectors in the same country, and as the Ameco data tell us that revisions are correlated across countries (note that both features would reduce the effect of data revisions on the transfer scheme), this experiment represents the worst-case scenario for investigating the robustness of our earlier findings.

Figures 7 and 8 show, respectively, the annual and cumulated transfers implied by our baseline scheme based on the actual data together with 20 successive simulations for the same scheme based on the same data but with random revisions. It can be seen how, regardless of the artificially constructed revisions, the simulated annual transfers exhibit the same pattern as that of the “actual” transfers shown in Figure 2. This is even more evident for the cumulated transfers, suggesting that the scheme remains countercyclical. Indeed, performing the same regressions as those in Table 2 shows us that the scheme would have been countercyclical for each of the individual simulated transfer series (see Table 5).

6.2. Sectoral aggregation

This subsection explores the robustness of the transfers to the definition of the sectors. The specific division of the economy into sectors may matter for the transfers. Appendix B shows this formally for the case in which there are three sectors. Merging two of the three sectors into a new sector does in general affect the transfers. Only in the special case in which the sectors are equally large at the euro-area level and in which they have identical growth patterns, i.e. they are affected by the same shocks, is the aggregation of the sectors irrelevant. However, the potential usefulness of the transfers is larger precisely when sectoral shocks are more different.

Nevertheless, as any reasonable aggregation into fewer, bigger sectors would imply merging sectors that are already similar (and therefore subject to similar shocks) in the first place, we show here that doing so has relatively minor implications for the actual transfers. Based on their description and, hence, our interpretation of the degree to which the sectors are related, we aggregate the thirty-three original sectors into sixteen new sectors, as shown in Table A.3 in Appendix A. Indeed, for our baseline scheme we observe that the correlation between the transfers under the new aggregation and those under the original sectoral division is as high as 0.99.

However, further reducing the number of sectors is not as harmless anymore: aggregating the original thirty-sectors into only five macro-sectors (agriculture, mining, energy, manufacturing and services) reduces this correlation of the transfers to 0.59.

6.3. Leaving out one country at a time

The countries in our transfer scheme differ substantially in size, while in some sectors a single or only a limited number of countries are dominant within the Eurozone. In this robustness check we explore how our baseline transfer scheme is affected if we leave out specific countries. We focus on leaving out (one at a time) the five largest countries in the euro-area, i.e. Germany, France, Italy, Spain and the Netherlands, since their dominant shares in a number of sectors potentially have a significant effect on the transfers received or paid by all the other countries. Also, any shock that is specific to one of these countries in a sector in which they are highly specialised would, in our definition, automatically translate into an aggregate euro-area shock for that sector. In each exercise in which we exclude one of these countries, the remaining ones form a “closed” system in that all the shares are calculated in terms of the total for the euro-area minus that country, while the transfers among the remaining countries add up to zero each year. Table 4 reports the correlations between the transfers under the baseline scheme when all countries are included and when a specific country is excluded. We observe that leaving out France, Italy, Spain or the Netherlands

leaves the correlations of the transfer series always 0.95 or even higher. Only when Germany, which produces around 30% of euro area total exports, is left out, are the correlations somewhat lower. Still, the correlation with the case in which all the countries are included is as high as 0.87.

7. Concluding remarks and discussion

Asymmetries in shocks and transmission mechanisms are the main obstacles to a proper functioning of a monetary union. The current range of possibilities to deal with such shocks in the EMU is rather limited. Cross-border labour mobility is low, but it may increase in the future as European economic integration proceeds and national institutions become more alike. Risk sharing at the private level through capital markets is rather limited too, although again one might expect this channel to become more important as impediments to the cross-border trade of assets are reduced. Finally, the use of fiscal policy is restricted, because of the Excessive Deficit Procedure in the Maastricht Treaty and the Stability and Growth Pact. The Stability and Growth Pact calls for a government budget that is close to balance or in surplus in the medium run, to enable automatic stabilisers to do their work. However, reaching a situation in which all the EMU participants have eliminated their structural deficits will be a difficult task.

Motivated by these considerations we analyze the adoption of a cross-border transfer scheme. Obviously, a major source of (political) resistance to such a scheme is the potential for moral hazard. In this paper, we propose a scheme that goes a substantial way towards avoiding moral hazard by conditioning transfers on (exogenous) world market developments for the relevant sectors in the EMU area. Our scheme has other advantages as well: transfers are imposed to add up to zero on an annual basis and they are based on *changes* in aggregate exports in each sector relative to other sectors, implying that a given (relative) reduction in exports can lead to only a one-time transfer. Further transfers can only follow from further reductions in aggregate exports. We show that for a scheme aimed at equalising income shifts as a fraction of exports the transfers are highly countercyclical, especially when a cap is introduced that limits the size of the annual transfers. Moreover, cumulative transfers tend to stabilise or even return towards zero over time. These findings are robust for different variants of our transfer scheme and in particular also for the fact that transfers are partly based on real-time figures.

Of course, before our scheme can be made fully operational, practical obstacles would need to be overcome. Although we have demonstrated the robustness of our scheme to data revisions, we still view the timely availability of the data that serve as input for the calculation of the transfers as the main practical obstacle. This is in particular the case for data on sectoral activity. However,

when sufficient practical need is perceived for the timely availability of such data, governments and statistical agencies may invest more resources in achieving this objective. Another issue concerns the question how transfers received by governments should be put to best use. When transfers are capped, they are by construction limited in their size (although a, say, 0.5% of GDP income receipt is not particularly small), hence they can generally alleviate adverse economic conditions only on a limited scale. However, because a transfer receipt comes on top of regular resource flows it could be politically easier to earmark it for ameliorating the consequences of structural reforms or help in transforming the economy towards activities with a more prosperous future.

References

D'Alfonso, A. and A. Stuchlik, 2016, *A Fiscal Capacity for the Euro Area? Options for Reforms to Counter Asymmetric shocks*, European Parliament, September.

Allard, C., P.K. Brooks, J.C. Bluedorn, F. Bornhorst, K. Christopherson, F. Ohnsorge and T. Poghosyan, 2013, Toward a Fiscal Union for the Euro Area, IMF Staff Discussion Note, No. 13/09, Washington, D.C.

Ameco database, 2017, http://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm.

Asdrubali, P., Sorensen, B.E. and O. Yosha, 1996, Channels of Interstate Risk Sharing: United States 1963-1990, *Quarterly Journal of Economics* 111, 4, 1081–1110.

Balli, F., S. Basher and R. Jean Louis, 2012, Channels of risk-sharing among Canadian provinces: 1961–2006, *Empirical Economics* 43, 2, 763-87.

Bara, E., L. Castets, T.E. and A. Zakhartchouk, 2017, A Contribution to the Work on the Strengthening of the Euro Area, *Trésor-Economics*, No. 190.

Beetsma, R.M.W.J. and A.L. Bovenberg, 2001, The Optimality of a Monetary Union without a Fiscal Union, *Journal of Money, Credit, and Banking* 33, 2, Part 1, 179-204.

Beetsma, R.M.W.J. and C. Oudshoorn (eds.), 1999, Tools for Regional Stabilisation, *Discussion Paper*, No.9903, Dutch Ministry of Economic Affairs.

Beblavý, M. and K. Lenaerts, 2017, Feasibility and Added Value of a European Unemployment Benefits Scheme, European Commission, Brussels.

Berger, H., Dell'Ariccia and M. Obstfeld, 2018, Revisiting the Case for Fiscal Union in the Euro Area, International Monetary Fund, Washington DC.

Cimadomo, J., Furtuna, O. and M. Giuliodori, 2017, Private and Public Risk Sharing in the Euro Area, *Discussion Paper*, TI 2017-064/VI, Tinbergen Institute.

Cœuré, B., 2016, A budgetary capacity for the euro area, *Introductory remarks at a public hearing at the European Parliament*, Brussels, March 2.

De Grauwe, P., 2000, Monetary Policy in Euroland, *Revue de la Banque.*

Dolls, M., C. Fuest, D. Neumann and A. Peichl, 2016, An Unemployment Insurance Scheme for the Euro Area? A Comparison of Different Alternatives using Micro Data, *CESifo Working Paper*, No. 5581, CESifo, Munich.

ECB, 2017, *Financial integration in Europe*, Frankfurt.

Enderlein H., L. Guttenberg and J. Spiess, 2013, Blueprint for a Cyclical Shock Insurance in the Euro Area, *Notre Europe*, Paris.

European Commission, 2017, *Reflection Paper on the Deepening of the Economic and Monetary Union*, Brussels.

European Parliament, 2017, *Report on budgetary capacity for the Eurozone*, February 13.

Eurostat, 2017, http://ec.europa.eu/eurostat/data/database, spring vintage.

Farhi, E. and I. Werning, 2017, Fiscal Unions, *American Economic Review*, 107(12), 3788-3834.

Furceri, D. and A. Zdzienicka, 2015, The Euro Area Crisis: Need for a Supranational Fiscal Risk Sharing Mechanism? *Open Economies Review*, 26(4), 683-710.

Hepp, R. and J. von Hagen, 2013, Interstate risk sharing in Germany: 1970–2006, *Oxford Economic Papers* 65, 1-24.

IMF, 2016, *Country Report on the Euro Area*, July.

Juncker, J.C., Tusk, D., Dijsselbloem, J., Draghi, M and M. Schultz, 2015, *Completing Europe's Economic and Monetary Union*, European Commission, Brussels.

Knot, K.H.W., 2016, *Public hearing of the European Parliament on a budgetary capacity in the euro area*, Brussels, March 2.

Marjolin, R., F. Bobba, H. Bosman, G. Brouwers, L. Camu, B. Clappier, I. Foighel, F. Forte, H. Giersch, P. Lynch, D. MacDougall, H. Markmann, F. Peeters, A. Shonfield and N. Thysegen, 1975, *Report of the Study Group 'Economic and Monetary Union 1980'*, European Commission, Brussels.

Mélitz, J. and F. Zumer, 1998, Regional Redistribution and Stabilisation by the Centre in Canada, France, the United Kingdom, and the United States: New Estimates Based on Panel Data Econometrics, *CEPR Discussion Paper*, No. 1829.

Milano, V., 2017, Risk sharing in the euro zone: the role of European Institutions, Center for Labor and Economic Growth, Department of Economics and Finance, *LUISS Guido Carli Working Paper*, No. 01/17.

Obstfeld, M. and G. Peri, 1998, Regional Non-Adjustment and Fiscal Policy, *Economic Policy* 26, 207-47.

OECD, 2017a, https://data.oecd.org/.

OECD, 2017b, *Trade in Value Added* (TiVA), http://www.oecd.org/sti/ind/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm, retrieved in July 2017.

Pisani-Ferry, J., Italianer, A. and R. Lescure, 1993, Stabilisation Properties of Budgetary Systems: A Simulation Analysis, in European Commission, The Economics of Community Public Finance, *European Economy Reports and Studies* 5, 417-55.

Padoa-Schioppa, T., M. Emerson, M. King, J. Milleron, J. Paelinck, L. Papademos, F. Pastor and F. Scharpf, 1987, *Efficiency, Stability and Equity: A Strategy for the Evolution of the Economic System of the European Community*, Oxford: Oxford University Press.

Poghosyan, T., Senhadji, A. and C. Cotarelli, 2016, The Role of Fiscal Transfers in Smoothing Regional Shocks: Evidence from Existing Federations, *ESM Working Paper*, No.18.

Sala-i-Martin, X. and J. Sachs, 1991, Fiscal Federalism and Optimum Currency Areas: Evidence for Europe from the United States, *NBER Working Paper*, No.3855.

Sorensen, B.E. and O. Yosha, 1998, International Risk Sharing and European Monetary Unification, *Journal of International Economics* 45, 211-38.

Van Rompuy, H., 2012, Towards a Genuine Economic and Monetary Union, *Report by President of the European Council*, Brussels.

Van Rompuy, H., Barroso, J.M., Juncker, J.-C. and M. Draghi, 2012, *Towards a Genuine Economic and Monetary Union*, European Council, December 5.

Von Hagen, J., 1999, A Fiscal Insurance for the EMU?, in Beetsma, R.M.W.J. and C. Oudshoorn (eds.), Tools for Regional Stabilisation, *Discussion Paper*, No.9903, Dutch Ministry of Economic Affairs.

Von Hagen, J. and G.W. Hammond, 1995, Regional Insurance against Asymmetric Shocks: An Empirical Study for the European Community, *CEPR Discussion Paper*, No. 1170.

World Bank, 2017, http://databank.worldbank.org/data/home.aspx.

Zettelmeyer, J., 2016, Wirtschaftspolitik neu denken – ein besserer Fiskalrahmen für die Eurozone, in Schellinger, A. and P. Steinberg (eds.), *Die Zukunft der Eurozone - Wie wir den Euro retten und Europa zusammenhalten*.

Tables

Table 1. Share of each country's export in total euro area export in that sector (w_{ij}); averages over the period 1995-2014

SECTOR	AT	BE	EE	FI	FR	DE	GR	IE	IT	LV	LU	NL	PT	SK	SI	ES	CY	LT	MT
Agriculture, hunting, forestry and fishing	1.7	3.3	0.3	1.3	26.3	12.0	4.0	1.4	8.4	0.5	0.3	19.5	1.3	1.0	0.4	17.4	0.1	0.8	0.1
Mining and quarrying	2.6	2.5	0.2	0.8	7.3	13.2	1.4	1.3	5.5	0.1	0.1	56.9	1.7	0.8	0.1	5.0	0.0	0.3	0.0
Food products, beverages and tobacco	2.7	5.9	0.2	0.8	20.1	19.9	2.1	6.7	11.7	0.3	0.3	15.9	1.7	0.5	0.3	10.3	0.2	0.4	0.1
Textiles, textile products, leather and footwear	2.5	3.7	0.3	0.6	14.6	15.6	2.1	0.5	40.0	0.3	0.3	2.3	5.6	0.9	0.7	9.2	0.1	0.6	0.1
Wood and products of wood and cork	13.0	4.1	1.9	14.3	9.2	22.1	0.5	1.1	10.1	3.5	0.3	3.0	6.6	1.9	1.8	5.4	0.0	1.1	0.0
Pulp, paper, paper products, printing and publishing	5.9	3.7	0.2	13.8	12.3	33.5	0.4	3.2	8.3	0.1	0.3	7.1	2.3	1.0	0.7	6.7	0.0	0.2	0.1
Coke, refined petroleum products and nuclear fuel	1.6	10.4	0.2	2.5	16.5	18.7	2.7	1.2	10.5	0.0	0.0	22.0	0.8	1.2	0.1	9.3	0.0	2.4	0.0
Chemicals and chemical products	2.1	6.4	0.1	1.2	19.9	33.8	0.7	8.0	10.0	0.0	0.1	9.6	0.6	0.3	0.6	6.5	0.0	0.1	0.0
Rubber and plastics products	4.0	4.2	0.1	1.6	16.0	36.9	0.7	0.9	16.8	0.1	0.9	5.9	1.6	1.2	0.9	7.8	0.0	0.3	0.1
Other non-metallic mineral products	4.7	5.1	0.2	1.5	12.3	25.3	1.4	1.0	24.8	0.2	0.8	4.1	3.3	1.1	0.7	13.3	0.0	0.2	0.0
Basic metals	5.3	6.8	0.0	3.1	16.3	34.8	1.6	0.3	13.8	0.2	0.8	4.8	1.0	1.4	0.5	9.2	0.0	0.0	0.0
Fabricated metal products except machinery and equipment	5.1	4.4	0.2	1.8	11.4	33.6	0.6	0.6	24.1	0.1	0.3	6.5	1.5	1.3	1.2	7.0	0.0	0.2	0.0
Machinery and equipment n.e.c	3.9	1.8	0.0	2.7	12.1	43.2	0.3	0.5	25.6	0.0	0.2	3.9	0.6	0.5	0.5	4.0	0.0	0.1	0.0
Computer, electronic and optical products	3.3	1.6	0.2	5.7	19.7	39.3	0.4	7.0	10.4	0.1	0.1	5.7	1.0	1.0	0.4	3.8	0.0	0.1	0.2
Electrical machinery and apparatus n.e.c	4.2	2.3	0.2	2.4	16.5	46.6	0.5	1.2	14.0	0.1	0.1	2.3	1.5	1.2	0.7	6.1	0.0	0.1	0.1
Motor vehicles, trailers and semi-trailers	2.7	3.3	0.0	0.4	15.5	53.8	0.1	0.1	9.0	0.0	0.0	1.8	1.0	1.3	0.4	10.6	0.0	0.0	0.0
Other transport equipment	1.8	1.1	0.1	1.8	37.3	34.1	0.5	0.5	11.4	0.1	0.0	3.8	0.6	0.3	0.1	6.4	0.0	0.1	0.0
Manufacturing n.e.c; recycling	4.4	4.7	0.4	1.2	17.2	22.6	1.1	1.1	27.4	0.2	0.1	6.9	1.7	1.0	1.1	7.8	0.2	0.6	0.2
Electricity, gas and water supply	4.6	6.7	0.2	1.3	18.6	55.3	0.3	0.2	3.0	0.1	0.3	4.9	0.4	0.5	0.7	2.6	0.0	0.2	0.0
Construction	8.0	11.3	0.5	4.5	33.9	13.2	2.1	0.6	6.8	0.2	0.8	7.9	2.6	1.2	1.1	2.6	2.1	0.4	0.1
Wholesale and retail trade; repairs	4.2	5.5	0.2	1.6	20.0	27.0	1.1	2.8	17.8	0.2	0.7	7.4	1.8	0.9	0.4	8.0	0.2	0.2	0.1
Hotels and restaurants	8.7	2.6	0.3	0.8	13.4	8.8	5.9	1.4	23.3	0.1	0.8	2.4	3.2	0.5	0.5	25.7	1.0	0.2	0.4
Transport and storage	3.1	6.4	0.5	1.5	18.6	21.1	5.5	1.6	13.2	0.6	1.0	10.3	2.2	0.7	0.6	11.9	0.4	0.6	0.2
Post and telecommunications	5.9	11.7	0.3	1.4	11.9	20.5	1.9	3.6	13.7	0.3	5.3	10.1	1.8	0.8	0.6	8.5	1.0	0.4	0.3
Finance and insurance	6.1	7.7	0.1	0.4	9.9	17.6	0.4	13.1	8.6	0.4	16.9	8.9	1.1	0.2	0.1	6.6	1.6	0.0	0.2
Real estate activities	6.9	2.3	0.2	0.7	13.6	14.5	2.7	0.8	30.3	0.1	1.1	5.4	4.5	0.6	0.6	12.5	2.4	0.5	0.2
Renting of machinery and equipment	3.2	2.8	0.2	1.3	36.4	23.5	1.5	13.2	4.0	0.1	1.5	4.7	1.1	0.2	0.0	5.6	0.4	0.1	0.2
Computer and related activities	2.6	6.5	0.2	4.4	4.9	29.5	0.6	19.0	7.3	0.1	1.3	8.3	0.5	0.4	0.3	13.2	0.4	0.1	0.1
Research and development and other business activities	4.5	11.1	0.1	2.4	18.6	27.8	0.6	2.8	10.6	0.2	0.7	7.9	0.7	0.5	0.3	10.3	0.5	0.1	0.2
Public admin. and defence; compulsory social security	6.0	7.3	0.2	2.8	28.5	1.0	1.0	0.0	1.3	0.0	1.0	18.7	3.6	0.3	0.2	27.8	0.0	0.0	0.1
Education	2.9	12.5	0.3	0.7	17.6	13.4	2.0	2.5	6.4	0.1	1.2	25.4	1.8	0.8	1.3	8.8	1.9	0.2	0.2
Health and social work	8.5	2.0	0.1	2.8	28.7	25.1	2.4	2.9	2.6	0.1	0.9	10.0	2.2	1.3	1.1	8.9	0.2	0.2	0.1
Other community, social and personal services	7.2	4.9	0.3	1.3	20.2	19.9	4.8	1.8	11.0	0.1	2.8	8.6	1.6	1.5	1.3	9.9	1.5	0.5	0.8
SHARE OF THE COUNTRY IN TOTAL EURO AREA EXPORT	3.9	5.0	0.2	2.2	17.5	30.4	1.5	3.2	15.0	0.2	1.0	7.6	1.6	0.8	0.5	8.8	0.3	0.3	0.1

Three highest shares Three lowest shares

Table 2: Relationship between transfers and the state of the economy

Dependent variable: transfers as a share of GDP

Explanatory variable	Output gap	Lag of output gap	Output gap minus weighted average of Eurozone output gap
Baseline: compensation for full income loss			
Estimate	-0.038**	-0.036**	-0.033
p-value	0.011	0.021	0.113
Baseline with cap on transfers			
Estimate	-0.015***	-0.015***	-0.018***
p-value	0.000	0.000	0.000
Compensation for labour income loss			
Estimate	-0.020**	-0.023**	-0.019
p-value	0.049	0.023	0.172
Compensation for labour income loss, with cap			
Estimate	-0.008**	-0.011***	-0.011***
p-value	0.014	0.001	0.008
Compensation based on taxes for full income loss			
Estimate	-0.015**	-0.014**	-0.013
p-value	0.010	0.022	0.108
Compensation based on taxes for full income loss, with cap			
Estimate	-0.008***	-0.007***	-0.009***
p-value	0.001	0.005	0.008
Shock as deviation from 4-year moving-average growth rate			
Estimate	-0.053*	-0.065**	-0.043
p-value	0.056	0.024	0.279
Shock as deviation from 4-year moving-average growth rate, with cap			
Estimate	-0.016***	-0.019***	-0.019***
p-value	0.001	0.000	0.006
Compensation based on stabilisation as a fraction of GDP			
Estimate	-0.076***	-0.043	-0.039
p-value	0.004	0.130	0.300
Compensation based on stabilisation as a fraction of GDP, with cap			
Estimate	-0.008	-0.002	-0.002
p-value	0.138	0.715	0.796

Note: Random effects generalized least squares panel regressions on a constant and the reported variable over all countries in the sample and period 1996 – 2014. Annual transfers are here assumed to be capped at 0.5% of GDP.

Table 3: Correlation table of annual transfers across the various schemes

	Baseline	Baseline, cap	Labour share	L. share, cap	Taxation	Taxation, cap	MA4	MA4, cap	Based on GDP	Based on GDP, cap
Baseline	1									
Baseline, cap	0.68	1								
Labour share	0.97	0.66	1							
Labour share, cap	0.71	0.89	0.76	1						
Tax	1.00	0.68	0.97	0.71	1					
Tax, cap	0.83	0.93	0.81	0.90	0.83	1				
Shock from MA4	0.80	0.54	0.80	0.59	0.81	0.67	1			
Shock from MA4, cap	0.49	0.65	0.49	0.59	0.49	0.60	0.62	1		
Based on GDP	0.55	0.32	0.41	0.32	0.55	0.40	0.32	0.16	1	
Based on GDP, cap	0.27	0.39	0.21	0.31	0.28	0.36	0.11	0.17	0.63	1

Note: the table reports the correlations between transfers of each pair of schemes, where the correlation is computed over all (year, country) combinations.

Table 4: Correlations of transfers under baseline scheme when all countries are included and when a specific country is excluded

	All countries	Excluding Germany	Excluding France	Excluding Italy	Excluding Spain	Excluding the Netherlands
All countries	1					
Excluding Germany	0.87	1				
Excluding France	0.99	0.84	1			
Excluding Italy	0.99	0.87	0.97	1		
Excluding Spain	1.00	0.86	0.98	0.99	1	
Excluding the Netherlands	0.97	0.82	0.95	0.95	0.96	1

Table 5: regression coefficients for transfers based on simulated data revisions

Regression of the simulated transfers on:	Range of coefficients	Average
Output gap	-0.0499 to -0.0265	-0.0381
Output gap deviation	-0.0407 to -0.0180	-0.0319
Lag of output gap	-0.0456 to -0.0285	-0.0361

Notes: the table shows the range of the regression coefficients and the average of these coefficients for regressions analogous to those reported in Table 2 for the transfers series based on each of the 20 simulated data revision series.

Figures

Figure 1. Growth rates of Euro Area exports in the 33 sectors

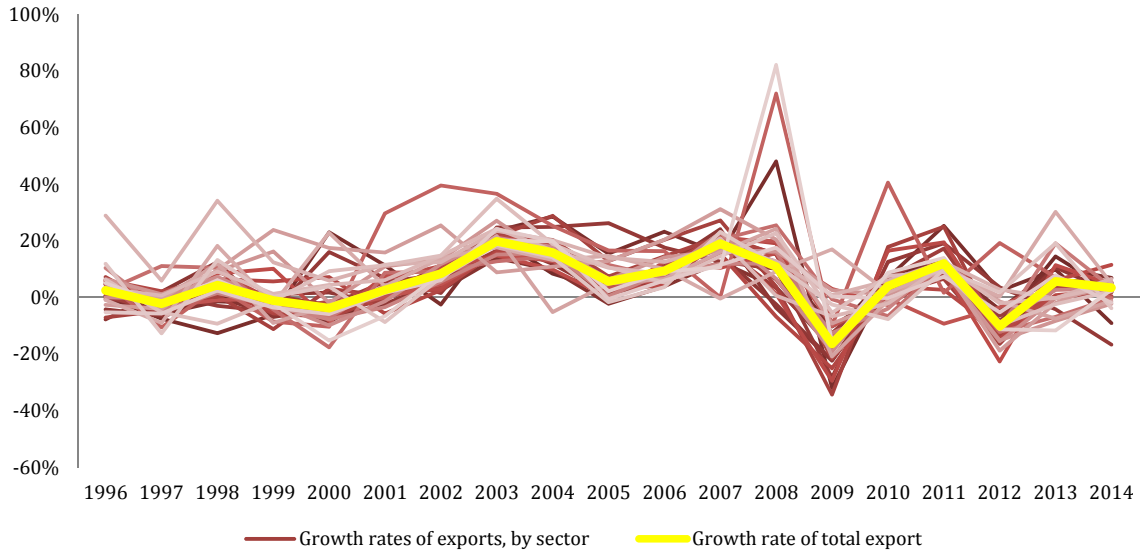
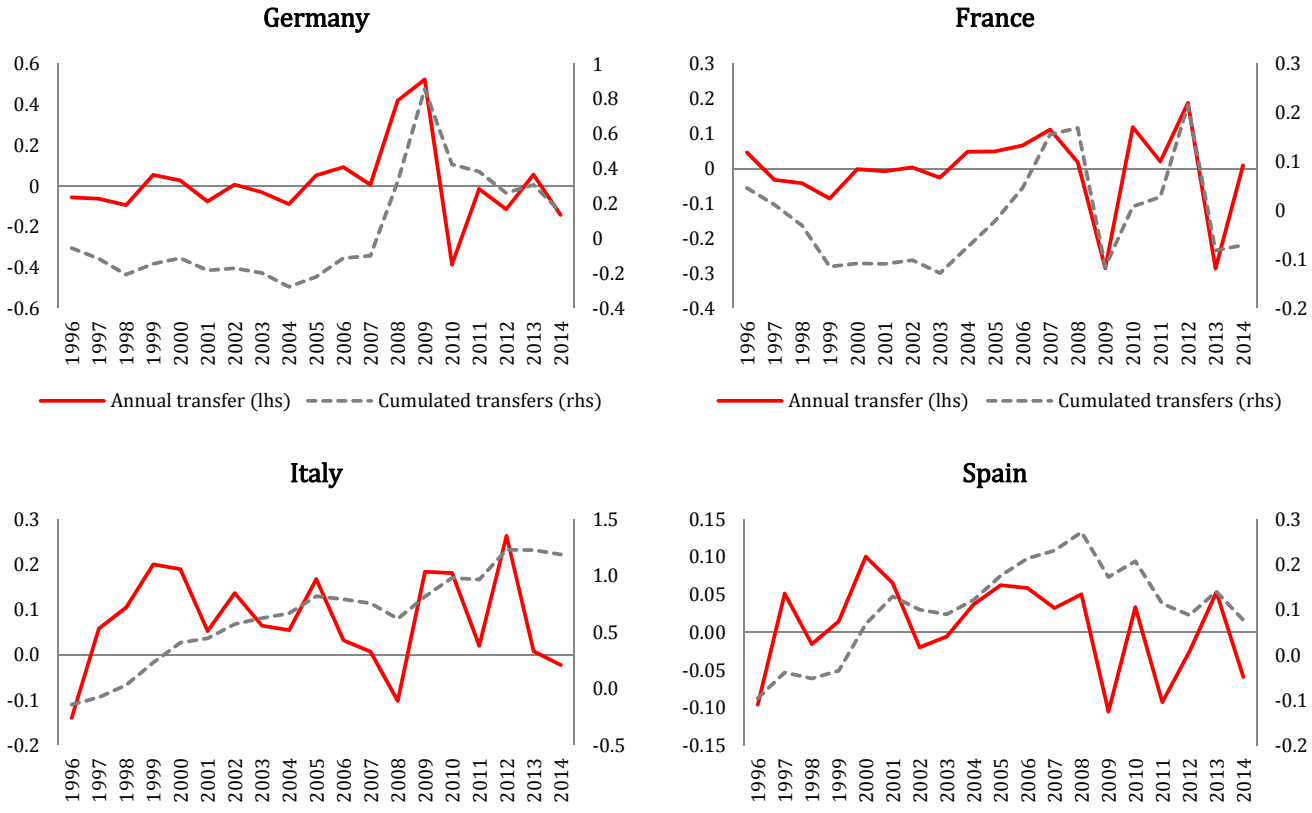
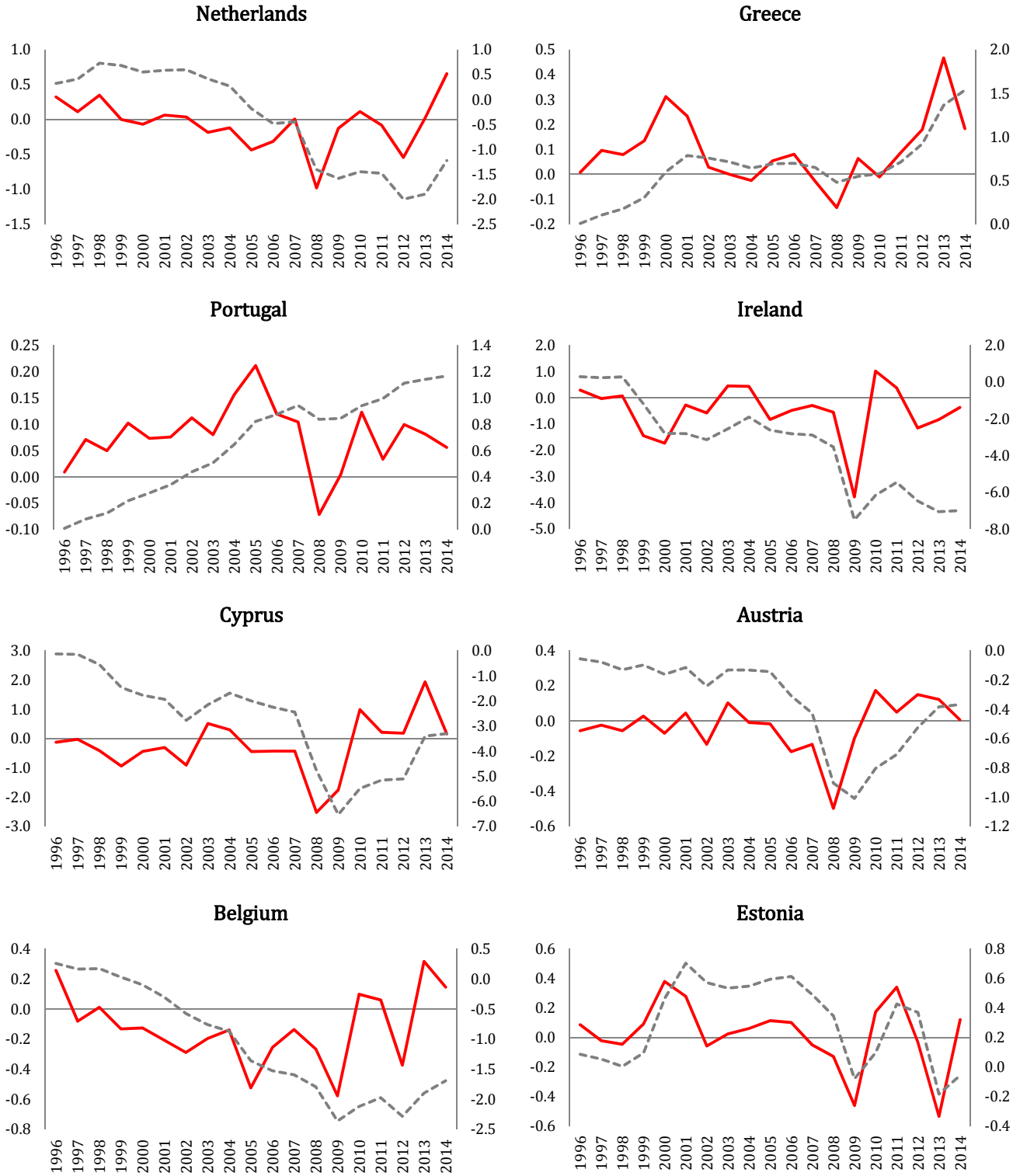


Figure 2. Annual and cumulated transfers implied by the baseline scheme, % of the country's GDP.




Netherlands
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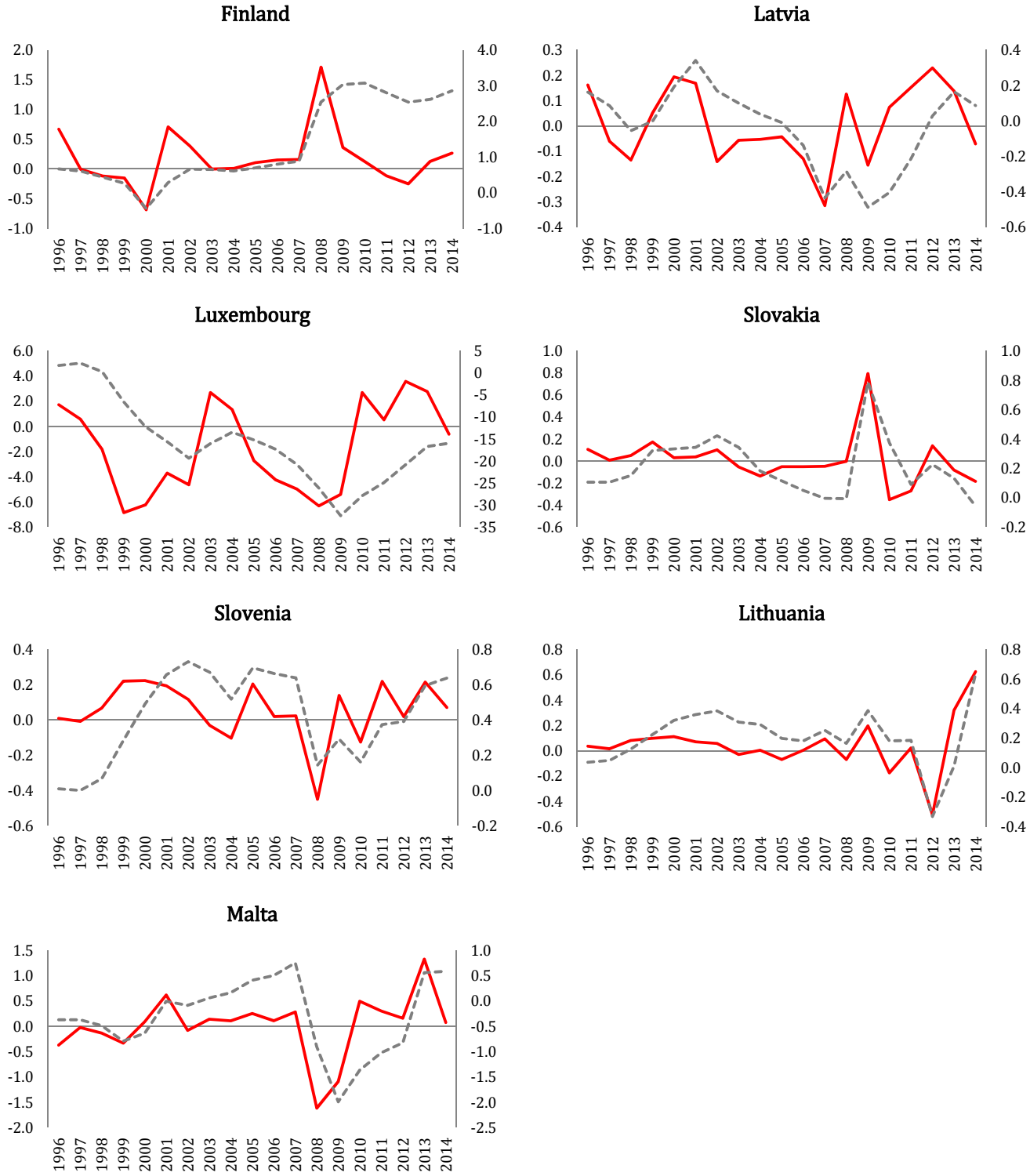
Portugal
Ireland
Cyprus
Austria
Belgium
Estonia



Note: transfers are calculated using data from the OECD TiVA database, based on (2).

Figure 3: Sectoral diversification and size of transfers

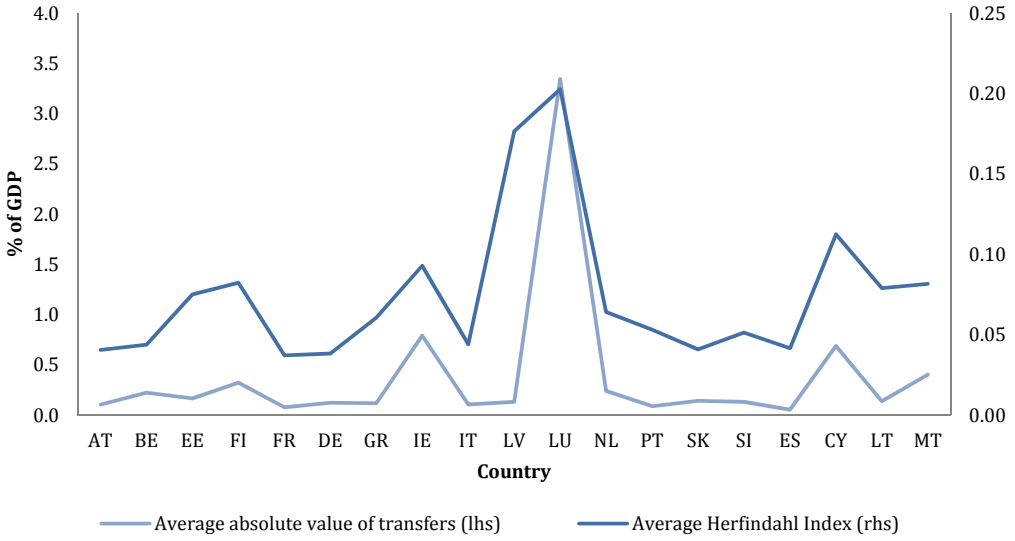
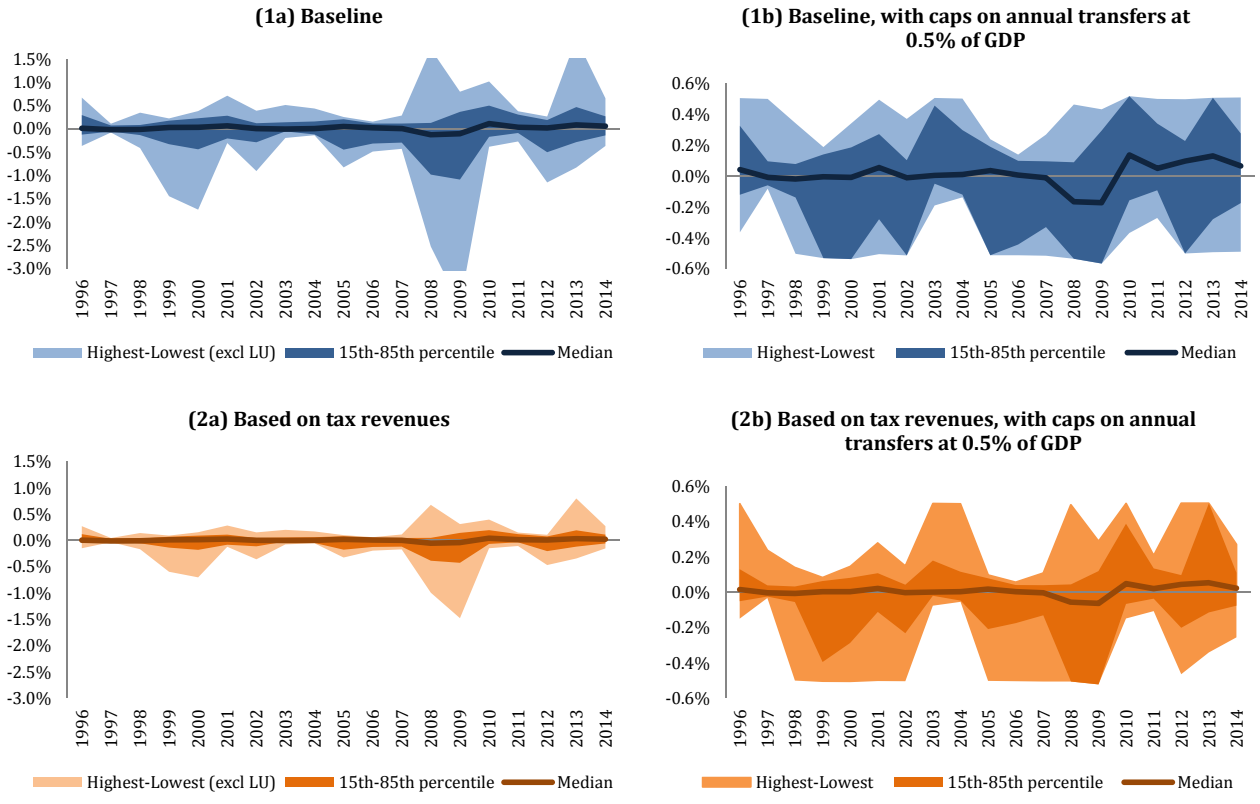
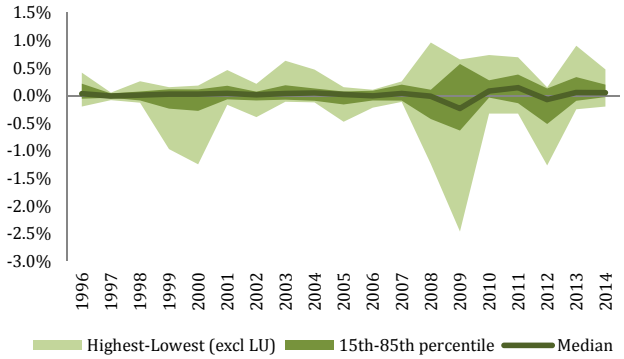


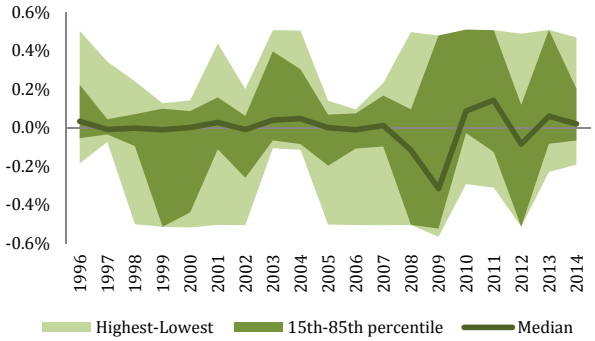
Figure 4. Dispersion of transfers across the various schemes.



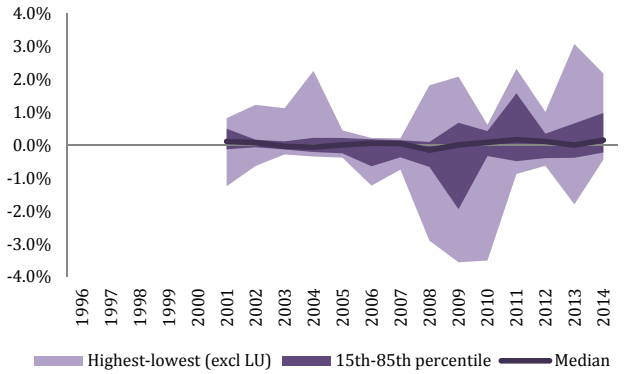
(3a) Based on the labour share of income



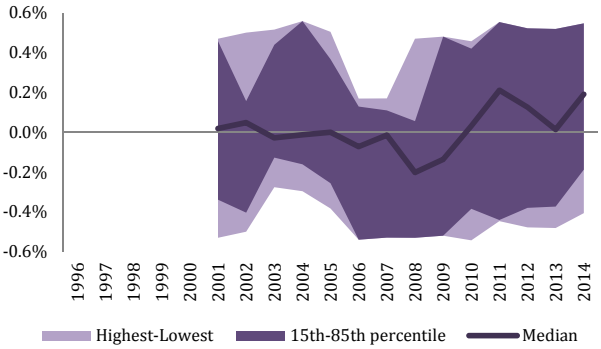
(3b) Based on the labour share of income, with caps on annual transfers at 0.5% of GDP



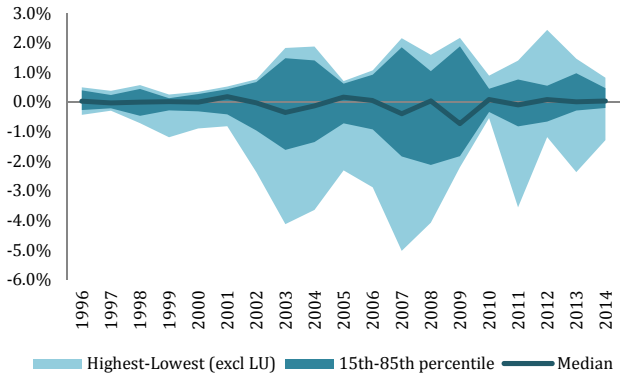
(4a) Based on shock from 4-year moving average



(4b) Based on shock from 4-year moving average, with caps on annual transfers at 0.5% of GDP



(5a) Based on GDP



(5b) Based on GDP, with caps on annual transfers at 0.5% of GDP

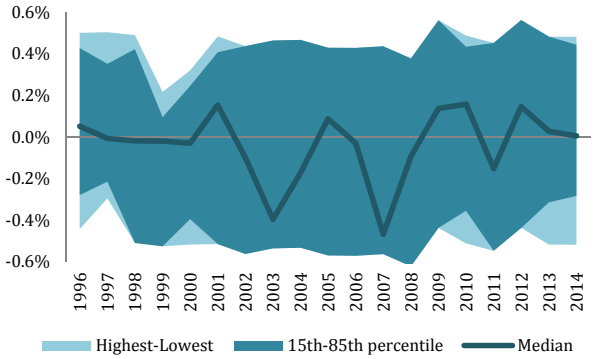


Figure 5. Annual and cumulated transfers after applying a cap on annual transfers of 0.5% of GDP

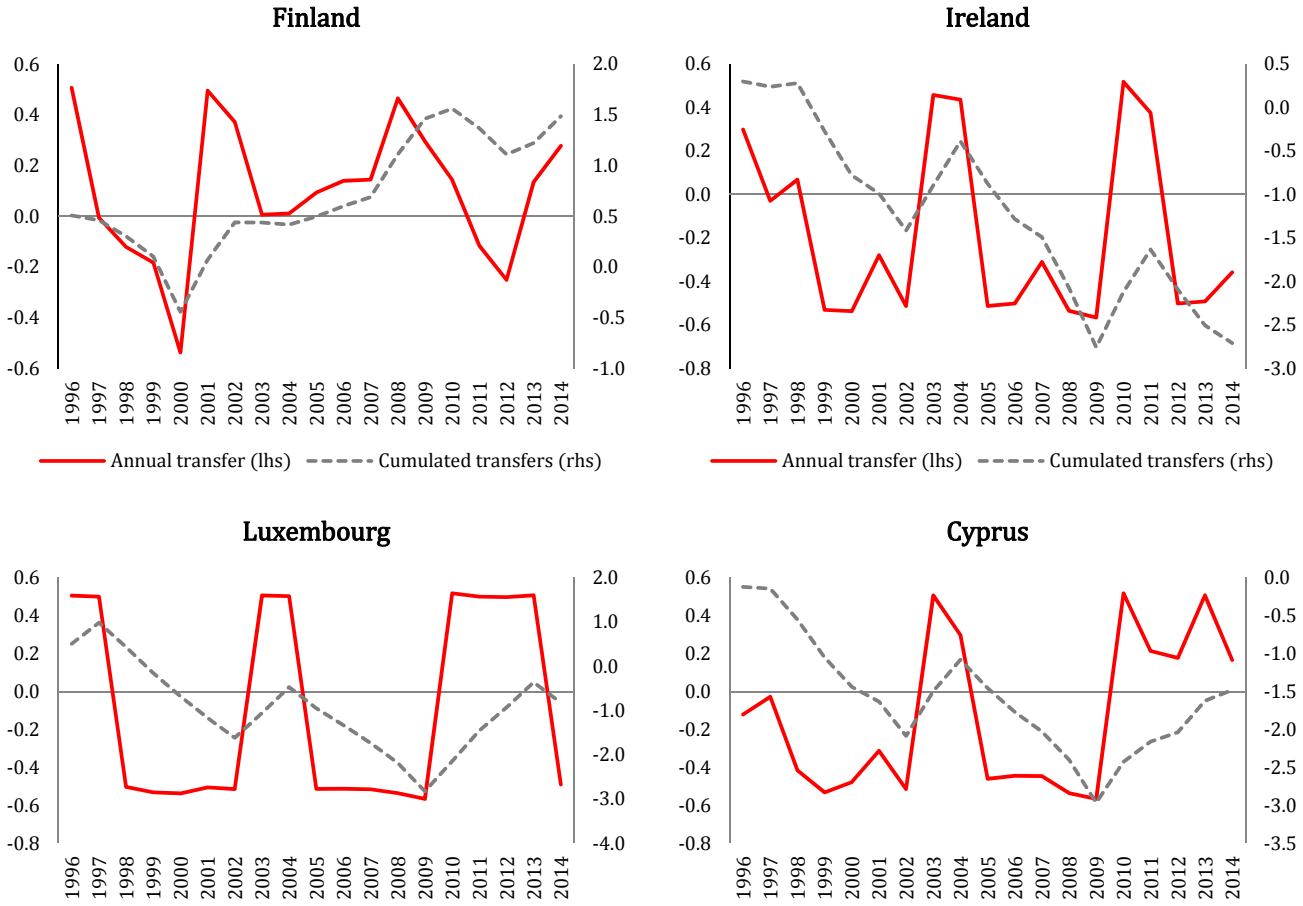


Figure 6. Average absolute value of revisions (in %) from the real-time edition - exports

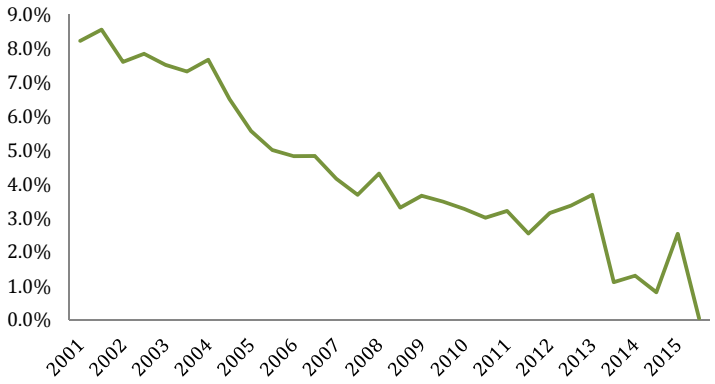
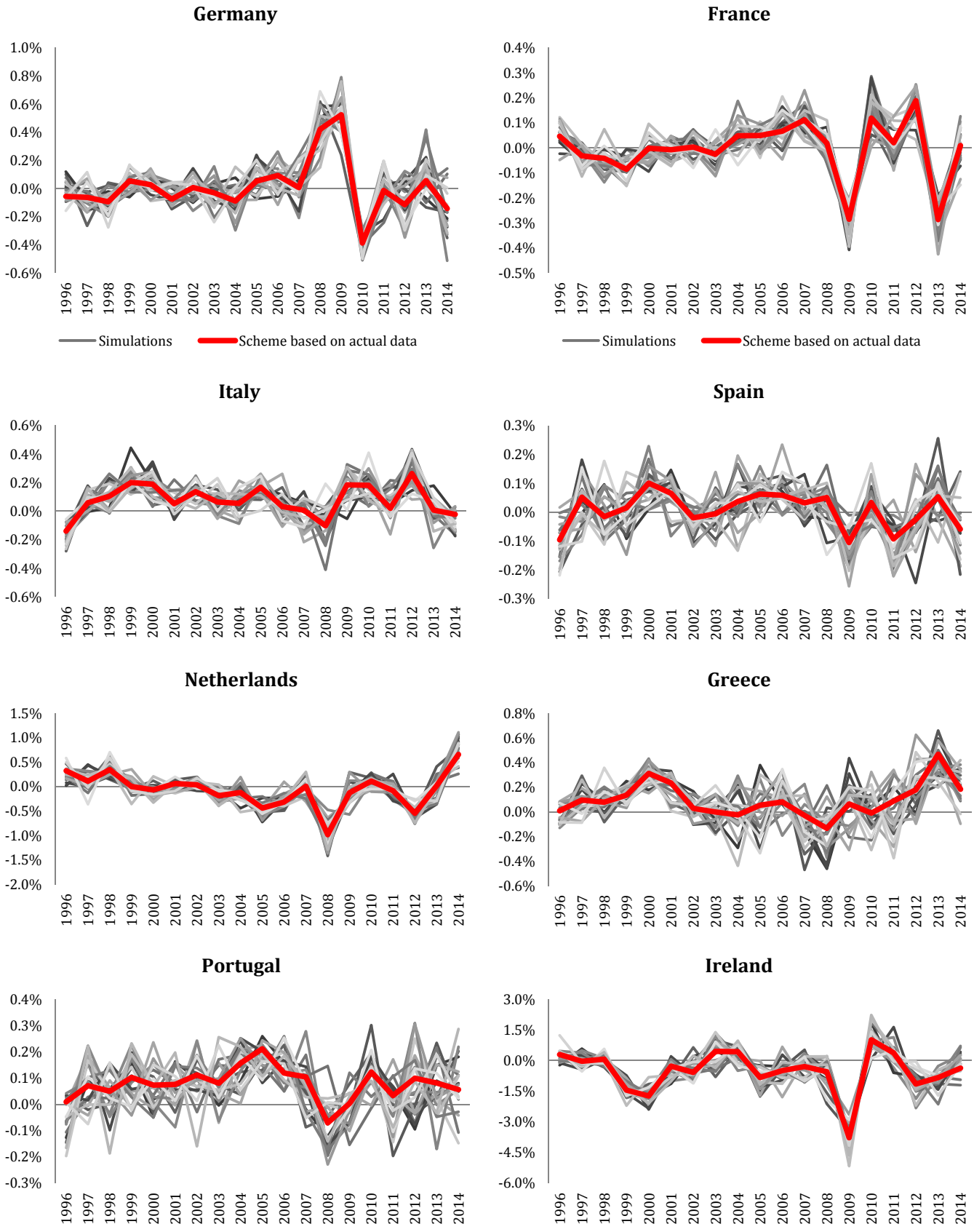
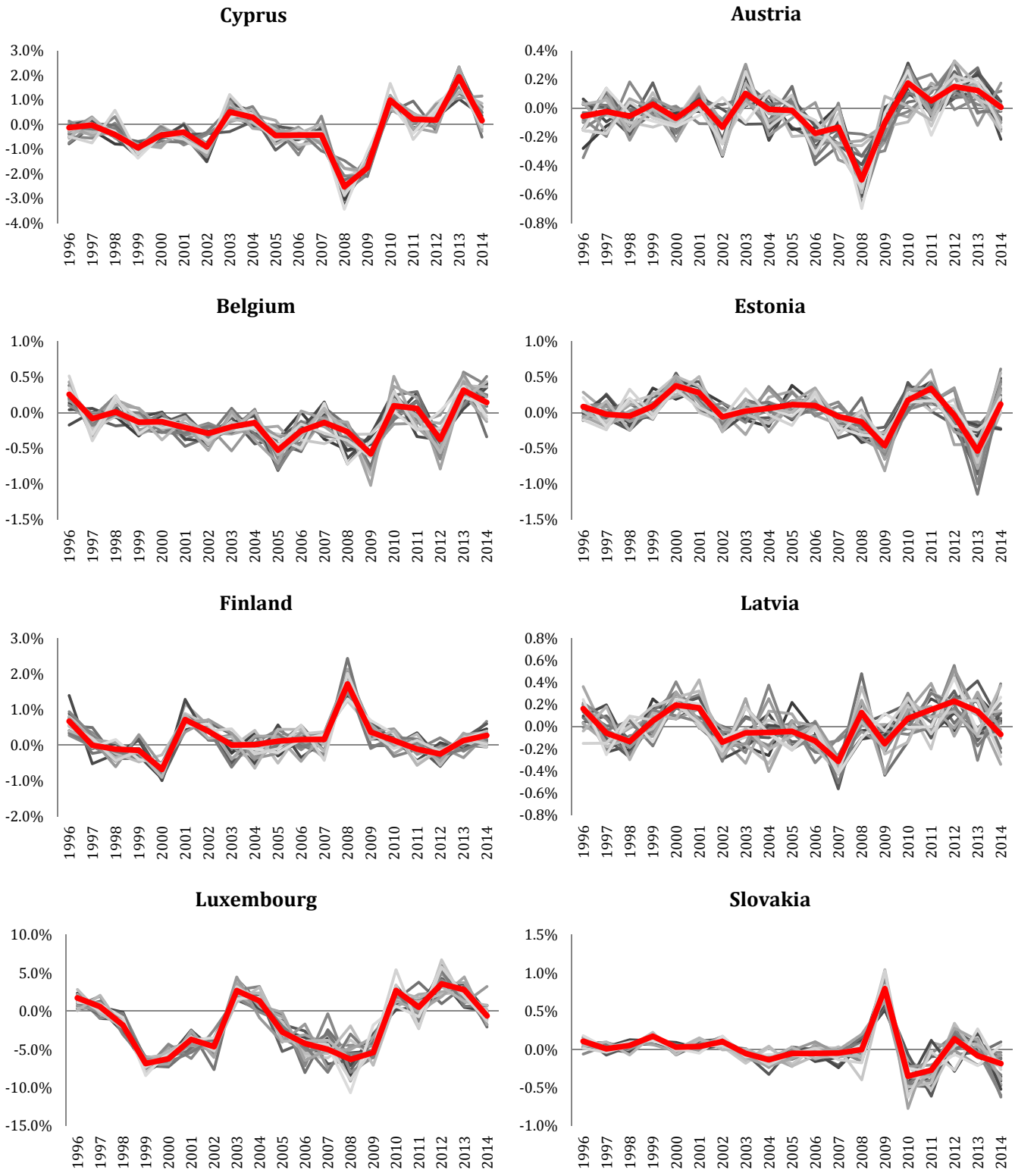


Figure 7. Baseline annual transfers under actual and simulated revisions data

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3.0%
2.0%
1.0%
0.0%
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1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Austria
0.4%
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Belgium
1.0%
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Latvia
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Slovakia
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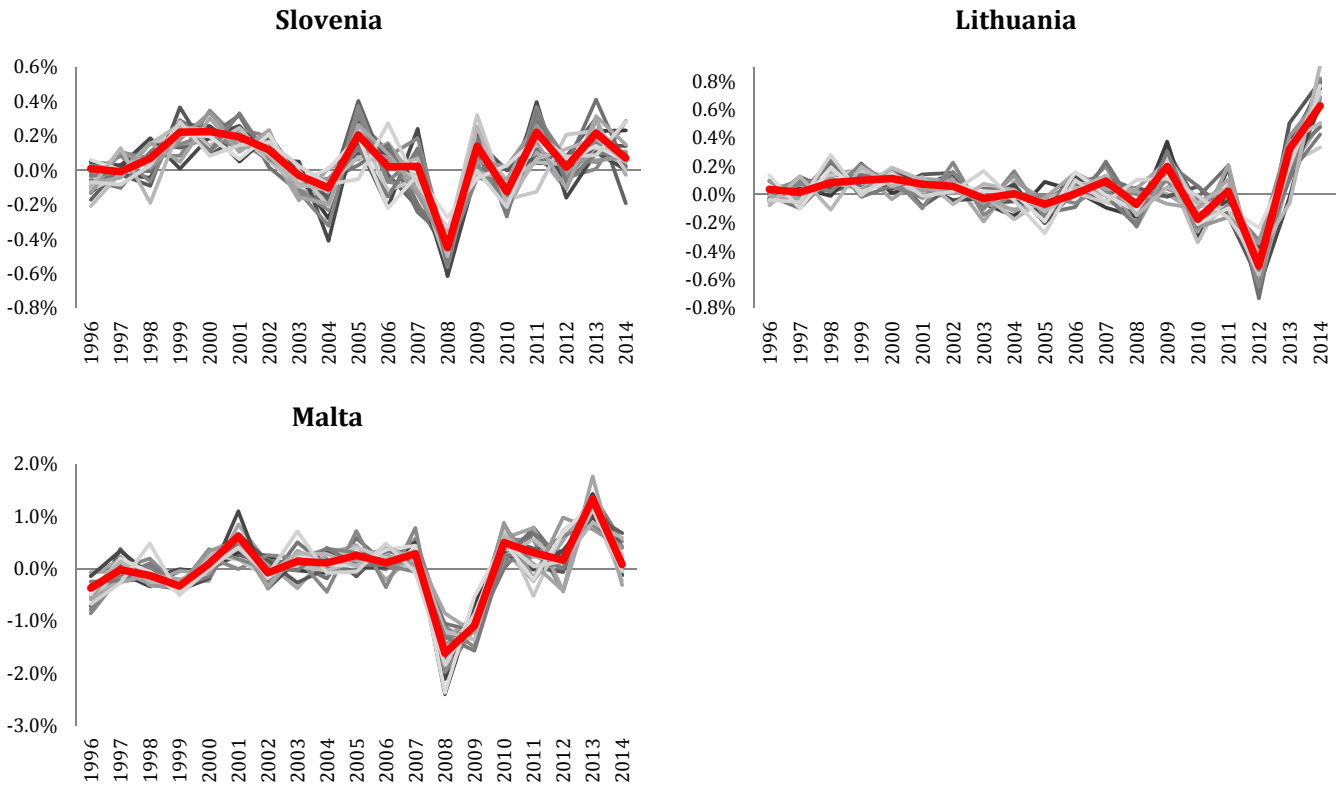
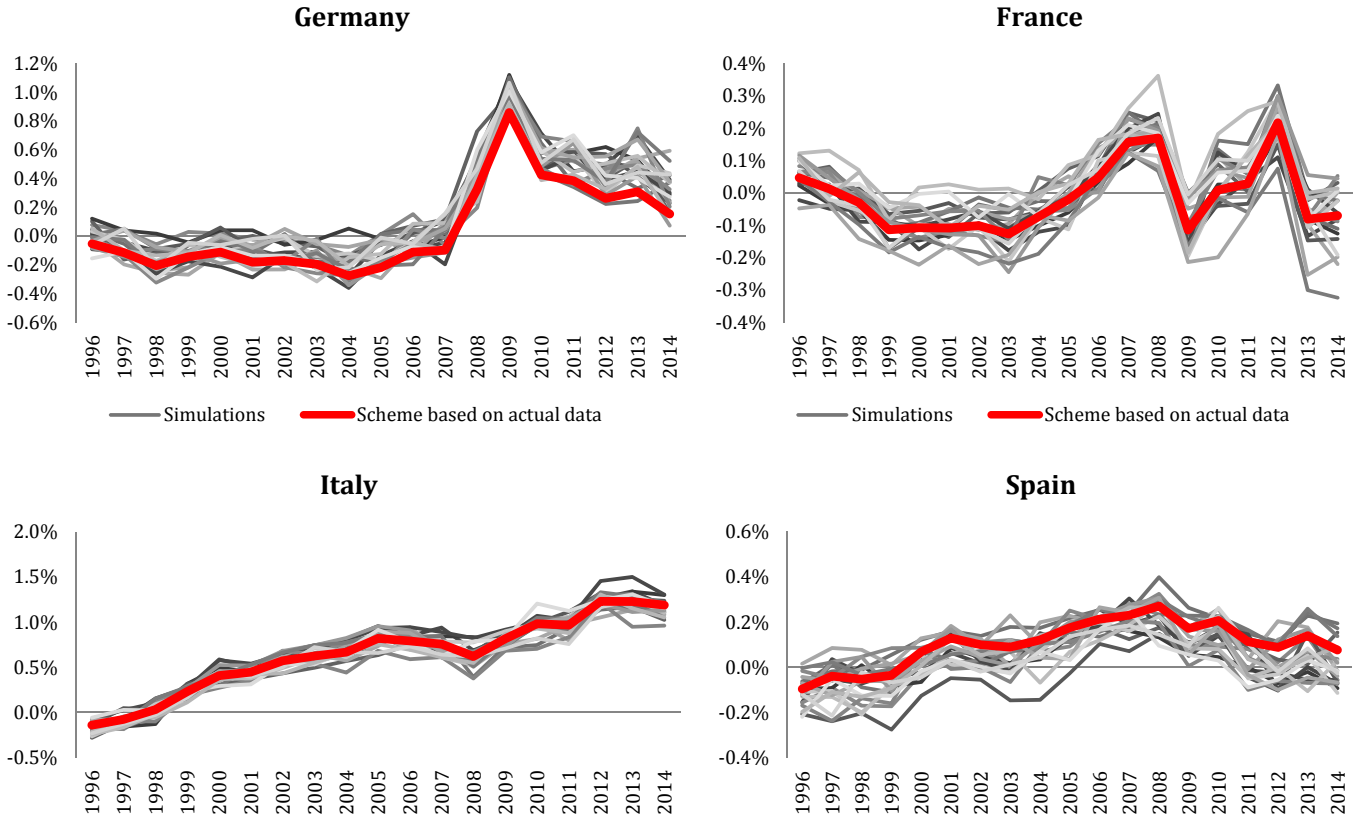
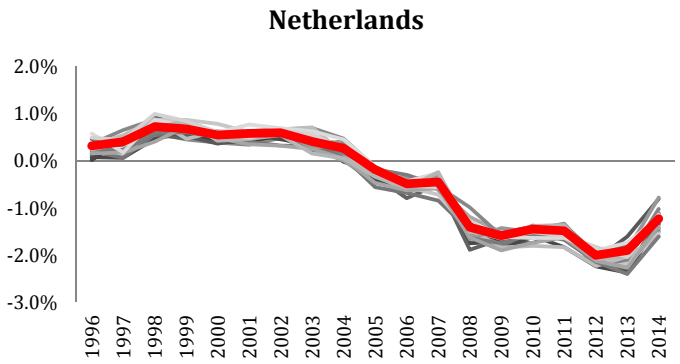


Notes: simulations based on assumption that each value of x_{ijt} is subject to a random revision between -10% and +10%

Figure 8. Baseline cumulated transfers under actual and simulated revisions data

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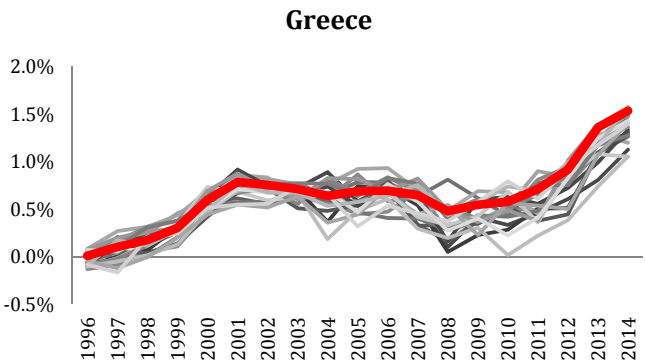
Greece
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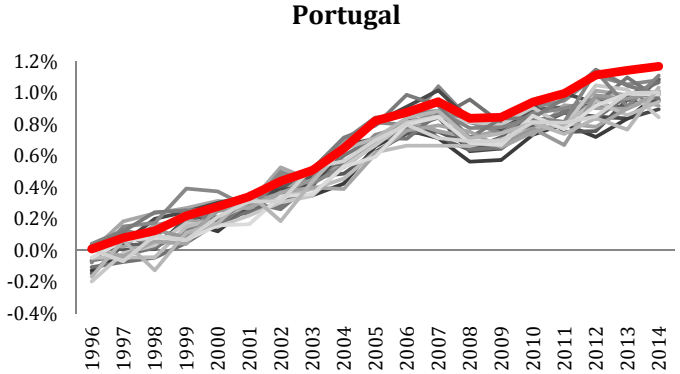
Portugal
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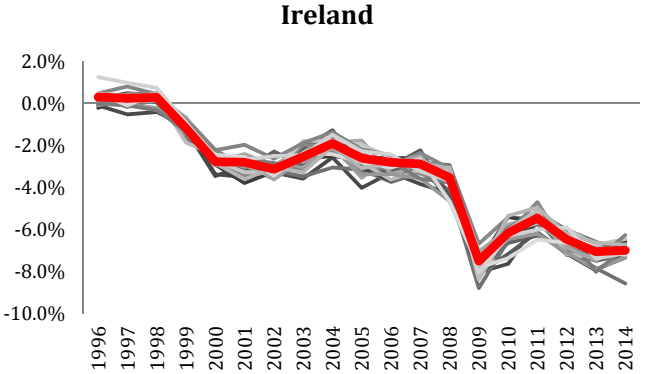
Ireland
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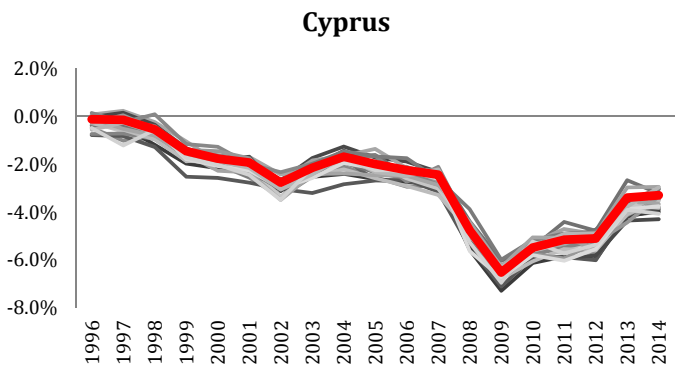
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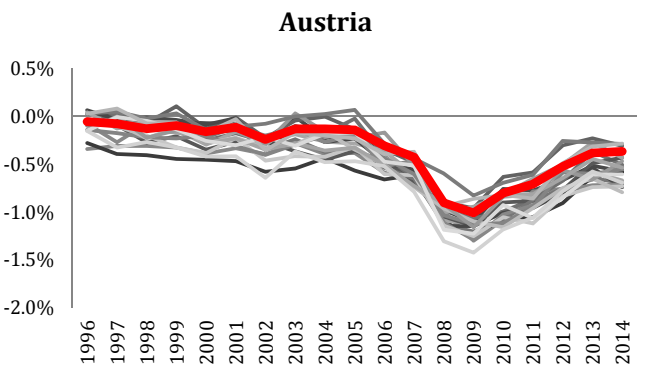
Austria
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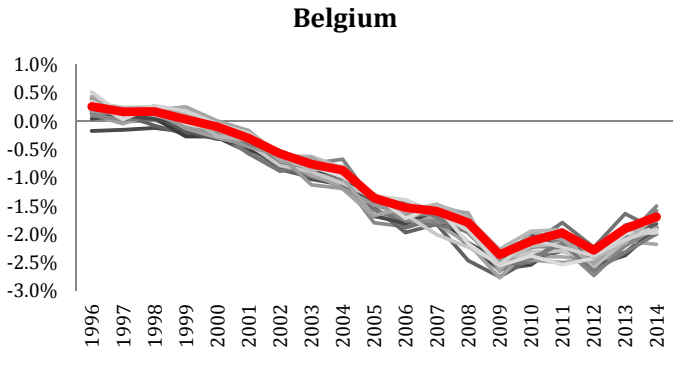
Belgium
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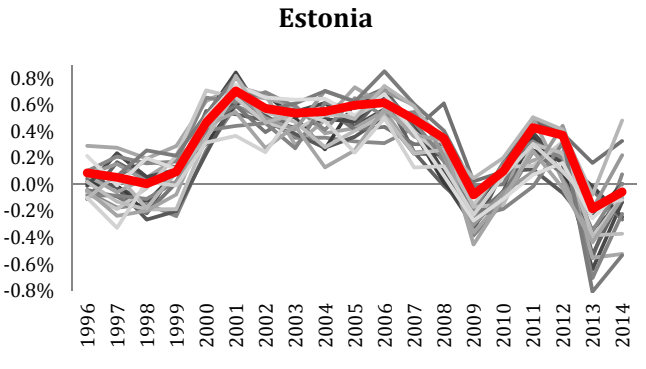
Estonia
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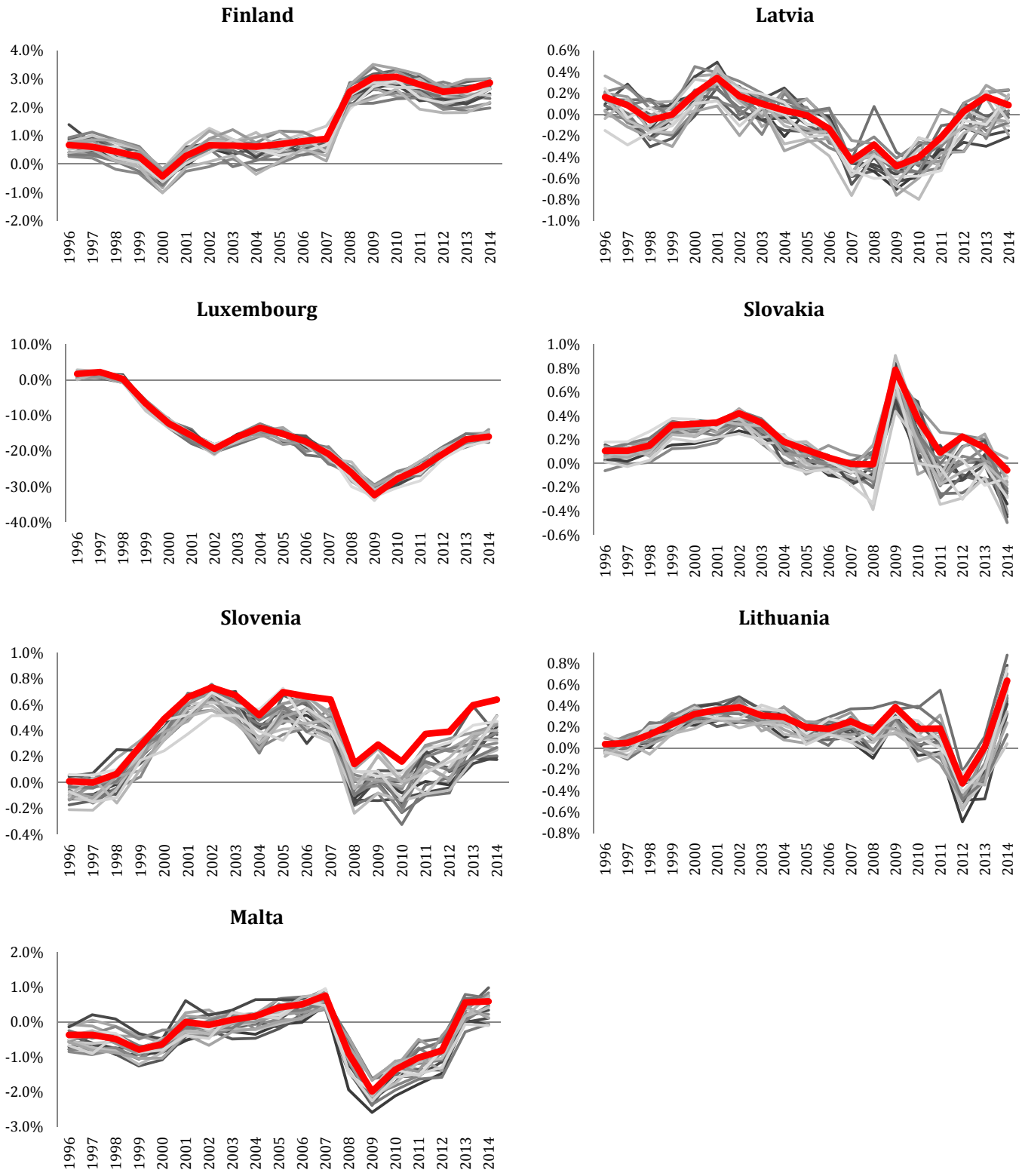
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014



Note: simulations based on assumption that each value of x_{ijt} is subject to a random uniformly-drawn revision between -10% and +10%

Appendix A: Additional tables

Table A.1. Herfindahl index and transfers

Country	Average Herfindahl Index	Average absolute value of transfers, % GDP
AT	0.0404	0.10%
BE	0.0437	0.22%
EE	0.0750	0.16%
FI	0.0822	0.32%
FR	0.0370	0.08%
DE	0.0381	0.12%
GR	0.0605	0.12%
IE	0.0928	0.79%
IT	0.0440	0.10%
LV	0.1764	0.13%
LU	0.2026	3.34%
NL	0.0640	0.24%
PT	0.0530	0.09%
SK	0.0408	0.14%
SI	0.0512	0.13%
ES	0.0414	0.05%
CY	0.1122	0.69%
LT	0.0788	0.14%
MT	0.0815	0.40%

Note: correlation between the two columns is 0.734.

Table A.2. Tax rate used for transfers based on tax revenues.

	Total receipts from taxes and social contributions (including imputed social contributions) after deduction of amounts assessed but unlikely to be collected, in % of Eurozone GDP
1995	39.9
1996	40.5
1997	40.8
1998	40.6
1999	41.1
2000	40.6
2001	39.8
2002	39.4
2003	39.4
2004	39.1
2005	39.3
2006	39.7
2007	39.8
2008	39.4
2009	39.1
2010	39.0
2011	39.5
2012	40.6
2013	41.2
2014	41.3

Table A.3. Re-aggregation of sectors in Subsection 6.2

Original sectors	Re-aggregation
(1) Agriculture, hunting, forestry and fishing	(1) Agriculture and mining
(2) Mining and quarrying	
(3) Food products, beverages and tobacco	(2) Food, beverages and tobacco
(4) Textiles, textile products, leather and footwear	(3)Textiles, textile products, leather and footwear
(5) Wood and products of wood and cork	(4) Wood and paper products
(6) Pulp, paper, paper products, printing and publishing	
(7) Coke, refined petroleum products and nuclear fuel	(5) Chemicals and non-metallic mineral products
(8) Chemicals and chemical products	
(9) Rubber and plastics products	
(10) Other non-metallic mineral products	
(11) Basic metals	(6) Basic metals and fabricated metal products
(12) Fabricated metal products except machinery and equipment	
(13) Machinery and equipment n.e.c	(7) Machinery and equipment n.e.c
(14) Computer, electronic and optical products	(8) Electrical and optical equipment
(15) Electrical machinery and apparatus n.e.c	
(16) Motor vehicles, trailers and semi-trailers	(9) Transport equipment
(17) Other transport equipment	
(18) Manufacturing n.e.c; recycling	(10) Manufacturing n.e.c; recycling; energy
(19) Electricity, gas and water supply	
(20) Construction	(11) Construction
(21) Wholesale and retail trade; repairs	(12) Wholesale and retail trade, repairs, hotels and restaurants
(22) Hotels and restaurants	
(23) Transport and storage	(13) Transport, storage, post and communication
(24) Post and telecommunications	
(25) Finance and insurance	(14) Finance and insurance
(26) Real estate activities	(15) Real estate, renting and business activities
(27) Renting of machinery and equipment	
(28) Computer and related activities	
(29) Research and development and other business activities	
(30) Public admin. and defence; compulsory social security	(16) Community and social services
(31) Education	
(32) Health and social work	
(33) Other community, social and personal services	

Appendix B:

Condition for invariance to sectoral divisions in the case of three sectors

Here we show formally for the case of three sectors under what conditions the aggregation of two of the three sectors leaves the transfers unaltered. Denote the sectors by A, B and C. Based on (2) we have

$$T_{ijt}=\left[\frac{x_{i,t-1}}{X_{t-1}}-w_{ij,t-1}\right]\Delta X_{jt}$$

where j is A, B or C denotes the sector. Consider the case in which sectors A and B are aggregated into a single sector AB. Note that the aggregates x_{it} and x_t are not affected by this change. We have:

$$\Delta x_{ABt}=x_{ABt}-x_{ABt-1}=(x_{At}+x_{Bt})-(x_{At-1}+x_{Bt-1})=\Delta x_{At}+\Delta x_{Bt}$$

$$w_{iABt}=\frac{x_{iAt}+x_{iBt}}{x_{At}+x_{Bt}}\neq w_{iAt}+w_{iBt}.$$

Hence, the transfers are:

$$T_{iABt}=\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{iAB,t-1}\right](\Delta x_{At}+\Delta x_{Bt})$$

$$T_{iCt}=\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{iC,t-1}\right]\Delta x_{Ct}$$

$$T_{it}=T_{iABt}+T_{iCt}$$

Since T_{iCt} remains the same, to keep T_{it} unchanged requires $T_{iAt}+T_{iBt}=T_{iABt}$, which is written as:

$$\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{iAB,t-1}\right](\Delta x_{At}+\Delta x_{Bt})=\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{iA,t-1}\right]\Delta x_{At}+\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{iB,t-1}\right]\Delta x_{Bt}\Leftrightarrow$$

$$\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{iAB,t-1}\right]\Delta x_{At}+\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{iAB,t-1}\right]\Delta x_{Bt}=\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{iA,t-1}\right]\Delta x_{At}+\left[\frac{x_{i,t-1}}{x_{t-1}}-w_{iB,t-1}\right]\Delta x_{Bt}$$

$$\Leftrightarrow w_{iAB,t-1}\Delta x_{At}+w_{iAB,t-1}\Delta x_{Bt}=w_{iA,t-1}\Delta x_{At}+w_{iB,t-1}\Delta x_{Bt}$$

Hence,

$$w_{iAB,t-1}=\frac{w_{iA,t-1}\Delta x_{At}+w_{iB,t-1}\Delta x_{Bt}}{\Delta x_{At}+\Delta x_{Bt}}$$

Clearly, this will not necessarily hold in any given year. However, let us assume that, on average, x_{At} and x_{Bt} will move together, so that $\Delta x_{At}=\Delta x_{Bt}$. Note that this is not a strong assumption, especially if the sectors are very similar to each other, which is indeed the reason why one would aggregate them together in the first place. If this holds, then the above equation is reduced to:

$$w_{iAB,t-1}=\frac{w_{iA,t-1}+w_{iB,t-1}}{2}.$$

This can be rewritten as:

$$\frac{x_{iA,t-1}+x_{iB,t-1}}{x_{A,t-1}+x_{B,t-1}}=\frac{x_{iA,t-1}}{2x_{A,t-1}}+\frac{x_{iB,t-1}}{2x_{B,t-1}}$$

Hence, after rearranging:

$$x_{iA,t-1}x_{A,t-1}x_{B,t-1}+x_{iB,t-1}x_{A,t-1}x_{B,t-1}=x_{A,t-1}^2x_{iB,t-1}+x_{B,t-1}^2x_{iA,t-1}.$$

This is an identity if $x_{A,t-1}=x_{B,t-1}$, i.e. if the two sectors are of the same size at the Eurozone level.

Summarizing, the above results suggest that our transfer scheme is robust to alternative ways of aggregating the sectors, provided that the sectors that are aggregated are of equal size at the Eurozone level and provided that they have a similar growth pattern, i.e. they are affected by the same shocks. The more the aggregation diverges from these criteria, the more the resulting transfers will be affected by the change in aggregation.

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