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Keyword: Inequality, Global modelling, international interdependencies, income inequality, Europe.

JEL Cassification: C32, E52, I30

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1 Introduction

> "*This is how the other half live, I would like to get one of these people and just say 'Look, this is how the other half live.' I don't think they would last a day. They don't realise what is happening in the real world. They are in a little world of their own.* Unemployed man, London, 2013[1]"

The issue of inequality is one of the major continuing problems facing developmental economics and it is set to stay at the top of the global debate. While Europe is now beginning to shake off the after effects of the Eurozone debt crisis, income inequality has increased in two thirds of member states, particularly in Slovenia, Greece, France, Italy, Estonia, Slovakia, Ireland, Cyprus and Spain (in ascending order). The fiscal consolidation programmes that numerous EU countries have introduced are likely to exacerbate the situation in the short and medium run (Mulas-Granados 2005; Brinca *et al.* 2017). High and rising inequality damages our societies, reducing social cohesion and political coherence as well as affecting the prospects for future economic growth. There is a real danger of a self-reinforcing cycle establishing itself in Europe, comprised of a growing inequality of opportunity (education and skills, access to employment, healthcare and affordable housing) leading to a weakening of economic growth and greater inequality.

There are important longitudinal and spatial dimensions of this cycle; advantages and disadvantages (particularly indebtedness) are transmitted over time, from generation to generation (Corak, 2013). They are also transferred spatially as places compete and regions become locked into path-dependencies determined by relative attractiveness, skills, infrastructure and investment. The importance of directing attention to the problem of inequality has been highlighted by recent publications, such as the World Bank (2016), Atkinson (2015), and Piketty (2013), and by the two headline targets identified in the EU's 2020 strategy to combat inequality and lift 20 million people out of poverty. Reducing the growing income gap between the rich and poor regions is vital if poverty is to be reduced faster (World Bank, 2016). There are several dynamics in an integrated Europe that are driving up levels of inequality. The debate about the need for European arrangements for tackling welfare reform is intensifying in the literature as well as in the policy arena. It is argued that solidarity requires that the disparities between the EU regions be reduced, and that support for further European integration will be eroded if integration itself creates a growing income gap between the rich and poor regions.

Most of the debates on the EU integration process and regional development continue to be framed from a narrowly national point of view, with little attention given to the diffusion of mutual policies for economic welfare and the diffusion of mutual rules affecting market behaviour. At an empirical level there are research gaps around the effects of European integration on income distribution, and what little work there is does not focus explicitly on analysing the effects on cross-country income disparities through all the transmission channels including migration, trade and finance jointly. Either these channels are not well understood or they have not been dealt with in depth because of methodological difficulties or data constraints. There are major methodological challenges in evaluating income inequality in the European Union, since much of the existing literature focuses only on national trends, excluding the redistributive role played by central governments and to some extent the EU.[2] European countries differ

[1] Lansley and Mack, *Breadline Britain*, 2015, p.175

[2] See, for example, Forster *et al.* (2005), and Beckfield (2006).

significantly in the mixture and size of benefits they provide, and each has its own attitude to the level and breadth of out-of-government transfers. Analysis should take account of how social transfers alleviate inequality in different member states. To prioritise interventions and develop a more effective strategy for reducing inequality and poverty, it is necessary to take into consideration the multifaceted channels operating in an integrated Europe to analyse how income inequality has been shared among countries over time, and how macro policies have affected growing disparities between different income groups. Also, it is vital to analyse the dynamics driving up inequality across Europe as a whole since they have both internal and external country components; levels of economic development vary between countries and there is income inequality within countries.

The complexities of multidimensional, longitudinal and spatial interdependencies between regions needs to be understood in combination with a more robust knowledge about the redistributive effects of different government policies. Achieving this overarching goal will provide both individual national governments and supra-national organizations such as the EU a better basis for intervening in their economies to reduce inequality. Our proposed approach (in a new variable denoted here as MQ) by building on the work of Malul *et al.* (2013), departs from the traditional literature by including the redistributive impact created through benefits-in-kind. With this in mind, this paper uses a rich multi-country dataset to empirically examine the combined effect of multiple transmission channels operating in the EU.

As an econometric strategy that can bring evidence to bear on these questions we use the recently developed Global VAR (GVAR) approach (Pesaran *et al.* 2004; Pesaran and Smith, 2006), which allows rich and flexible modelling of macroeconomic interdependencies across countries, while keeping dimensionality controllable. This is important for empirically examining the consequences of policy transmissions between member states given the EU's recent efforts to strengthen regional integration. More importantly, this methodology allows the impact of rising economic inequalities in EU countries to be evaluated while avoiding all the limitations that arise from the use of single VAR models providing a consistent and flexible framework for checking the intensified interdependencies by linking the countries using a novel, multidimensional linking approach. The novelty in linking countries is achieved by including trade weights while also accounting for the impact generated through bilateral migration flows, geographical proximities and financial linkages. Our dataset comprises quarterly macroeconomic, financial and welfare variables from 18 developed and developing European economies over the period $1996Q1 : 2012Q1$, covering, where available, for each country GDP, short term interest rates, and our newly developed modified inequality indicator. Each country-specific model is linked by foreign variables that are the weighted averages of the variables of all the other countries. The weights are determined by the bilateral exposures of each country to the other countries through trade, migration and financial linkages as well as geographical proximities.

This paper makes four main contributions. First, we add to the empirical literature on income inequality spillovers *(international spillovers and inequality)*. To the best of our knowledge no other scholars have measured cross-border income disparities in this way. We measure *income inequality interdependencies* between European countries in a way that addresses the limitations of the uni-dimensional interdependency approach by providing an in-depth analysis of multifaceted interdependencies across member states. We address the transmission in developments in inequality and find that spillover processes for income dispersion are in operation at both the national and the EU levels.

Second, to improve the accuracy of the measurement of inequality, we suggest a shift towards a more meticulous definition of inequality that allows the evaluative space to be widened by the inclusion of in-kind benefits provided by states by building upon the work of Malul et *al.* 2013 *(modified measurement of inequality).* Although the size of in-kind redistributions can vary greatly across countries and might have substantial implications for inequality (Malul *et al.*, 2013), this factor is largely neglected by existing inequality metrics that overlook the redistributive role played by central governments. Based on the results of empirical analysis, the proposed modification shows a differentiated degree of response within the sample where some countries display greater sensitivity to the inclusion of benefits in kind in the measurement of inequality. From an empirical point of view, we gain more meaningful quantitative assessments in terms of inequality rankings as well as a more holistic understanding of income distribution supplemented with an analysis of in-kind benefits system.

Third, this paper proposes a novel multidimensional weighting approach that is intended to provide an in-depth analysis of multifaceted interdependencies across member states. We introduce a new scheme of inter-country links, combining bilateral trade exposures, financial exposures, geographical proximity and bilateral migration flows. Capturing multidimensional exposures in a GVAR not only reflects the actual depth of interlinkages among member states, but fits the data better than if only trade weights are used. This goes beyond most previous studies that have identified international transmission mechanisms in multi-country models, but have failed to address multidimensional exposures across economies. Recent GVAR studies of international dynamics only capture cross country dynamics through trade weights (e.g. Dees *et al.*, 2007), or through weights constructed from asset-side exposures alone (e.g. Beaton and Desroches, 2011; Chen *et al.*, 2010). Other GVAR studies rarely test alternative schemes that include both trade and financial weights (e.g. Eickmeiner and Ng 2015). The benefits of introducing multifaceted interdependencies into a global modelling framework are more than just the addition of realism. First, the empirical heart of the paper produces the agglomerative forces that can lead to a core-periphery pattern through backward and forward multidimensional linkages. Second, it serves to improve our understanding of a deeper integration of distributional issues. This is crucial in any attempt to design a directly applicable framework consisting of a set of policy recommendations that can be used in deciding what should remain on the to-do list for a more effective inequality reduction strategy to be developed.

Fourth, we add to the empirical literature on dynamics between economic performance, monetary policy and modified income inequality *(linkages between inequality, economic growth and monetary policy).* The current literature on European economies is limited and is focused on a small number of countries or regions with no attention paid to potential contagion mechanisms. This is because of the technical challenge in multi-country models of potentially there being many more variables and parameters than observations. We tackle this challenge by an econometric strategy that allows rich and flexible modelling of macroeconomic interdependencies across countries, while keeping dimensionality controllable. Key results of our analysis show the distinctive patterns of response to global shocks to real output and their specificities by type of economy within the EU. We similarly elaborate on the spillovers and *ripple effects* of inequality shocks between differentiated groups of EU economies. In addition, our results also show that monetary policy shocks affect income distribution relatively rapidly and that they can even get amplified via international linkages.

The remainder of this paper is structured as follows. Section 2 provides the importance and rationale for developing the modified inequality measure. Section 3 explains: a) our dataset and the model and b) our approach on multidimensional linkages. Section 4 presents the results of the dynamic GVAR analysis. Finally, concluding comments and policy implications are given in Section 5.

2 Measuring inequality using Modified Inequality Ratio

It has long been appreciated that theory is silent on how the normative roles played by social transfers can reduce income inequality. However, as Sen (1977) advocated more than 40 years ago in his pioneering contribution to measuring inequality, underlying any wellbeing measure is an ample perception of social welfare that should be of interest to scholars. Indeed an operative government-run social protection scheme is an important aspect of any modern community that seeks a defined form of social justice. Stack (1978) evaluated the consequences of active direct government involvement in the economy and identified that it was highly associated with lower income inequality whatever the level of development. This is mainly because social transfers affect the wellbeing of households considerably by increasing it substantively for the poorest and by narrowing the gap between rich and poor by altering the dynamics of wealth.

In the European context, benefits and well-targeted transfers can alleviate income inequalities significantly, reducing the Gini index of the 27 member states by an average of 20 points.[3] It is worth noting, however, that European countries differ significantly in the mixture and size of the benefits they provide, and each has its own attitude to the level and breadth of its out-of-pocket payments for public services. Cash transfers are more universal and taxes are not very progressive for example in the most egalitarian member states, such as the Scandinavian countries and Switzerland. The same holds true for Belgium, Estonia, Finland, France and Italy where taxes and transfers are not particularly progressive. In a similar vein, Aaberge *et al.* (2010) analyse the distributional impact of public services in European countries and found that increasing levels of non-cash benefits to households helped to reduce inequality. They show that about half of welfare state transfers in developed European countries are in-kind benefits such as health insurance, education and other public services. All of these would also reflect in the conditions to promote economic growth.

Studies that have explored the broader redistributive impact of transfers have arrived at similar conclusions. Oxley *et al.* (2009), in the most authoritative work of its kind, demonstrated that most European countries achieve better efficiency[4] by channelling social transfers toward low-income groups. Government transfers to households through additional social outreach measures can work together producing synergies so that in-kind benefits can be intended to create an egalitarian impact on income distribution, even though they vary considerably in volume between countries (Malul et al, 2013).

There are several transfers that can affect income inequality, while others deliver benefits more progressively. For example, cash allowances for children appear to be more effective in combating child poverty if they are accompanied by in-kind child support (Daria 2014). This approach is particularly relevant for developing European countries, where the child allowance budget or childhood development services are limited. Only a handful of the dozens of successful examples of well targeted benefits in kind need be cited.[5]

[3] Avram, Levy, and Sutherland (2014); De Agostini, Palaus, and Tasseva (2015).

[4] That is, poverty is reduced to a greater degree for every additional Euro spent.

[5] See among others: Kazianga, 2015; Fizsbein and Schady; 2009, Maluccio and Flores, 2005; Heady *et al.* 2001; Wang *et al.*, 2011; Caminada *et al.*, 2001, and Soares *et al.*, 2001; Lustig *et al.*, 2016; Wolf *et al.*, 2016.

Although the size of in-kind redistributions may have considerable consequences for inequality, it is largely neglected by income inequality metrics such as the Gini index and the income quintile ratio[6]. This means that earlier studies, based on traditional indicators may methodically overestimate the degree of inequality, and especially so for countries with public sectors which are more efficient at providing in-kind benefits. This is so because they do not account for the redistribution generated by governments and are, therefore, biased towards the upper quintile of the income distribution. Thus, the differences in the benefit systems mean the traditional assumption of uniformity in measurement of inequality can generate misleading and incomplete results, particularly in relative rankings of inequality. For these reasons, the redistribution generated by social transfers should not be seen as a separate issue from the broader problem of inequality.

The measurement approach used in this paper takes the criticisms on both the Gini coefficient and the s80/20 ratio into account and formulates an alternative solution that advances the work of Malul *et al.* (2013) and departs from the traditional literature by including the redistributive impact created through benefits-in-kind (see Appendix A for a detailed derivation of this modified measurement.). Our proposed solution advances the methods of Malul's modified Gini index by using the income quintile share ratio to measure the actual depth of distributional inequalities in the European Union for two reasons. First, the s80/s20 ratio methodology is a widely accepted measurement of inequality in European countries that accounts for the sensitivity of inequality to changes in the tails rather than in the top ends of the distribution and is in line with the official statistics and data series from Eurostat.

In the fields of studies on inequality, the Gini index has been criticised on several critical grounds and could not be discussed in depth due to space considerations. Examples of established and contemporaneous accounts are found in Wade (2014),and Ravaillion and Chen (1997) and, among alternative measurements, the s80/s20 is adopted by both researchers and practitioners to the extent of constituting one of the standards used in official statistics by Eurostat, with series dating back to 1995[7]. It is worth noting that this study is not about comparing the Gini index and quintile ratio (either in their conventional or modified calculations). Our study, however, is not intended to immerse again into the recurrent discussion comparing measurements of inequality but rather to take a step forward and focus on the relevance of including benefits in-kind in relative rankings of inequality.

The newly developed technique employs a sequential solution approach to incorporate the approximate effect of benefits-in-kind into the measurement of inequality (Malul *et al.* 2013). Like the ratio for the inequality of income distribution, the modified inequality ratio is defined as the relative size of the corresponding area of the Lorenz curve, but with in-kind benefits added. All incomes are compiled as equalised disposable incomes that include all market and non-market income.

In Figure 1 we represent the modified inequality rankings that result from the proposed modification *vis-a-vis* the traditional S80/S20 ratio in European countries.[8]

[6]The income quintile share ratio (Langel and Tille 2011) is defined as $L(0.80)/L(0.20)$, or the ratio of the total income of the 20 per cent of households with the highest values relative to the median and the 20 per cent with the lowest values, and the ratio curve $\dfrac{1-L(0.80)}{L(0.20)}$.

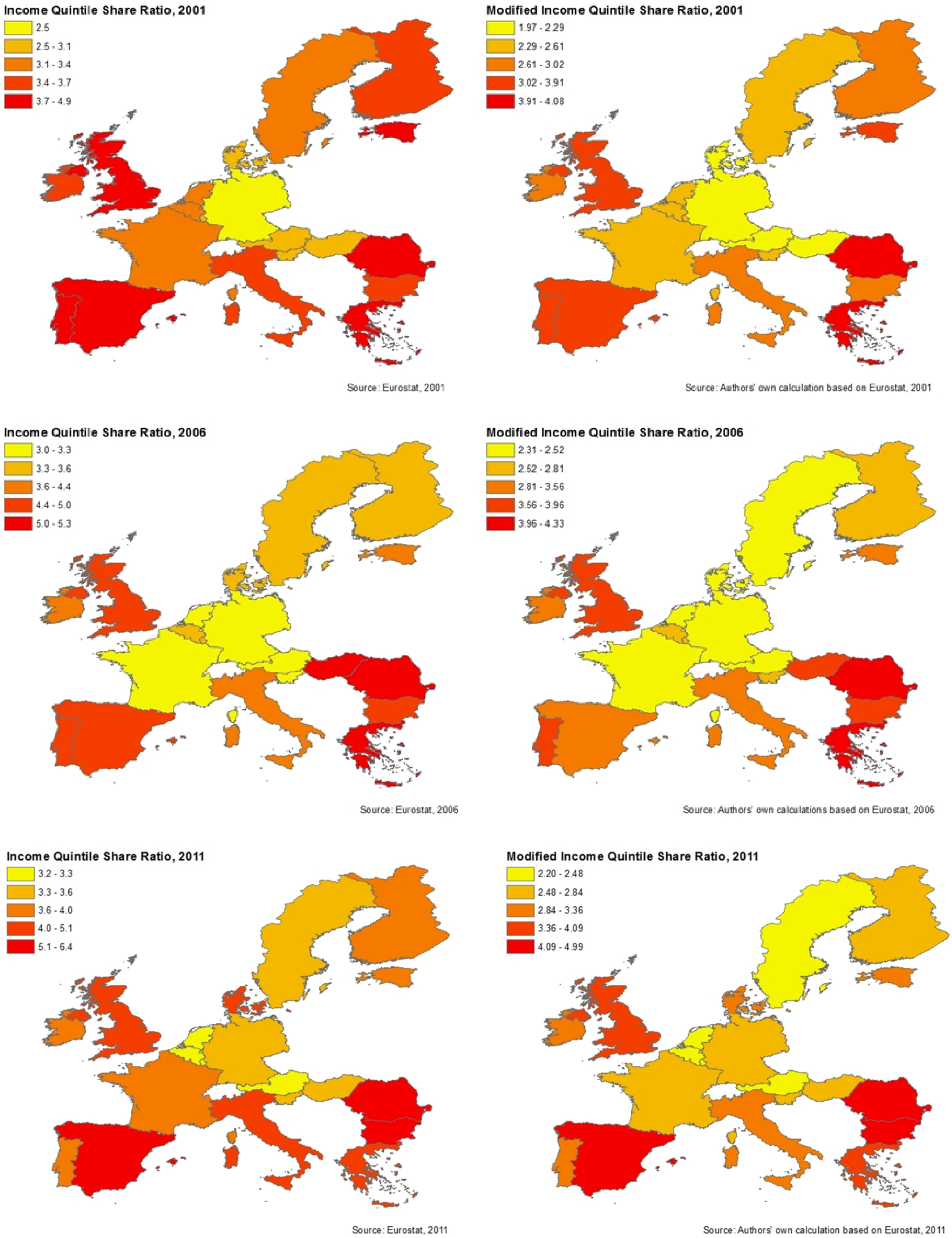
[7]See `http://appsso.eurostat.ec.europe.eu/nui/show.do?dataset=ilspns4&lang=en`

[8]Using geographic information system (GIS), natural breaks (jenks) categories are built on natural groupings inherent to the data. Class breaks are identified that best group similar values and that maximise the

We observe that there is a differentiated degree of response to benefits in kind within the sample and, consequently some countries show greater sensitivity to their inclusion in the measurement of inequality through the reflection of governments' redistributive role played by the means of provision of social transfers. This is a consequential finding to build on as it reveals specific implications of including benefits in kind in the measurement of inequality in European countries which would translate into actual changes in their inequality rankings. For instance, in 2001, it can be observed that with the modified approach Austria, Italy, Bulgaria and Romania would move up in terms of income distribution. Similar results appear in the cases of France, Portugal, Germany and Austria in 2001 and in Spain, Sweden and Hungary in 2006. In 2011, we can see that the rankings of Spain, France and Bulgaria improve significantly because these countries provide a considerably larger quantity of in-kind benefits to the public. According to the modified inequality ratio, Germany is the country with the lowest inequality in income distribution throughout the analysed time horizon whereas, according to the standard income quantile share ratio, Denmark appears as the most egalitarian state.

dissimilarities between groupings.

Figure 1: Comparison of traditional vs modified measurements of inequality in Europe: Changes in inequality rankings 2001-2011.



3 The GVAR model and identification

3.1 Data and VARX setup

Our dataset comprises quarterly macroeconomic, financial and welfare variables from 17 developed and developing European economies over the period 1996Q1:2012Q1 covering, where available, GDP, short term interest rates, at risk poverty population share and social exclusion rates, and our newly developed modified inequality indicator. In the GVAR structure, each country-specific model is linked by foreign variables that are weighted averages of the variables of all the other countries. The weights are determined by the bilateral exposures of each country to each other through trade, migration and financial linkages as well as geographical proximities (see details in section 3.3 below).

A GVAR is a set of linked country VARX models and is a widely used, clearly defined and well-validated modelling framework for analysing the dynamics of spillovers. The GVAR framework has significant advantages for the analysis of simultaneous, asymmetric interdependencies within a system. We use the properties presented in Pesaran *et al.* (2005), as they offer the most intuitive interpretation. The model consists of two stages. First, each country is modelled individually as a small open economy by estimating a country specific vector error correction model in which the domestic macroeconomic variables $\mathbf{x}_{it}$ are related to country-specific foreign variables $\mathbf{x}^*_{it}$. Second, a restricted reduced form global model is built by stacking the estimated country-specific models and linking them through a matrix of cross-country multidimensional interdependencies.

Our empirical framework covers seventeen European countries, accounting for nearly 35 per cent of global output. These countries are classified responding to two key factors relevant to our discussion: 1) aggregate income represented by the Gross Domestic Product with Purchasing Power Parity valuation (Eurostat) and 2) income quintile ratios (Eurostat) as their comparative levels of inequality.

Table 3.1: Country Groups

Highly Vulnerable	**Unbalanced**	**Leading**
Hungary	France	
Estonia	United Kingdom	Denmark
Greece	Ireland	Luxembourg
		Austria
Vulnerable	**Balanced**	
Spain	Sweden	
Portugal	Netherlands	
Italy	Finland	
	Germany	
	Belgium	

Note: Author's own classification based on GDP-PPP rankings and income quintile share ratios drawn on Eurostat tables. For further information: (i) `http://ec.europa.eu/eurostat/web/gdp-and-beyond/quality-of-life/s80s20-income-quintile` (ii) `http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00114&plugin=1`

The emphasis on the relationship between EU integration and inequality gives country grouping *a double focus*. We particularly focus on a two stage procedure as a step towards forming country groups building upon structured evidence based literature and empirical evidence. First, forming country groups sharpens the focus of interactions while *keeping the dimensions of the model under control.* Our framework consists of 17 European countries and for every country specific equation, we take into account a historical quarterly dataset covering 16 recent years as well as the weighting variables based on every countries' interdependencies with the rest of countries in terms of import and export volumes, inward and outward migration flows, geographical proximities as well as international inward and outward financial exchanges. Thus, this inevitably leads to a high dimensional model. One of the main aims of forming country groups is to effectively link all the countries like pieces of a big puzzle whilst paying particular attention to income disparities between them.[9] Second, more importantly, this perspective lets us *focus on the actual state of income disparities within similar sized economies* while *ensuring that there are no substantial differences within the groups* (see Table 3.1). Therefore, as a first cut-off, we analyse country positions by GDP-PPP rankings. A second cut is to analyse the actual level of inequality within these individual countries.

The groupings are as follows: the first group consists of *Highly Vulnerable* countries where there has been a significant negative impact on overall income distribution. This group contains Greece, Hungary and Estonia. The *Vulnerable* group is Portugal, Italy and Spain, three Southern European countries where a clear similar upward trend for inequalities can be observed. France, the United Kingdom and Ireland constitute the third group, the *Unbalanced European* group, since income inequality is among the highest in these developed countries. The *Balanced European* group consists of Sweden, Finland, Germany and Belgium, which have managed to maintain sustainable growth rates though their level of income inequality is higher than that of the *Leading European* group. Finally, at the most egalitarian end is the Leading European group that consists of the Netherlands, Denmark, Luxembourg and Austria.

The models are estimated over the period 1996Q1:2012Q1, which includes the *2008/09* global recession, the Eurozone collapse, and a few quarters of the global recovery. The dataset comprises quarterly macroeconomic, financial and welfare variables from seventeen developed and developing European economies, covering, where available, for each country real GDP to reflect the impact of overall economic performance, gdp_{it}, the rate of inflation $\Pi_{it} = ln(CPI_{it}/CPI_{it-1})$, sr_{it}, the short-term rate of interest in per cent per annum (a three-month rate) to include the impact of monetary policy, the rates of risk of poverty and social exclusion to reflect the extent of material deprivation pov_{it}, and our newly developed modified inequality indicator mq_{it} for a credible evaluation of the adjusted socially inclusive aspect. We explore and address the dynamics between inequality and all the components of the GVAR framework throughout the paper starting with Section 3.1 with references to literature and authoritative works of their kinds. In addition to this, the dynamics between the variables of interest and the logic behind their inclusion supplemented by interpretations of such relationships can also be found throughout the Dynamic Analysis section. All country models cover the same set of variables where the data are available (see Appendix B). As a function of data availability, some components of the analysis use slightly different samples, so for example, the analyses of modified income inequality exclude Greece, Hungary and Estonia. Equally, the analysis does not extend past 1996 because there are missing data for some of the key variables.

[9] For alternative regional specifications see: Galesi and Sgherri (2009), Chudik and Fratzscher (2011), and Cakir and Kabundi (2013).

Each country-specific model is linked to foreign variables that are the weighted averages of the variables of all the other countries. The weights are determined by each country's bilateral exposures to the other countries through trade, migration and financial linkages as well as geographical proximity.[10]

3.2 VARX models: Country specific VAR models with weakly exogenous variables

Each country i is denoted by a vector autoregressive model for vector: $\mathbf{x}_{it} = [gdp_{it},\ \Pi_{it},\ sr_{it},\ mq_{it},\ pov_{it}]$ augmented by a set of weakly exogenous variables $\mathbf{x}^*_{it}$.

The individual country VARX*(p_i, q_i) model for the ith economy is defined as below. For $i = 1, 2, ..., 17$ where $\mathbf{x}_{it}$ is the $k_i \times 1$ vector of domestic variables, $\mathbf{x}^*_{it}$ represents the $k^*_i \times 1$ vector of country specific foreign variables, where $w_{ij} = 1, , ..., 17$ are the set of multidimensional weights -as will be explained further in details- affiliated with the foreign variables. u_{it} is a vector of idiosyncratic country specific shocks which are serially uncorrelated with mean 0 and a non-singular covariance matrix. Main objective is to model country-specific variables for $\mathbf{x}_{it}$ vector, in course of time $t = Q_1, ..., Q_{64}$, and among all 17 countries.

$$\varphi_i(L, p_i)\mathbf{x}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1}t + \Lambda_i(L, q_i)\mathbf{x}^*_{it} + u_{it} \tag{3.1}$$

$$\mathbf{x}^*_{it} = \Sigma^N_{j=1} w_{ij}\mathbf{x}_{jt} \tag{3.2}$$

Countries are notated by $i = 1, 2, ..17$. $\mathbf{a}_{i0}$ and $\mathbf{a}_{i1}t$ are, the coefficients of deterministics, respectively, intercepts and linear trends, and $\mathbf{u}_{it}$ is the idiosyncratic country specific shock. The vector of foreign country-specific variables, $\mathbf{x}^*_{it}$, plays a central role in the model. As will be discussed shortly, for each time t, this vector is identified as the weighted average across all corresponding $\mathbf{x}_{it}s$ in the model. Furthermore, L is the lag operator and p_i and q_i are the lag orders of the domestic and foreign variables of the i^{th} country. For estimation purposes $\varphi_i(L, p_i)$, and $\Lambda_i(L, q_i)$ can be treated as unrestricted. It is beyond doubt that their political and economic role gives advanced countries a considerable influence on the European region. However, it would appear somewhat artificial to assign any country a leading role in analysis of the patterns of distributional disparities in the EU, whether at the national or the regional level. So in terms of the integrated European economy, no country is considered as an origin economy and all endogenous variables remain active as domestic variables. In a more conventional form, for country i, abstracting from deterministics and high order lags, consider the VARX*$(1, 1)$ structure:

$$\mathbf{x}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1}t + \Phi_{i1}x_{i,t-1} + \Lambda_{i0}\mathbf{x}^*_{it} + \Lambda_{i1}\mathbf{x}^*_{i,t-1} + \mathbf{u}_{it} \tag{3.3}$$

Note that, each country model is augmented with country specific foreign variables $\mathbf{x}^*_{it}$, constructed using country specific multidimensional weights $\mathbf{w}_{ij}$, $j = 0, 1, ..., N$ that capture the importance of country j for country i's economy, and are calculated in the form of country-specific weighted averages of the corresponding variables of other European countries. Lag orders of domestic and country specific foreign variables VARX*$(p_i,\ q_i)$, are selected based on Akaike information criterion (AIC).[11] As shown in Dees *et al.* (2007), country specific VARX

[10] For more information: Guio, 2005; Eurostat, 2015.

[11] Please note that, p_i, q_i do not have to be the same. The lag order of the GVAR, denoted by p, is given by $p = max(maxp_i,\ maxq_i)$ across all i.

models as in equation (3.1) can also be written as VECMX* in its error correction form where x_{it} and x^*_{it} are integrated of order one. The estimation procedure for these error correcting models allows for unit roots and was pioneered by Johansen (1992). The error correction form of the VARX*(2, 2) *et al.* (2005) model, is given by

$$\Delta x_{it} = c_{i0} - \alpha_i \beta_i^{'} [z_{i,t-1} - \gamma_i(t-1)] + \Lambda_{i0} \Delta x^*_{it} + \Gamma_i \Delta z_{i,t-1} + u_{it} \tag{3.4}$$

where $z_{it} = [x_{it}^{'}, x_{it}^{*'}]^{'}, \alpha_i$ is a $k_i \times r_i$ matrix of rank r_i and β_i is a $(k_i + k^*_i) \times r_i$ of rank r_i. That is, the number of cointegration relationships in the specification, the VECMX*(1, 1).[12] model, is given by

$$\Delta x_{it} = c_{i0} - \alpha_i \beta_i^{'} [z_{i,t-1} - \gamma_i(t-1)] + \Lambda_{i0} \Delta x^*_{it} + \Gamma_i \Delta z_{i,t-1} + u_{it} \tag{3.5}$$

where $z_{it} = [x_{it}^{'}, x_{it}^{*'}]^{'}, \alpha_i$ is a $k_i \times r_i$ matrix of rank r_i and β_i is a $(k_i + k^*_i) \times r_i$ of rank r_i.[13]

3.3 Redefining European linkages: an innovative proposal

3.3.1 Connectedness and rationale for multi-dimensional linkages

The past two decades have shown that the convergence process at the European level may be accompanied by increasing disparities in the levels of regional inequality, development and competitiveness within the European states (Petrakos, 2008). At the regional level in particular, the evidence in the literature seems to have moved steadily away from the common, shared euphoria in the convergence models of the 1990s (Barro and Sala-i Martin, 1992; Mankiw *et al.*, 1992) to the more divergent findings in the 2000s (Martin, 2001; Rodriguez Pose and Fratesi, 2004). In the realm of theory, such findings have added their weight to old and new discussions about the link between growth, connectedness, and income inequality.

The European economies are intensely interconnected. The trade in goods between EU Member States was 78 per cent larger in 2016 than the flow of exports leaving the EU-28 to non-member countries. Around 63.8 per cent of imports to members of the European Union came from other EU countries, and 66.7 per cent of their exports went to other EU member states. Equally only 17 per cent of the debt and equity securities of the Eurozone were held by external investors in 2016 (European Central Bank, 2015). Common legal spaces have also contributed to this strong regional integration and the predictability of legal decisions associated with this is a major requirement for cross-border investment. It is no coincidence that from 1999:2003, 68 per cent of the European Union's foreign direct investment flows were directed to other EU countries *(EU, 2005:Foreign Direct Investment Yearbook, p.22)*. It follows that the integration of European markets and the standardisation of basic legal conditions make it more likely that the EU can help reduce the distributional disparities between nations. Such benefits may stem from the free trade effect, the customs union effect, the common market effect or the economic and monetary union effect.

However, most of the debates on the process of EU integration and regional development continue to be framed from a narrowly national point of view, and little attention is given to the diffusion of policies for economic welfare and the wide range of rules designed to affect market

[12]Detailed derivations are not presented here due to space considerations. For more details, see Dees *et al.* (2005).

[13]That is, the number of cointegration relationships in the system.

behaviour. Indeed the idea that the regulation and integration of European goods, finance, and labour markets is homogeneous should be viewed with a more sceptical attitude, as should the suggestion of supranational coordination and harmonisation of national social policies. Along these same lines, a number of recent works on economic inequalities in Europe have discussed in depth the negative effect of increased income inequality that can come from a process of integrated activity in core areas that is driven by the economic cycle. In the European context, such concentrated economic activity is associated with the current variations in levels of growth in technology and human capital, differences in productive efficiency within countries, ease of access to major European markets, and the degree of periphericity (De la Fuente and Vives 1995; Rodriguez-Pose 1998; Stockhammer 2015; Artelaris and Petrakos 2016). It is therefore crucial to analyse in depth how the connectedness through the Single European Market (SEM) and the Economic and Monetary Union (EMU) affects patterns of income distribution highlighting the outcomes of economic integration for labour, finance and trade, and of political integration for the welfare states that are deeply embedded in the regional European economy.

Remainder of this section is devoted to the clarification of the nature, relevance and complementarity between the components of the proposed multidimensional weighting scheme. We crucially analyse how the connectedness through the Single European Market (SEM) and the Economic and Monetary Union (EMU) affects patterns of income distribution highlighting the outcomes of economic integration for labour, finance and trade, and of political integration for the welfare states that are deeply embedded in the regional European economy. As a part of this process, we explore the exposition of each component and outline the rationale for using trade, finance, migration and geographical proximity weights in a combined scheme representing and measuring international sources of exposure to economic and financial shocks. Each subsection provides evidence from European countries based on statistics from EUROSTAT as well as previous studies that focus on the relative importance of each separate dimension with EU context.

3.3.2 Bilateral migration flows

An under explored element is migration, which is typically associated with allocative, distributive and external effects.[14] Migration of various kinds within the EU has become increasingly common as a way that individuals can diversify household income and reduce the divide they perceive between their own circumstances and those of people in more advanced countries. People from Southern and Eastern Europe are moving more and more to other, more settled, parts of Europe mainly because benefit systems are more generous and there are more job opportunities. Among the 3.8 million people who immigrated to one of the EU-28 Member States in 2014 were an estimated 1.6 million citizens of non-member countries, and 1.3 million people whose citizenship was from a different EU Member State from the one they immigrated to.[15] The ongoing discussion on immigration and integration is consequently very important, as it can inform national and European policies and highlight areas of EU-wide importance, especially given the debate over the UK's membership of the European Union, in which a major

[14] For further discussion, see Freeman (1986).

[15] Germany reported the largest total number of immigrants in 2014 at 884.9 thousand, followed by the United Kingdom with 632.0 thousand, France with 339.9 thousand, Spain with 305.5 thousand and Italy with 277.6 thousand. Spain reported the highest number of emigrants in 2014 at 400.4 thousand, followed by Germany with 324.2 thousand, the United Kingdom with 319.1 thousand, France with 294.1 thousand, and Poland with 268.3 thousand.

point of contention has been how Brexit could affect migration levels and whether immigration has increased inequality in the UK. While intra-EU migration for EU citizens has been rationalised and justified, free movement has substantial welfare and fiscal implications.[16] For instance, qualified migration often contributes to economic resources being better employed, leading to increased production and greater well-being as the financial contributions made by immigrants help stabilise social security systems. Controversially, Obstfeld and Peri (1998) noted that an influx of unskilled EU migrants can generate problems because of unemployment, the dependants who have come with them, or the increased burden they place on public services.

It is customary in the twenty-first century for migrants to be seen not only as a source of foreign currency but also as bearers of skills, knowledge and social remittances (Faist and Fauser 2011; Levitt 1998). This view often contains the underlying assumption that migration has significant potential for tackling inequality, either through the cash remittances that migrant workers are able to send back, or through the skills, technology transfer and knowledge they acquire abroad and then take back to their country of origin. The main cause of this optimism is the realisation that worker flows and social remittance flows are often larger than either bilateral aid or foreign direct investment (Ratha and Shaaw, 2007). These effects may be significant, but they are not guaranteed, automatic or free. Kapur and McHale (2009) argue that emigration from poorer to richer countries increases the income of the migrants, and also that of their relatives who remain in the country of origin. In fact, migration holds greater potential for reducing inequality when the migrants are from poorer households. However, migration from poorer households could also undermine this process in contexts where it might, for example, end up perpetuating debt and dependency (Mosee *et al.* 2002). Indeed some studies have identified a positive relationship between migration and inequality arising from a loss of capital and population in the traditional sector, which may not be offset by remittances (Kahanec and Zimmerman, 2008, Faria 2002). Another dramatic difference is the current recognition that there are important distinctions between the skill levels of immigrants whatever their ethnicity and country of origin. Some studies distinguish between skilled and unskilled migration and find conflicting evidence for its relationship to inequality. For example, Davies and Wooton (1992) find that skilled migration can reduce inequality in countries of origin but increase it in countries of destination.

As discussed above, it is true of course that migratory exchanges in Europe can have significant impacts on economic performance, primarily through the pressure they put on labour markets. Although deeply constrained by data limitations, analysing intra-regional linkages and incorporating emigrational exchanges is an urgent and a crucial task for an integrated Europe. However, no attempt has been made in the GVAR literature to measure these cross-border externalities, and so given the role played by migration described above, total bilateral stocks of migration are used for formulating an index of the relative position between countries in the form of:

$$M_{i,j} = \frac{0.3 \times M_{i,j,1990} + 0.7 \times M_{i,j,2000}}{0.3 \times \sum_{j=1}^{N-1} M_{i,j,1990} + 0.7 \times \sum_{j=1}^{N-1} M_{i,j,2000}}$$

It is worth noting that, as for any applied study, data availability is a binding constraint.

[16]Further work with major contributions of: Mau *et al.* (2009); Schierup *et al.* (2006); Geddes (2001).

As a function of data availability, some components of the multi-dimensional interdependency matrix have to use slightly different samples. In this case, for migration flows, historical time series for both inward and outward migration among every European country covering the sample 1996 Q1 to 2012 Q1 do not exist. However, as discussed in detail above, migratory exchanges in Europe have significant impacts on economic performance, primarily through the pressure they put on labour markets. Therefore, instead of entirely eliminating such an important exposure between countries altogether, we had to make use of the available datasets where data points exist for all the countries in the sample. Hence, given the absence of continuous time series, this representation is intended to privilege the most recent data (that is, the 2000 cut) by assigning a higher weight to it (70 per cent) in each historical profile and, by doing so, to emphasise on the most up to-date features of the considered migratory exchanges.

3.3.3 Trade Exchanges

A substantial portion of the GVAR literature has already used trade linkages to explore propagation mechanisms, as the exchange of goods and services between economies is an indisputable element in the exposure of one economy to the variability of a foreign one. It is challenging from a distributive point of view to disentangle the impact of intra-EU trade on income disparities as the relationship depends on factor endowments and productivity variations across economies, and also on how much income individuals obtain from wages or capital. Ravallion (2004) argues that trade does not directly affect inequality but fosters economic growth, yet it remains essential to recognise the determinants of how trade flows impact income distribution.

The principal theoretical references for the relation between trade and inequality come from the Heckscher-Ohlin and Stolper-Samuelson theorems (Stolper and Samuelson, 1941). These indicate that in a two-country two-factor setting, increased trade relationships shift labour demand from unskilled to skilled workers as they are particularly specialised in the production of skill-intensive products. Protectionist views are fuelled by the observation that the benefits of productivity gains accrue mainly to highly skilled, highly educated workers, leaving the low skilled labour force behind (Kremer and Masking, 2006). Several studies, such as Manasse and Turrini (2001), Munch and Skaksen (2009), Costinot and Vogel (2010) and Blanchard and Willmann (2011) have concluded that international trade could potentially have mixed effects on the wage gap by raising the skill premium while also lowering employment and the relative earnings of low income workers. More recent studies such as Furusawa and Konishi (2013) and Osgood *et al.* (2017) show that international trade benefits firms producing high quality products/services, while it reduces the profits for those that barely export their products and those that mainly serve the domestic markets.

The second theory acknowledges that trade specialisation and offshoring have led labour demand in advanced economies to shift towards skilled workers, underpinning the impact of technological change on inequality. However, it is uncertain whether the volume of trade between developed and developing countries is substantial enough to cause the increases in inequality that have been observed, as most trade flows occur between countries with similar endowments (Matano and Naticcioni, 2010). For these reasons, further channels through which trade can affect labour income inequality have been suggested, one of which is labour outsourcing. Deeper trade linkages make it relatively easier to offshore as additional tasks can be subcontracted to countries with fewer qualifications and lower wages. Indeed, the literature demonstrates that offshoring from industrialised countries has led to increased labour demand for more highly skilled workers, indicating that skilled workers become better off and unskilled workers worse

(Feenstra and Hanson, 1996). Tasks that are relocated from advanced economies to emerging economies are not usually very demanding in skills from the skill-rich country's point of view, though they appear skill-demanding for the skill-poor country. Consequently, offshoring makes labour demand more demanding of skills in both poorer and richer countries, thus escalating inequality in both locations. This underlines just how important the potential labour market effects of offshoring could be; Baumgarten *et al.* (2013) use individual and firm level data from Germany to demonstrate that the wage effects of offshoring activities are moderate and relate to how much the task to be offshored requires personal interaction or can be reported as non-routine. As in most of the published literature, the relative degree of interdependency towards a specific economy is here identified by using total trade volume measured in exports and imports to reflect the importance of country i in country j, and defined as:[17]

$$T_{i,j} = \frac{Ex\bar{p}orts_{i,j} + Im\bar{p}orts_{i,j}}{\sum_{j=1}^{N-1} Ex\bar{p}orts_{i,j} + \sum_{j=1}^{N-1} Im\bar{p}orts_{i,j}} \tag{3.6}$$

with $i \neq j$ and where $\bar{X}_{i,j}$ and $\bar{M}_{i,j}$ represent, respectively, the mean of exports and imports from country i to country j during the period under consideration.[18]

3.3.4 Finance

The degree of financial interlinkages among Western European countries and those in Central, Eastern, and South-eastern Europe (CESE) has grown notably, with a consequential increase in foreign ownership of the CESE banking systems. In a recent study, Maechler and Ong (2009) analyse the structure of bank claims and its potential implications for financial stability, in both the creditor and the borrower countries of CESE. Their results suggest that Austria, Germany, and Italy hold the biggest share of bank claims for the CESE region as a whole, while it is mainly Sweden for the Baltics, but some CESE economies have more diversified sources of funds. Financial exposures are quite concentrated in these country groups, either through the local banking sectors or the private sector. Arvai *et al.* (2009) also show that the financial interlinkages within Europe are economically significant. It may be noted that intra-EU FDI inflows rose by 40 per cent in 2015 and reached €365 billion (Eurostat, 2015). Ongoing efforts for regional surveillance of financial sector linkages boosted EU GDP by more than €40 billion over the period 2001-2012, and made a positive and noteworthy contribution to the competitiveness of EU firms in the form of higher productivity particularly in the CEE economies.

The tentative message of the emerging bulk of empirical research is that stronger financial links between countries can assist the efficient international distribution of capital, and these links have been cited as underlying causes of the increase in financial prosperity. Conversely, increased financial flows, particularly foreign direct investment (FDI) and portfolio flows, have been shown to raise income inequality in both advanced and emerging market economies (Freeman 2010). While there is a great deal of literature on the effects of financial globalisation on the growth in volatility (European Regional Economic Outlook 2009), its effects on inequality have received far less attention, even though increased financial flows have had a significant

[17] See, for example, Chudik et al (2011) for a detailed explanation on trade weights to construct foreign variables.

[18] Results using trade linkages only weights are available upon request.

impact on income distribution (Roine, Vlachos and Waldenström, 2008; and the review articles by Claessens and Perotti, 2007; Beck *et al.* (2007)). It is questionable whether the volume of financial flows and outsourcing between developed and developing European countries directly increases inequality between skilled and unskilled workers. One possible explanation of this increase is the concentration of foreign assets and liabilities in sectors that are more skill intensive and technology intensive, which increases the demand for more highly skilled workers and also lifts their wages. In a recent paper, Chen *et al.* (2014) showed that outsourcing reduces the real wage for unskilled workers by up to 1.8 per cent while it increases the real wages for skilled workers by up to 3.3 per cent. What may be seen as low-skill, outward FDI from advanced European economies can actually in effect be relatively high-skill, inward FDI for emerging European economies (Figini and Görg 2011), thus exacerbating the demand for high-skilled workers in the recipient countries.

Therefore the third part of the multi-dimensional interdependency matrix must focus on the increased role of external financing as a source of funding and analyse possible channels of contagion through financial exchanges. The complexity and variety of financial interactions make it necessary to focus on specific aspects that, for the purpose of this paper, reflect a more structural component that generates a strain in broader social terms rather than short-term speculative flows, because this structural component has a stronger relation with the real sector.

In this case, an index of the international exchange of direct investments is calculated as:

$$F_{i,j} = \frac{\bar{out}_{i,j} + \bar{inw}_{i,j}}{\sum_{j=1}^{N-1} \bar{out}_{i,j} + \sum_{j=1}^{N-1} \bar{inw}_{i,j}} \tag{3.7}$$

with $i \neq j$ and where $\bar{out}_{i,j}$ and $\bar{inw}_{i,j}$ stand, respectively, for the means of total outflows and inflows of direct investments from country i to country j.

3.3.5 Geographical proximities

Tobler's first law of geography, *"everything is related to everything else, but near things are more related than distant things"* is appropriate here as an indicator of geographical proximities between economies that can absorb other channels of interaction not captured by the other three channels.[19] The importance of location decisions by the centripetal forces of large markets has been emphasised by scholars such as Krugman (1991) and Mulabdic *et al.* (2017), who have demonstrated that economic integration in Europe has been central to the concentration of economic activities.

Studies analysing the effect of economic geography on spatial income distribution fall into two categories, with one strand consisting of the studies of Brakman *et al.* (2004) for Germany, Hanson (2005) for the USA, Mion (2004) for Italy and Tirado *et al.* (2003) for Spain, who all assume labour to be perfectly mobile and real wages to be equalised. The second strand meanwhile concentrates on the same effect at international level, and is represented by the work of Redding and Venables (2004), in which real wage levels are influenced by intermediate factors of production. Studies at both national and international level have shown geography to have a significant impact on access to markets, which then shapes income levels. Krugman (1991) and Venables (1994) also document the economic relevance of such proximities in examining

[19] See Tobler (1979) for further details.

regional integration. Redding and Venables (2003) produced an authoritative study of its kind, showing that the geography of access to markets and sources of supply is statistically significant and is essential in explaining cross-country variation in income per capita. Economic and income inequalities in the EU can partly be defined by the location of regions within the European space. Geographical access to markets is vital in shaping the spatial distribution of wages across EU regions. Around 29 per cent of cross regional variation in wage levels can be explained by a region's proximity to customer markets (Lopez-Rodriguez and Faina, 2007). Geographic location may alter income per capita in a variety of ways as it affects flows of goods and factors of production. In this section we concentrate on the country's location within the European space. An index of inverse distances that assigns greater weight to closer neighbourhoods is calculated using the World Bank's API.[20] This is chosen mainly because inverse-distance weights are commonly used in configurations of spatial econometrics involving units that are geographically dispersed (LeSage and Pace, 2009). Income per capita may be altered by geographic location in various ways, through the impact on flows of goods and factors of production.

$$G_{i,j} = \frac{1}{(dist_{i,j})} \tag{3.8}$$

It is also worth noting that there may be inequality between EU member states because levels of technology vary (Garcia-Penalosa, 2010). Income distribution in member states may be affected by both political economy equilibrium and technological progress without any casual effects being implied across countries. It still remains uncertain how much these developments are driven by broader economic pressures related to technology or globalisation, but as much as we would like to capture the impact created by these variables, it is not possible to do so in a GVAR setting.

3.4 Composite weights based on key international linkages: rationale and justification

This section flags the importance and justification of specifying weights so that multidimensional interdependencies can be incorporated in GVAR models. As will be explained below, different weights are assigned to the indexes for individual channels of interaction as they operate with distinctive strength in the map of exchanges between European economies. This is achieved by constructing a sensible composite weight matrix reflecting the means of key indicators that show the relative importance of each European economy towards each other in the sample.

As mentioned above, the vast majority of GVAR studies only use either trade or finance weights not having to work with this level of complexity of economic exposures of different contagion mechanisms, thus there is no need to assign weights between interdependency mechanisms. In any case, assigning equal weights to components of the weight matrix in GVAR settings does not reflect the dynamics of economic reality in the European space, as not all the linkages are equally important (i.e. in an era of technology geographical proximities cannot possibly be as important as trade or migrational linkages). Therefore, we depart from equal weighting approach to construct a sensible composite weight matrix reflecting the importance

[20] Geo-localisation of capital cities.

of key components that show the relative importance of each individual economy towards each other economy in the sample.

Following theoretical and empirical considerations and the relative importance of these linkages as documented throughout sections 3.1.1., 3.1.2, 3.1.3 and 3.1.4, the composite matrix **W** is constructed from the corresponding entries in each of the previous matrices as:

$$W_{i,j} = 0.05G_{i,j} + 0.35T_{i,j} + 0.35F_{i,j} + 0.25M_{i,j} \tag{3.9}$$

$$\Rightarrow \mathbf{W} = [0.05\mathbf{G} + 0.35\mathbf{T} + 0.35\mathbf{F} + 0.25\mathbf{M}] \tag{3.10}$$

with $W_{i,i} = 0$ being a result of the null diagonals in all of the constituent matrices (see Appendix G).[21]

Further justification for the weighting scheme draws from the suggestions in three well-known papers. First, Eickmeier and Ng (2014) consider a range of different connectivity matrices and assess differences through a forecasting exercise. Second, Feldkircher and Huber (2015) analyse weight schemes that allow for different weights for different foreign variables in the system, specifically evaluating different weight schemes to suit the likelihoods of the model. Third, Gross (2013) proposes estimating weights rather than choosing them exogenously for the model. Also, to avoid a potential problem of endogeneity in the formulation of these weights, the study utilizes averages, formulated in a way that their outcomes are as disengaged from quarterly policy variations as possible. Also, it is noteworthy to mention that GVAR framework does not allow running simulation exercises in order to check a sort of statistical dominance approach as implemented by Pinar *et al.* (2017) for Human Development Index. A stochastic dominance (SD) framework studies the impact of causal factors on a target variable. However, in a GVAR setting weighting matrices do not contain causal variables of the country-specific VAR models (which, by nature, do not adhere to the causality principles contained in the SD framework), they describe the strengths of the links between them (in our case, bi-lateral exposures). In our framework, trade, finance, migration and geographic proximity are not the set of variables included in the VAR parts of the model which, by design, significantly differ from the modelling principles in Pinar *et al.* (2017) where, in a marked contrast, a clear differentiation exists between independent and dependent variables. Even so, in order to disentangle further how multidimensional weights differ from conventional weights, the empirical severity of the problem of robustness has already been quantified for six different weighting schemes for any given specification of the model. However, it is worth noting that each GVAR estimation with a varying weighting scheme produces around 1000 dynamic GIRFS. Each run times 6 weighting schemes equals to almost 6000 GIRFs.

With this in mind, in order to incorporate multi-dimensional interdependencies in a GVAR setting in the most objective manner, we particularly consider 3 crucial components as explained above and highlighted by historical series of European interdependencies: (1) relevant data availability to enable empirical explorations (2) available empirical evidence - namely, by building upon structured evidence based literature regarding the multifaceted and inter-linked nature of European economies as outlined throughout subsections above: connectedness and rationale for multi-dimensional linkages, bilateral migration flows, trade Exchanges, financial exchanges, geographical proximities and composite weights based on key linkages (3) historical patterns and actual intensity of these interdependencies among European economies as mea-

[21]For the purposes of estimations these weights have been column-normalised.

sured and referred to Appendices (intensity of trade, migration and financial linkages between European countries). Weighting figures based on the relative importance of linkages also reaffirm to a considerable extent the weighted averages specified for these separate connectivity measures (see Appendices D, E, F, G and H).

The described 35-35-25-5 scheme is undoubtedly an original setting as no other GVAR study provides such a comprehensive view on the multi-dimensionality of relevant exposures between economies. However, beyond any mechanistic approach, the scheme is the product of our analysis of previous literature on international linkages as outlined throughout subsection 3 which results in the following considerations: (1) Trade and finance are factors which display leading and direct effects on aspects like national accounts (as GDP) as compared to more indirect effects (as explained above) from migration and spatial neighbourhood. The combined implications of the exposure to the first two channels, therefore, need to be sufficiently emphasised as predominant in this context (here, adding up to 70% of the exposure to foreign economies. (2) The literature is so far inconclusive about the comparative strengths of trade and finance as sources of international exposure. Therefore, equally splitting in two their combined effect is consistent with the current state of the debate. (3) A third channel, migration, is proposed as having a significant role in the level of exposure to other economies but, it is acknowledged to be comparatively indirect so its weight should be lower (no study assigns a leading role to it over trade or finance). (4) The complementary nature of the socio-economic aspects proxied by spatial neighbourhood, although in our view are relevant to be considered, can only justify a participation that is consistent with their complementary role.

In fact, evidence from European countries that is documented in the previous sections also reaffirms to a considerable extent the weighted averages specified for these separate connectivity measures. Trade linkages meanwhile have always been important drivers of an increased interdependency among Eurozone economies. Given the significant strides that European countries have made towards a common market by lowering trade costs and impediments to factor mobility, trade linkages are assigned a weight of 0.35. As discussed in the previous sections, exposures are well diversified among European countries, but potential financial spillovers increase the overall exposure much more. So because the exposures between the countries are non-negligible and so the concentration of their financial exchanges is intensified, these exposures are also allocated a weight of 0.35. Bilateral mobility patterns are at least as important as the other dimensions already noted and so a weight of 0.25 is assigned to European migration flows in an attempt to allow a coherent hierarchy of principles for verification. Furthermore, geographical proximities are also taken into consideration in order to tackle temporal and spatial interdependencies in Europe. The geographical neighbourhood is highly relevant for common markets like Europe. However, its impact on economic entities is small next to that of the other dimensions in the era of globalisation and web-based technologies, and so a weight of 0.05 is assigned for the neighbourhood entity. This set of considerations serve as supporting arguments to the scheme[22] and as the rationale against a) levelling the roles of the considered channels (simplistic stance) or b) assigning a higher value to any of them (unsupported stance).

[22]The reader should recall that these values only provide a description of the contribution that each factor can have in the full depiction of international exposures made in this paper, which is complemented by the specific, observed values of the variables being weighted: G,T,F and M (which, in turn, can be close to zero for countries weakly engaged in trade or which are far apart, for example, or higher for intense relationships in each factor).

4 Dynamic analysis

4.1 Spillover of real shocks: negative global shock to economic performance

GVAR allows aggregated foreign variables to be incorporated in analysis of the spillover of shocks not only on the country-specific level, but also on a global level.[23] This feature is of notable relevance given the worldwide consensus among policy-makers that continuing economic globalisation requires more policy coordination at the supranational level. One place where this paper has direct policy relevance is in the potential effects of a country's economic performance on modified inequality. Indeed, the recent European economic difficulties provide a clear reminder of that need. The main long-run policy concern and priority for Europe is well known to be the slow pace of economic growth; if inequality is non-neutral in any sense, correct understanding and accurate measurement of it are crucial starting points for designing and implementing growth policy.

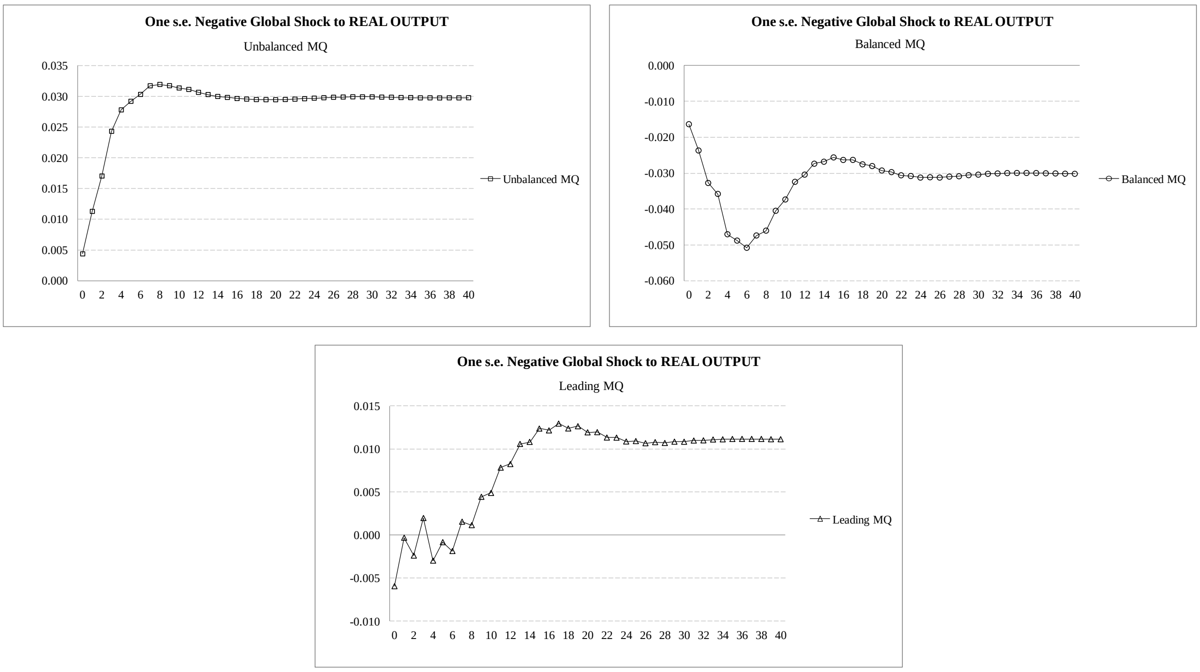
Figure 2 summarises the estimated GIRFs to a negative shock of one standard error to the European Union's overall economic performance. The cyclical variation throughout the time horizon is quite similar in the *Leading European* and *Unbalanced European* countries. It is somewhat puzzling that the *Balanced* group seems to experience a small dip in the modified inequality ratio (MQ) initially, one which is originally small, but follows a decreasing trend. On impact MQ decreases by between 0.02 and 0.05 in the second year, then gradually rises so the fall is cancelled out in the subsequent quarters. Thus, one of the main findings is related to the asymmetry between the effects of the shock in such a way that the impact on the Balanced region is clearly contrasting, supporting the notion that certain regions/economies, given their structural differences, exhibit distinctive exposures to the shocks. In this case, the Balanced region shows a significant decrease in MQ until a new equilibrium is found which is also below the initial level. This may be considered as a surprising contradiction of the indisputable impact of economic growth on income distribution. In contrast, the MQ in the *Unbalanced* European group is expected to rise by 2 pp (percentage points) on impact, and over 3 pp in the second year before declining afterwards. A similar but more pronounced pattern can be observed in the Leading European group, where the impact on MQ is relatively longer lasting, as MQ in the Leading group, which contains the Netherlands, Denmark, Luxembourg and Austria, increases significantly over the first three years. The impact reaches its peak in the third year with an increase of approximately 1.2 per cent, so any future movement towards a secular stagnation (Gordon, 2012) for example, is likely to be associated with even greater inequality.

In this interpretation, globalisation has two effects. One is that it increases inequality in *Leading* and *Unbalanced* EU member states because economic growth is negative for a period, but the other is that it reduces the overall growth rate of income disparity in the *Balanced* group. More specifically, the global analysis provides further evidence that a negative shock to European economic performance does indeed exaggerate the rise in inequality in the *Leading* and the *Unbalanced* European country groups within four to twelve quarters as a result of a shock. It also seems to be the case that events predominantly drive the adjustment towards a long run equilibrium or at least that global shocks are largely *absorbed* by the *Leading* and the *Unbalanced* European countries, and from there transmitted further (as noticeable in Figure 2 given the the smaller impact of real shocks on the Balanced group.) As confirmed in this analysis, the impact of economic growth on income distribution is indisputable, which is consistent with earlier findings in the literature. Other authors, like Galor Bourguignon

[23]See Pesaran *et al.* (2004) for further technical details and other applications of this procedure.

and Morrisson (2002), Milanovic and Yitzhaki (2002) and Sala-i-Martin (2006) present similar findings that can explain this behaviour. Piketty (2014), for example, indicates that the rise in inequality witnessed in recent decades is a direct result of the slowing down of economic growth in modern capitalist economies, and he suggests this challenge would be exacerbated if growth rates decline further.

Figure 2: GIRF of a global shock to Real Output



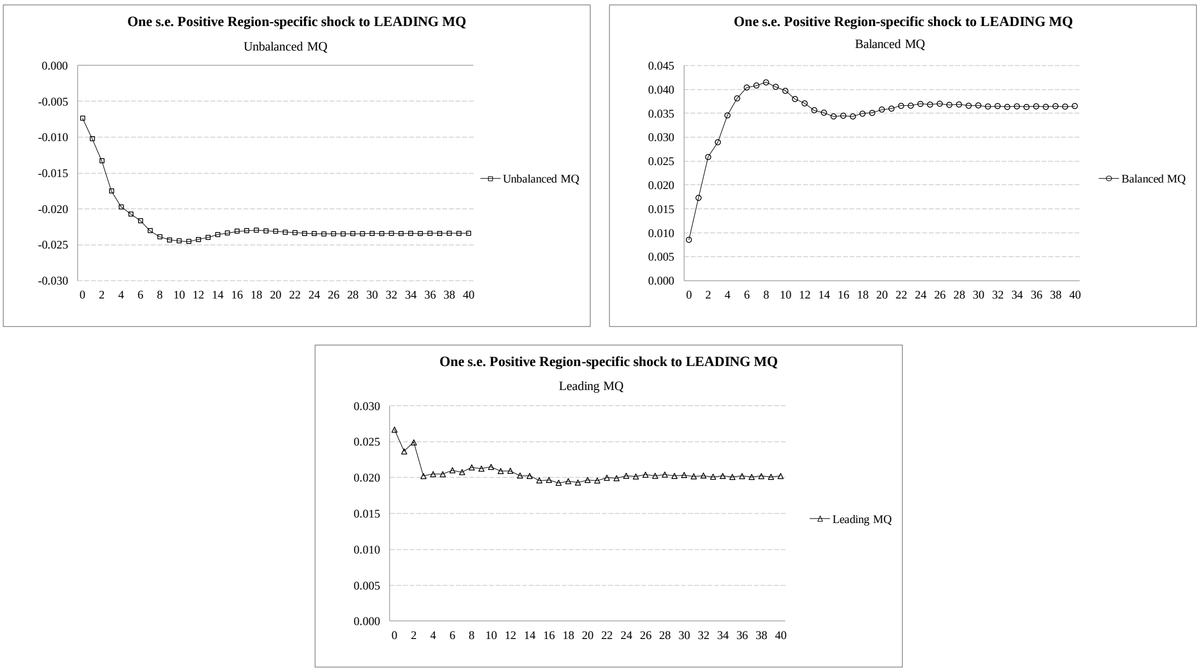
4.2 Spillover of distributional problems: a positive shock to Leading group's modified inequality ratio

The results of a positive one standard error shock to Leading European countries' modified inequality ratios are shown in Figure 3 below. Following a 1 standard error shock to modified quintile ratio, the *Leading* group's modified quintile contemporaneously increases by 2.67 p.p. displaying a smaller lagged effect in the first quarter, which then shows minor oscillations and mostly dissipates in the third quarter. A corresponding significant pass-through can be observed in the *Balanced* group, where the modified quintile initially increases by 0.85 p.p., and this effect continues operating, until around quarter 8, before it starts losing its strength and reaches a new steady state. In the *Unbalanced* group, on the other hand, the observed pattern is rather different. The shock on the *Leading* group, to start with, has a negative impact on the *Unbalanced* group's MQ with a contemporaneous decrease of 0.73 p.p. and continues pushing downwards for the following ten quarters up to a maximum decrease of 2.5 p.p. after which the shock loses most of its strength.

Overall, the dynamic analysis documents that, when there is a deterioration in relation to after-in kind benefits income inequality in the *Leading* European countries, the impact on its own region is mostly restricted to the first year. Whereas, in the other regions the repercussions are far less immediate, displaying a considerable lag and are also visible for longer periods. This is a clear indication of the delay with which the transmission mechanisms between these regions work and, mainly in the case of the spillover effect to the *Balanced* region, of the multiplicative effects they exhibit. Since, this indirect impact is clearly larger than the one derived from the original shock.

The specific cross-country mechanisms are of course of a more particular nature, but this exercise makes the value of employing multiple dimensions for the interrelations between economies even more evident. Interpretations based on the multidimensional link matrix can further clarify these developments. For example, as shown in Appendix D, there are strong commercial links between Denmark, Luxembourg and the Netherlands with the countries of the Unbalanced group. For countries like Luxembourg, the Netherlands and to a lesser extent Denmark, financial exchanges play an important role and the United Kingdom is a predominant counterpart (see Appendix E). Similarly, migration exchanges constitute a relevant source of interdependence between these groups which has potentially large implication in cases like Luxembourg or Denmark (see Appendix F). The fact that the spillover to the Unbalanced region is negative, implies that the original shock is promoting conditions that this specific group requires for the generation of improvements in terms of income inequality. In this particular example, the indirect improving effects seem to be pre-eminently operating through the financial channel, which, in turn, is of especial relevance for the overall performance of economies like the United Kingdom.

Figure 3: GIRF of a shock to Leading MQ

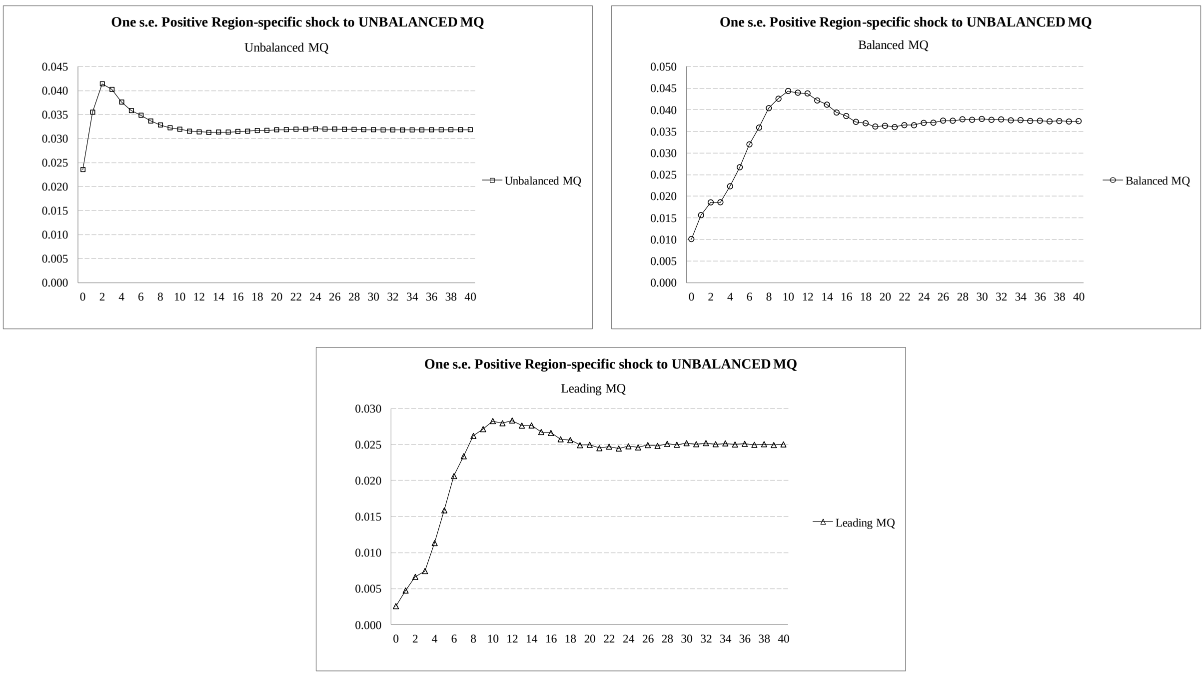


4.3 A positive shock to the Unbalanced country group's modified inequality ratio

The GIRFs of a one standard error positive shock to MQ display an immediate, though mostly short-lived, deterioration across the region. First there is an increase of 2.4 percentage points on impact, and this is followed by subsequent considerable increases in this indicator until it peaks in the third quarter after the shock at 4.1 percentage points. In contrast to the outcomes of the previous shock, the inter-regional responses follow a similar profile, with a lagged, sustained increase in the MQ until the spillover weakens in around quarter 10, and finally dissipates near the 20th quarter.

Although there is marked similarity in the shape of these spillovers, there is considerable difference in their size, with the response from the *Balanced* group displaying a larger multiplicative effect than that from the Leading region, and even a larger one than that from the originating region. In this sense, the Leading group displays a higher degree of resilience to shocks generated in the *Unbalanced* group, as the Balanced region is primarily exposed to shocks in the *Unbalanced* region through trade exchanges (see Appendix D) and, interestingly, there is a considerable contribution from inter-regional migration (see Appendix F). The diversification of financial exchanges out of the Balanced region and mainly into the Leading region acts as a contention barrier against the transmission of spillovers through this particular channel (see Appendix E). All these elements provide crucial information about the nature of the potential inter-regional spillovers. Germany is evidently a central player across this set of interactions, but Belgium also appears as a consequential counterpart within the same region.

Figure 4: GIRF of a shock to Unbalanced MQ



4.4 A positive shock to the Balanced country group's modified inequality ratio

The results of a positive one standard error shock to the *Balanced* MQ are shown in Figure 5. This shock leads to an immediate increase of 0.4 percentage point followed by considerable subsequent increases in the MQ up to a maximum of 0.12 percentage point ten quarters after the initial impact. These variations are comparatively large within our range of shocks to the

MQ and they reveal a worrying spiralling effect in the concentration of income in the group's economies. In turn, rising income inequalities originating in the *Balanced* group appear to elicit a more moderate impact on the MQ in other regions of Europe. The GIRFs show that the transmission of a one standard error positive MQ shock in the *Balanced* group to the *Leading* European countries is significant, and that it keeps building up in time to a maximum of 0.37 percentage point after two years. Furthermore, it is noticeable from the inter-regional weightings that the financial channel plays a considerable role in the interactions between these two groups, with Luxembourg and the Netherlands as key players. It is worth mentioning though that the Netherlands is also a significant counterpart for the *Balanced* group in trade and migration exchanges.

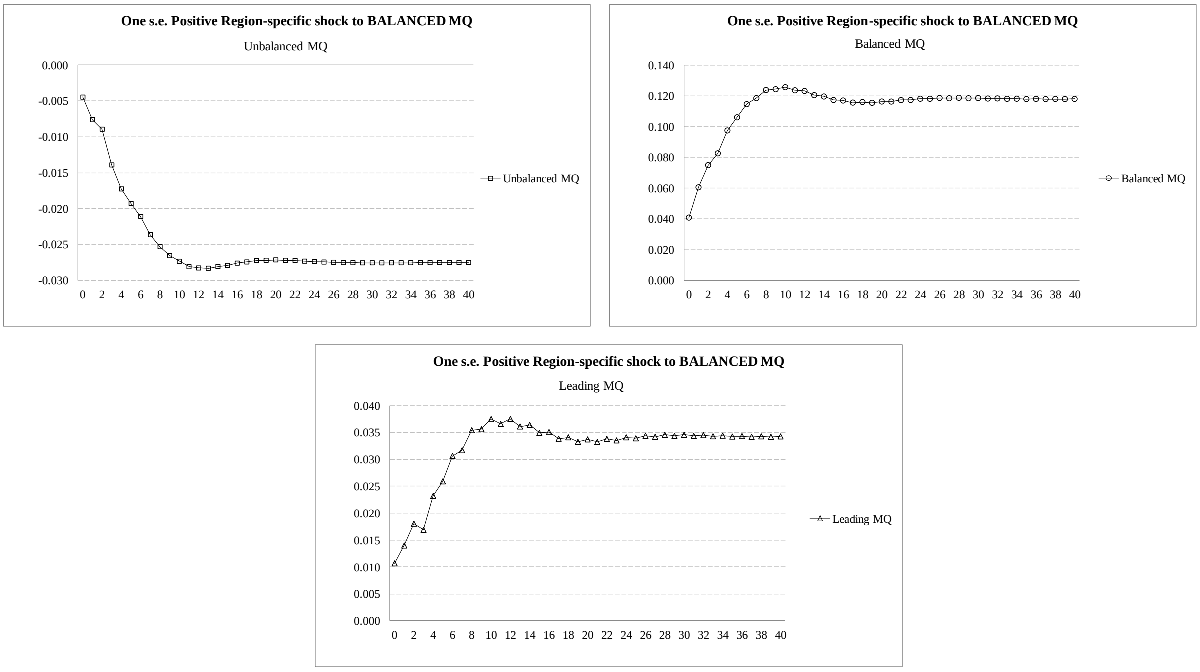
For the countries in the *Unbalanced* group, the MQ path after the shock is described by a decline in the group's MQ of around 0.5 per cent on impact, which again keeps operating until it reaches a maximum reduction of 2.8 per cent in a two-year horizon. The negative correlation identified between the developments of the MQ indicator in the *Unbalanced* group and shocks in the other European regions reveals contrasting features in the nature of the interactions between groups. This suggests that some of the factors affecting income distribution in *Unbalanced* economies are acting as direct competitors to their inter-regional equivalents. Take for example the competition between financial markets, which themselves have significant effects on overall macroeconomic performance and through that on the basis for income generation and distribution. Similar competitive stances in other categories such as trade or migration would also help make these contrasting outcomes appear, even in cases where the shocks result in similar adjustments.

In view of this, these spillovers can be classified into two types as (i) the trailing effect, when the external effect follows the same direction as the original shock, or (ii) the competitive effect, when the deterioration or improvement from the original shock is reflected by an opposite adjustment abroad. However, the extra-regional effects of income redistribution are also deeply conditioned by the specific structural features that distinguish each region. In this sense, it is noticeable that the positive shock described earlier to modified income inequalities in the Balanced group and spillovers from it also result in income concentrations in the Leading region. However, the *Unbalanced* region displays an improvement in equality meaning that the lower income strata are able to share the benefits of the increased economic activity, as is revealed by the impact of the shock on real output. This also makes evident the contrasting capacity of the *Unbalanced* group to translate increases in economic activity, like an expansion in foreign demand, into benefits for lower income agents.

4.5 Spillover of financial shocks: shocks to the interest rate in the Leading European Countries

Figure 6 displays the outcomes of a one standard error negative shock to the short-term interest rate in the *Leading* region. Dynamic analysis suggests that the macroeconomic effects of monetary policy shocks contribute significantly to the unprecedented increase in income inequality over the last quarter of a century. This finding is consistent with results documented in the literature by Coibion *et al.* (2012), Romer and Romer (2004) and Christiano *et al.* (1999). For the intra-regional responses it is of note that this shock generates a response in the MQ indicator that can mostly be described in two phases, with (i) an immediate impact leading to a reduction in inequality from current contracts, and (ii) a lagged, negative adjustment in the inequality associated with new contracts. More specifically, during the first quarter after

Figure 5: GIRF of a shock to Balanced MQ



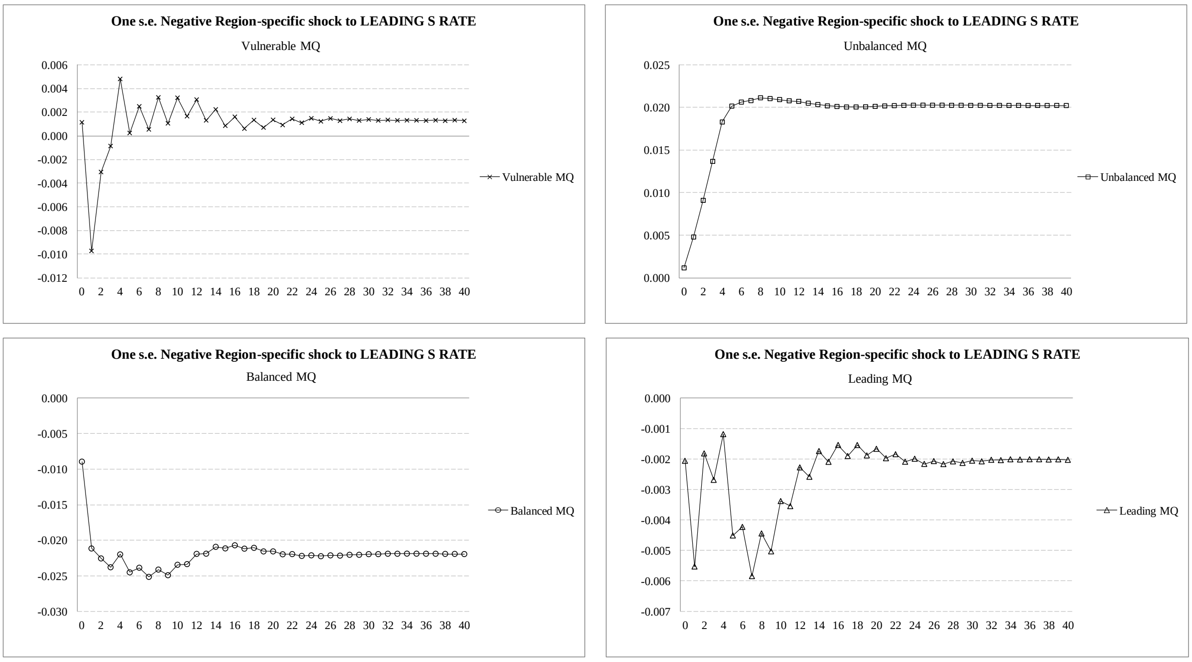
the shock there is an income effect for the economic agents with the largest elasticities, which are normally those with intermediate levels of income, as they get cheaper access to credit for a given level of individual and corporate earnings.

As highlighted by the works of Doepke and Schneider (2006) and Stiglitz (2013), the decline in interest rates benefits the borrowing counterpart for pre-existent variable-rate contracts like mortgages, as it increases their disposable income for every practical purpose. However, the second of these two phases clearly has significant implications for the resulting decline in the income inequalities within the region, which consists of the Netherlands, Denmark, Luxembourg and Austria. In this case there is a delay in the response that reflects an element of institutional, or contractual, rigidity, and the magnitude of this delay has a considerable effect on the distribution of income. Afterwards however, new contracts are agreed that reflect the lower costs of borrowing and promote credit for durable goods for households, and corporate investment programmes. As this is the region with the highest levels of output, such developments are likely to benefit households in the intermediate and upper-intermediate quintiles of the income distribution.

This shock also has contrasting implications for the *Balanced* and the *Unbalanced* European countries, particularly in the improvement in equality in the former and the deterioration in it in the latter. These opposite trends reveal that the structural drivers in the credit markets of these two regions are different in nature, as the shock benefits borrowers in the *Balanced* region while mostly affecting savers in the *Unbalanced* region, where access to borrowing is not as efficient or widespread. The international impact on the *Vulnerable* European group is much more muted and short-lived, peaking in the first quarter after the shock and then rapidly declining during the same year. This finding illustrates the difficulties these countries face in channelling advantages, such as reduced costs of capital, into more structural developments with significant consequences for income distribution.

The analysis thus shows that a reduction in the interest rate in advanced economies may generate multiple equilibria. We document that the estimated relationships between inequality and interest rates are different for poor and rich countries within the period considered in this paper, in accordance with the findings of Battisti *et al.* (2014), as they are significantly negative in the rich group. More specifically, dynamic analysis reveals that these empirical facts of a reduction in interest rates and a rise in income polarisation, can have contrasting effects for different country groups depending on their initial level of income and on their initial level of income inequality. These findings also confirm the recent evidence of the increased importance of developments in monetary policy in Europe. More importantly, these findings may document how the resilience of similarly sized country groups to shocks originating in the *Leading* region is likely to have played an important role in the unfolding of the recent Eurozone crisis, particularly throughout the recovery.

Figure 6: GIRF of a shock to Leading short-term interest rate



4.6 Generalised forecast error variance decomposition

The GFEVD computes the proportion of the variance of the h-step ahead forecast errors of each variable that is explained by conditioning it on contemporaneous and future values of the non-orthogonalised, or generalised, shocks to the system.[24] The results for a selected sample of variables which are of potential interest for their importance in European distributional dynamics are presented (see Appendix L). Since the model contains 85 endogenous variables and presenting the contribution of each of them to the forecast variance of the selected variables would take too much space, we only show the contributions of the five top determinants during the twenty-quarter horizon.

Starting with modified quintile ratios, the results for the *Balanced* European countries show that the domestic variables of real exchange rate, imports and GDP contribute equally to the forecast variance after two years, alone explaining more than one-third of the total variance. The contribution of the same domestic variables at a shorter horizon is however much more heterogeneous, with the inflation almost unimportant before one year, and real GDP and short-term monetary policy interest rates playing the role of the main determinants. Economic performance shocks have a relatively high explanatory power for the income disparities in the *Vulnerable* and *Unbalanced* regions. However, they contribute much less in the *Leading* European country group, while short-term interest rates play the biggest role, alone explaining one quarter of the forecast variance. This finding confirms the result of section 4.6 that monetary policy shocks can account for a significant component of the income distribution in Europe. A similar but more pronounced pattern is also observed for the *Vulnerable* country group.

Inequality shocks originating from Balanced and Unbalanced country groups display same-region, contemporaneous variance participations up to 49 per cent, and 34 per cent respectively which dissipate in time. The inter-regional contributions, in consistency with our previous findings, reach less simultaneous peaks which in some cases expand until the end of the considered time-horizon. While, the small share of *Balanced* group's forecast error variance explained by *Leading* group's inequality shocks is interesting in the light of *Balanced* group's large financial and trade exposure to the Leading group, but possibly is supplementary indication the reputation of this group's financial system as being particularly stable (see e.g. Allen *et al.* 2005).

Inequality shocks originating from Balanced and Unbalanced country groups display same-region, contemporaneous variance participations up to 49 per cent, and 34 per cent respectively which dissipate in time. The inter-regional contributions, in consistency with our previous findings, reach less simultaneous peaks which in some cases expand until the end of the considered time-horizon

Leading group, which consists of Netherlands, Denmark, Austria and Luxembourg, inequality shocks make a considerable contribution to same-region fluctuations, but also abroad where they account for 3-6 per cent. The explained shares are particularly large for *Unbalanced* group (France, United Kingdom and Ireland), but relatively small for *Balanced* group (Sweden, Netherlands, Finland, Germany and Belgium). The variance shares explained by *Unbalanced* and *Balanced* group of countries are smaller, accounting for 2 to 14 per cent. Finally, looking at the comparative contribution of each country group's inequality shock to the explanation of

[24]For a derivation of the generalised forecast error variance decomposition in a GVAR framework, see Dees *et al.* (2007).

the forecast error variance, the country group of origin of the shock explains a large portion of the variance of the shock at all horizons, although the rest of the analysed country groups increase relevance as quarters go by.

Variance decompositions of the poverty rates of the two major European country groups, the *Balanced* and *Leading* regions, are shown in Appendix L. One of the key determinants for both groups of countries is disparities in income distribution, which alone explains more than one tenth of the variance decomposition for the at risk of poverty forecast. This result can easily be reconciled with the general findings of Ravaillon (2001), Buhmann *et al.* (1988), Korpi (1998) and Kakwani (1990) that very small improvements in income distribution can affect poverty rates in a substantial way.

5 Conclusions

There is a need for European countries, collectively and individually, to develop better, more effective mechanisms for intervening in markets to reduce income inequality and promote growth. An improved measurement of inequality and a better understanding of the variety of factors which influence it, including spillover effects between countries, can form the basis for an improved decision-making on policies. Despite its limitations, this research has a number of consequential implications and opens new avenues for research in this field. Our model helps to evaluate the multifaceted nature of cross-country interdependencies and the subsequent effects on distributional disparities across the member states. Our findings suggest that spillover processes for income dispersion are not only in operation at the national but also at international, in this case EU level.

The main driver for decreasing regional inequalities according to the European Commission is economic growth. Our findings provide evidence of distinctive pro and anti-cyclical associations between inequality and growth depending on the inequality-size profile of an economy. These findings are critical for policy-making: economic growth may also generate new inequalities in certain regions. GIRFs and GEVDS of a global shock confirm this result and it appears that the stronger the European country is, the more the global shocks are absorbed. They are then transmitted from the *Leading* to the *Unbalanced* European countries, and from there they can be transmitted further to other member states.

This study aims to improve the measurement of inequality, helping to achieve a better understanding of the variety of the factors which influence inequality, including spillover effects between countries. Moreover, differences in the benefits and social transfers systems mean the traditional assumption of uniformity in measurement of inequality can generate misleading and incomplete results, particularly in relative rankings of inequality. It is this challenge that is addressed by developing and using a modified income inequality measure in the framework. This contribution has a significant value as it forms the basis of improving policy decision making on the subject. Our findings suggest that there is a strong need to consider the redistributive effects of cross-country exchanges in light of the spillovers and ripple effects revealed by the modified inequality index. This suggests a need to widen the portfolio of policy options and points to a number of potential avenues for policy-development.

This paper is the first of its kind to address the international transmission of developments in inequality. Individual country governments need to take wider account of the impacts of particular kinds of interdependencies with other countries. Contagion effects from financial interdependencies have been examined at length, but this study provides new insights into the timescale and magnitude of spillovers that country governments should consider in the context of the inequality-growth link. The uneven exchange of labour, with different skills and costs arguably has a more complex effect, both positive and negative, on relative inequalities for different local labour groups. Policy-makers should measure, monitor and shape a wider range of redistributive mechanisms that underpin the broader sources of disadvantages and inequality. This approach should also align with policies that promote growth. Inclusive growth policies that take account of the effects of different forms of fiscal intervention, influence opportunities and decision-making regarding education, skills-development, access to employment opportunities, adequate housing, health and welfare are economically as well as socially necessary.

Furthermore, our findings suggest in terms of the dynamics between monetary policy and income distribution that monetary shocks are transmitted relatively rapidly and often get amplified as they travel from the countries in the *Leading* group to other European countries. In fact, a reduction in the interest rate in advanced economies leads to distinctive new equilibria, particularly causing enhancement in the *Balanced* group and deterioration in the *Unbalanced* region. That the spillover to the *Unbalanced* region is negative implies that the original shock is promoting conditions that this specific group requires to generate improvements in terms of income inequality. In this particular example, the indirect improving effects seem primarily to operate through the financial channel, which, in turn, is of especial relevance for the overall performance of economies like that of the United Kingdom.

These are important *ripple effects* and the specific timescales and magnitudes with which, different forms of spillovers influence other linked regions need to be considered in policy making at the EU level and by national governments. Financial and migration exchanges appear to be particularly significant for countries like Denmark, Luxembourg and the Netherlands with the countries of the Unbalanced group. They are examples of a wider range of complex cross-country mechanisms and this highlights the value of employing multiple dimensions for the interrelations between economies.

Our study shows key implications of EU integration on inequality, macroeconomic policies and growth in the region. There is certainly a role for EU agencies in coordinating regional policies in this context, using the insights from this and other studies which have identified important interaction and spillover effects. But while inequality and growth increase in significance as a focus for integrated, Europe-wide policies, the structure and the politics of Europe are radically changing. First, the convergence between north and south, combining different varieties of capitalism (Regan, 2015) is now looking less and less likely. Second, BREXIT as a long-term process of extrication and disentanglement of the UK from the EU bloc has already started to reduce (positive and negative) interdependencies between the UK and other EU countries. This is unprecedented in terms of its complexity and its impact on the spillover and ripple effects highlighted in this paper and should be the focus of further research. There are clearly implications in this study for the UK as it progresses through the BREXIT process and cuts ties with mainland Europe. This process will significantly change the flows (and therefore the pricing) of capital, labour and goods and services into and out of the UK to other countries. This will have a knock-on effect for future UK inequality both relative to other EU nations and internally, between UK regions. This is fertile ground for future studies looking to support the adaptation of current inequality alleviation and inclusive growth policies through the BREXIT period.

Further paths of research could also apply the approach taken in this paper to other regions of the world. Also in the European context, this study provokes broader questions around the effects of EU integration on inequalities in gender, ethnicity and citizenship and points to the need for further research in these areas. This new model can certainly be modified and extended further, but it is hoped that the present version takes a further step towards the development of a transparent and coherent framework for analysing temporal and spatial interdependencies in the context of income inequalities and economic growth.

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Appendices

A Modified inequality (MQ) derivation

Consider $y(\theta_y)$ as the accumulated income of the θ-th percentile, while and the percentile of the households with income less than the income (I) of the k_{th} household is represented by $\theta_k = \frac{k}{N}$ where N is the total number of households. In that case s80/s20 income quintile share ratio, the upper bound value of the eight decile to that of the second decile would be $1 - \int_{0.2}^{0.8} y(\theta)d\theta$ where $y(\theta_y)$ is a function for the Lorenz curve, which follows

$$y(\theta_y) = \frac{\sum_{i=1}^{y} I_i}{\sum_{i=1}^{N} I_i} \tag{A.1}$$

Modifying this function to include in-kind benefits provided by the government, the value of total income increases by $\frac{G}{N}$ to $\hat{I}_i = I_i + (\frac{G}{N})$ where G is the government expenditure $\forall$ i ϵ natural numbers ; i $\leq$ N.

$$\hat{y}(\theta_y) = \frac{\sum_{i=1}^{y}\left(I_i + \frac{G}{N}\right)}{\sum_{i=1}^{N} I_i + G} = \frac{y(\theta_y) + \frac{y \times G}{N \times \sum_{i=1}^{N} I_i}}{1 + \frac{G}{\sum_{i=1}^{N} I_i}} = \frac{y(\theta_y) + \theta_y \frac{G}{\sum_{i=1}^{N} I_i}}{1 + \frac{G}{\sum_{i=1}^{N} I_i}}$$

$$\hat{y}(\theta_y) = \frac{y(\theta_y) + \theta_y SG}{1 + SG} \tag{A.2}$$

where $SG = \frac{G}{\sum_{i=1}^{N} I_i}$ represents the services that the government provides as a share of the total net income of the economy. To modify the income quintile share ratio, the share of government in-kind benefits has to be evaluated. First, transfer payments have to be deducted from tax to calculate total disposable income. Then total taxes out of GDP is measured as the difference between total taxes and social benefits other than social transfers in kind. Three measures are used for this: Gross Domestic Product, government consumption expenditures *(G)*, and total tax revenue as a percentage of GDP *(T)* to give the share of government consumption out of GDP. In a more conventional notation:

$$SG = \frac{G}{y(1-T)} \tag{A.3}$$

where the *y (1-T)* is a proxy for the total net income of the economy and SG represents the services that the government provides as a share of total net income of the economy. With the approximation $\sum_{i=1}^{N} I_i \approx y(1-T)$ modified income quintile share ratio equals to $\frac{s20/80\, ratio}{1+SG}$.

B Data Sources

The sample consists of 17 European countries: Hungary, France, Netherlands, Estonia, United Kingdom, Denmark, Greece, Ireland, Luxembourg, Austria, Spain, Sweden, Portugal, Italy, Finland, Germany and Belgium, quarterly data between 1996Q1 and 2012Q1 comprising geographic data, macroeconomic aggregates, financial indicators as well as migration and key open-economy variables.

1 S20/ S80 ratio, it is calculated as the ratio of total income received by the 20 percent of the population with the highest income (the top quintile) to that received by the 20 percent of the population with the lowest income (the bottom quintile). All incomes are compiled as equivalised disposable incomes, (EUROSTAT).

2 At-risk-of-poverty rates, the share of people with an equivalised disposable income (after social transfer) below the at-risk-of-poverty threshold, which is set at 60 percent of the national median equivalised disposable income after social transfers, (EUROSTAT).

3 Modified quintile ratio, own calculations. *Data adjustment: At risk of poverty rates and income quintile share ratios are interpolated using the Denton (1971) interpolation.*

5 Social benefits other than social transfers in kind, percent of GDP, (OECD).

6 Total imports and Total exports, bi-lateral trade data, millions US dollars (IMF DTS).

7 Total taxes, percent of GDP, (OECD).

8 Geo-localisation data, coordinates of capital cities from the World Bank's online database's API. Geographic distances are calculated using James P. LeSage's econometric toolbox.

9 Foreign direct investment positions (inward plus outward) bi-lateral totals, normalised with respect to each country's total in relation to the other economies in the sample. Calculated with data from IMF's Coordinated Direct Investment Survey.

10 GDP, (quarterly), current prices, current PPPs, millions (EUROSTAT).

11 Bi-lateral migration, total stocks 1990 and 2000, weighted average calculated with data from the World Bank's Global Bilateral Migration Database.

12 Short term interest rate, 3-months interest rate, (EUROSTAT).

C GVAR settings

C.1 Selecting lag-length and cointegration rank

Country specific models are estimated based on the appropriate lag order and cointegration dynamics. The lag order of the domestic variables, p_i, is selected in agreement with Akaike criterion, and q_i is set equal to 1 in all countries. Owing to data limitations, p_{max} and q_{max} are not allowed to be greater than 2.[25] The rank of the cointegrating space for each country is tested using Johansen's trace and maximal eigenvalue statistics as set out in Pesaran, Shin, and Smith (2000) for models with weakly exogenous *I(1)* regressors, where unrestricted constants and

[25]In the light of suggestions provided by Cesa-Bianchi *et al.* (2012) the orders of the VARX* models with very ragged responses are changed from VARX(2,1) to VARX(2,2) in an attempt to provide a convenient estimation procedure.

restricted trend coefficients are included in the individual country error correction models. The number of cointegration relations are reduced to address the issue of possible over-identification, as well as to assure the stability of the global model. More specifically, the following ad hoc adjustments in the number of cointegration relations are made: Austria from 4 to 3, Ireland from 2 to 1, Spain from 4 to 1, and Sweden from 4 to 3.

As mentioned earlier, a crucial condition underlying the estimation strategy is the weak exogeneity of x_{it}^* with respect to the long-run parameters of the conditional model.[26] This assumption is tested along the lines described in Johansen (1992) and Harbo *et al.* (1998), which involves a test of the joint significance of the estimated error correction term in auxiliary equations for the country-specific foreign variables, x_{it}^*. Clearly, there is no single best structure to be imposed across the countries, given data constraints and different specifications of the individual country models.[27] Overall, most of the countries have the same set of domestic variables, except for a few countries where *I(2)* variables are not included. Results suggest that for the majority of the variables being considered, weak exogenity assumptions could not be rejected.

C.2 Pair-wise cross-country correlations: variables and residuals

One of the key assumptions of the GVAR modelling approach is that the *idiosyncratic* shocks of the individual country models should be cross-sectionally *weakly correlated*, as otherwise they cannot be considered to be idiosyncratic. However, if the country-specific models are conditioned on weakly exogenous foreign variables, it is reasonable to expect that the degree of correlation of the remaining shocks will be modest across regions. This section outlines direct evidence verifying the weak correlation assumption and, with it, showing that $Cov(\mathbf{x}_{i,t}^*, u_{i,t}) \to 0$ as $N \to \infty$. The success of the model in securing this assumption is measured as how far the residuals are orthogonal to the variables.[28] Average pair-wise cross-section correlations are computed for the levels and first differences of the endogenous variables. The tables also include the correlations between the VECMX* residuals and each variable in the model (see Appendix K). It is quite interesting to note that the cross-sectional correlations of the residuals from the VARX* models are very small.[29] In fact, no residual series displays a correlation larger than 10 per cent with any foreign variables in levels or in first differences. In this way, these results give a promising picture and indicate that the model has indeed managed to capture the common effects driving the endogenous variables, meaning it can be considered successful at explaining cross-country interdependencies. Average cross section correlations with the domestic variables seem to be generally high, and this is a clear indication of their usefulness for modelling intra-regional interdependencies. Even the variables displaying a high degree of cross-sectional correlation such as real output, where all the available level-coefficients are larger than 0.90, display almost zero correlations with the VECMX* residuals.[30] Another variable with clearly strong international correlations is the interest rate.[31] The values for the cross-sectional correlations of the residuals from the individual country models that include the

[26] In practice, the weak exogeneity assumption permits considering each country as a small open economy with respect to the rest of the world.

[27] In fact, as noted earlier, the methodology adopted has the advantage to handle flexibly different specifications for different countries.

[28] As is the norm for the variables in this empirical application.

[29] Most of the residual series (12 out of 14) show correlations with the variables of 0.10 or lower.

[30] With Germany as the only exception where the correlation is larger than 10 per cent.

[31] This has a mean of 0.85 over all the available countries.

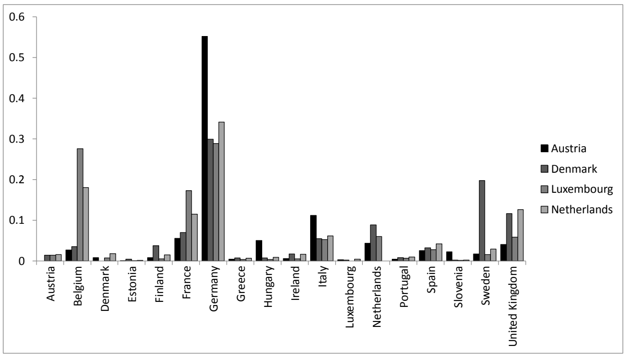
modified inequality measure, the rate for risk of poverty, and inflation appear to lie between zero and 0.10. Exceptions are noted for inflation, where the correlation of the residuals from the individual country models is slightly higher and these results suggest that the orthogonalisation noted earlier has been successfully achieved for these variables.

C.3 Persistence profiles and the stability of the global system

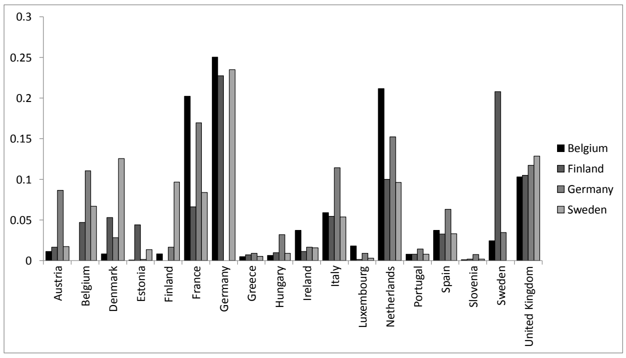
The stability of the system is analysed through persistence profiles, which are variable-specific shocks on the dynamics of the long-run relations, or the time profiles of the effects of the system. If the vector under consideration is a valid cointegrating vector, the persistence profiles should return to equilibrium at an acceptable rate, and normally in fewer than 40 periods.[32] The model satisfies this property, and the persistence profiles of all the cointegration relations settle down reasonably well. Specifically, all the cointegrating relations return to their long-run equilibria within ten quarters after a shock to the system. The stability of the system can also be examined by analysing the eigenvalues. Following Pesaran *et al.* (2005), the global system should have at least 48 unit roots, which is the number of domestic variables minus the number of cointegrating relations ($91 - 43 = 48$). The global system does indeed have 50 eigenvalues that fall on the unit circle, with the remaining eigenvalues having moduli that are all less than unity.

[32] See Pesaran and Shin (1996) for a discussion on the persistence profiles of the cointegrating models.

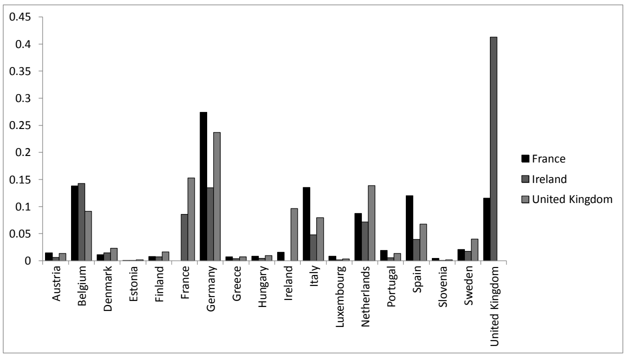
D Trade weights



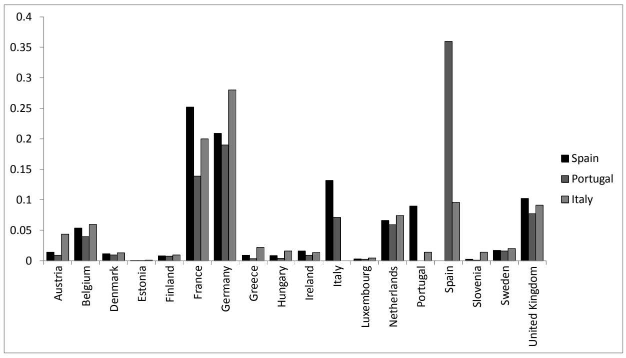
(a) Leading region



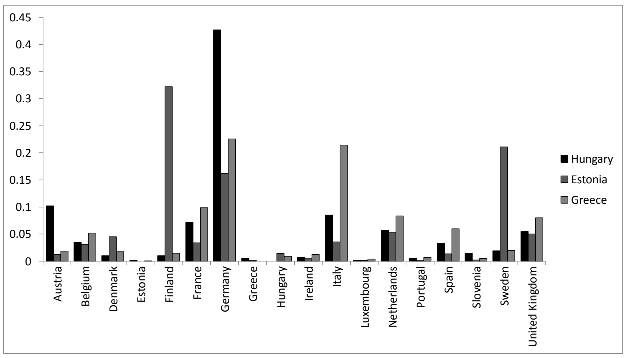
(b) Balanced region



(c) Unbalanced region

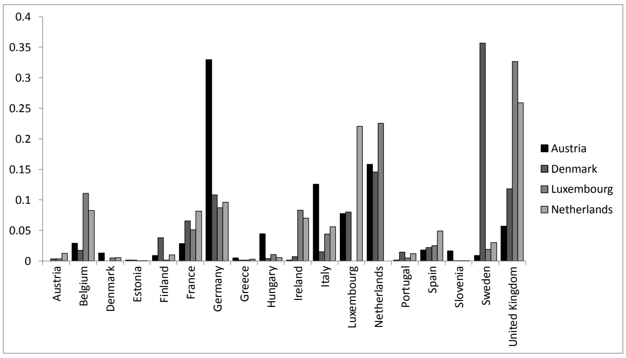


(d) Vulnerable region

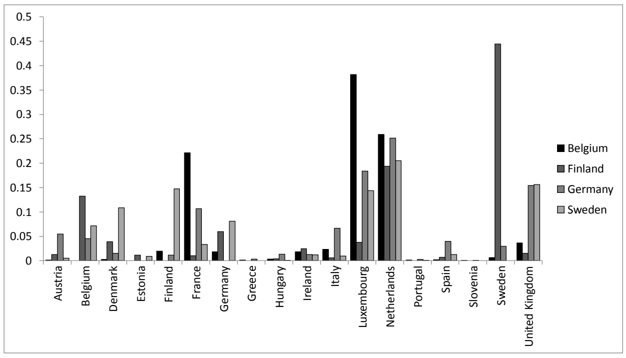


(e) Highly Vulnerable region

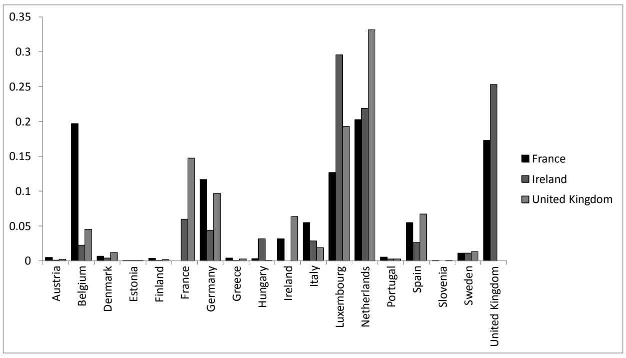
E Finance weights



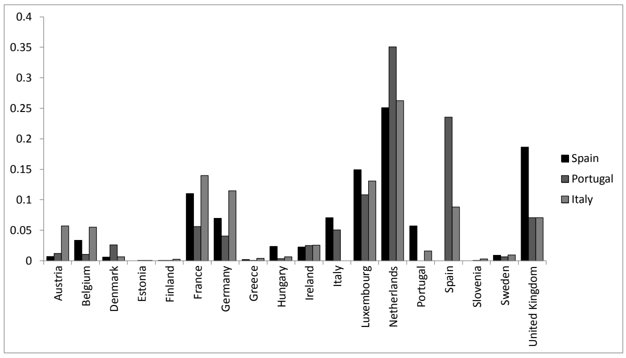
(a) Leading region



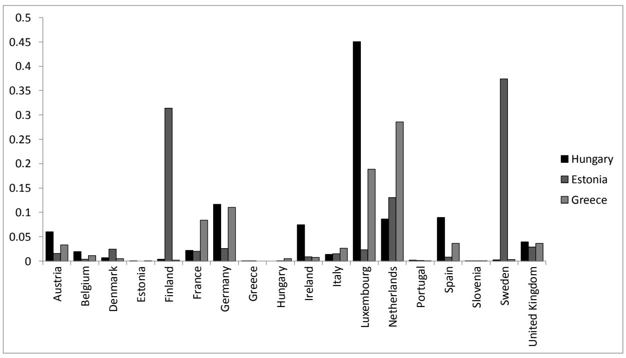
(b) Balanced region



(c) Unbalanced region

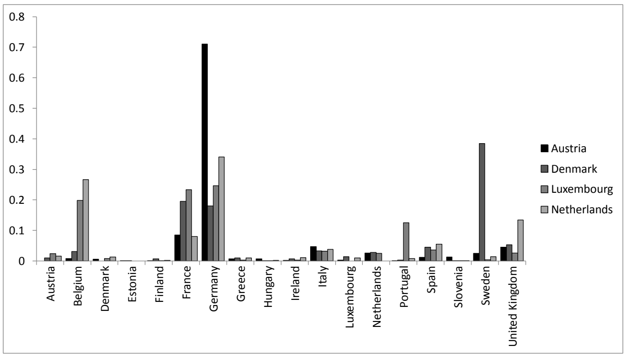


(d) Vulnerable region

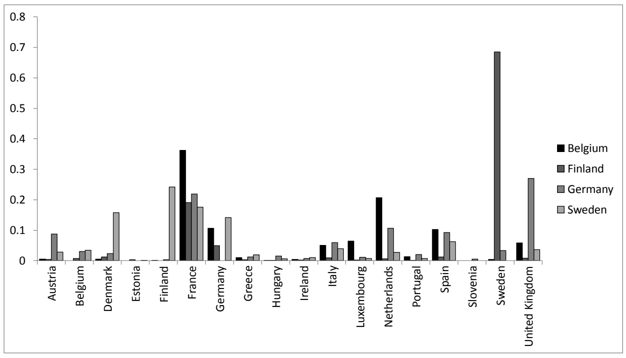


(e) Highly Vulnerable region

F Migration weights



(a) Leading region



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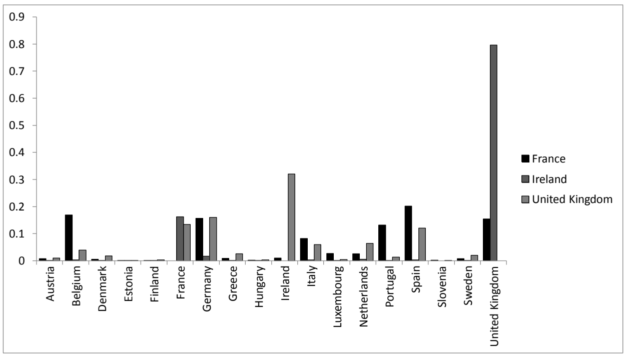
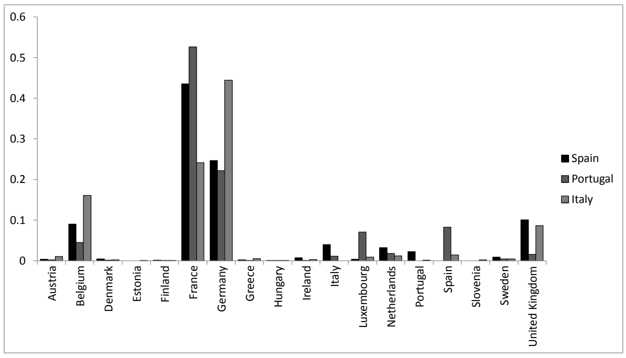
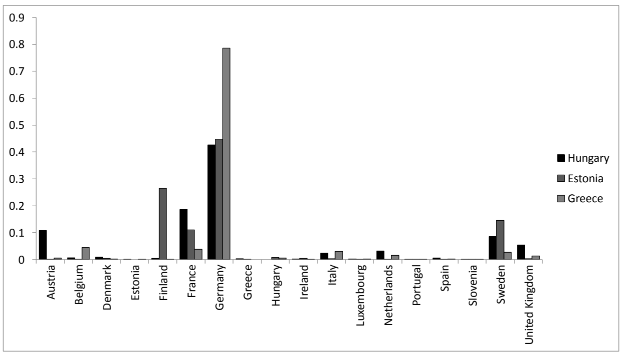


(c) Unbalanced region



(d) Vulnerable region



(e) Highly Vulnerable region

G Cross-country weight matrix

	AUSTRIA	BELGIUM	DENMARK	ESTONIA	FINLAND	FRANCE	GERMANY	GREECE	HUNGARY
AUSTRIA	0.0000	0.0075	0.0124	0.0117	0.0130	0.0109	0.0781	0.0274	0.1008
BELGIUM	0.0256	0.0000	0.0296	0.0139	0.0660	0.1699	0.0664	0.0390	0.0242
DENMARK	0.0133	0.0074	0.0000	0.0276	0.0372	0.0100	0.0305	0.0124	0.0121
ESTONIA	0.0029	0.0012	0.0045	0.0000	0.0514	0.0013	0.0030	0.0030	0.0032
FINLAND	0.0086	0.0109	0.0308	0.3206	0.0000	0.0055	0.0129	0.0095	0.0089
FRANCE	0.0551	0.2468	0.0990	0.0475	0.0755	0.0000	0.1560	0.0852	0.0860
GERMANY	0.5151	0.1236	0.1980	0.1797	0.1151	0.1799	0.0000	0.3371	0.3189
GREECE	0.0078	0.0057	0.0070	0.0019	0.0044	0.0076	0.0093	0.0000	0.0062
HUNGARY	0.0483	0.0053	0.0073	0.0089	0.0070	0.0063	0.0238	0.0129	0.0000
IRELAND	0.0045	0.0227	0.0118	0.0071	0.0138	0.0219	0.0140	0.0100	0.0311
ITALY	0.1055	0.0434	0.0352	0.0197	0.0246	0.0902	0.0824	0.1058	0.0473
LUXEMBOURG	0.0345	0.1656	0.0359	0.0097	0.0155	0.0611	0.0747	0.0840	0.1632
NETHERLANDS	0.0862	0.2297	0.0931	0.0662	0.1059	0.1148	0.1736	0.1581	0.0628
PORTUGAL	0.0036	0.0077	0.0099	0.0019	0.0038	0.0434	0.0124	0.0045	0.0039
SPAIN	0.0205	0.0411	0.0316	0.0086	0.0179	0.1151	0.0615	0.0408	0.0471
SWEDEN	0.0186	0.0132	0.2957	0.2455	0.4037	0.0145	0.0348	0.0187	0.0338
UNITED KINGDOM	0.0500	0.0682	0.0982	0.0295	0.0453	0.1476	0.1667	0.0515	0.0505

	IRELAND	ITALY	LUXEMBOURG	NETHERLANDS	PORTUGAL	SPAIN	SWEDEN	UNITED KINGDOM
AUSTRIA	0.0049	0.0443	0.0145	0.0159	0.0100	0.0105	0.0187	0.0100
BELGIUM	0.0635	0.0851	0.1979	0.1729	0.0319	0.0569	0.0600	0.0647
DENMARK	0.0095	0.0105	0.0090	0.0143	0.0150	0.0093	0.1279	0.0193
ESTONIA	0.0017	0.0024	0.0012	0.0016	0.0017	0.0016	0.0142	0.0018
FINLAND	0.0042	0.0063	0.0038	0.0103	0.0041	0.0046	0.1524	0.0084
FRANCE	0.0968	0.1865	0.1450	0.0945	0.2039	0.2412	0.0875	0.1474
GERMANY	0.0694	0.2584	0.1988	0.2421	0.1386	0.1622	0.1516	0.1599
GREECE	0.0033	0.0143	0.0034	0.0068	0.0033	0.0062	0.0087	0.0110
HUNGARY	0.0145	0.0132	0.0067	0.0071	0.0047	0.0133	0.0085	0.0058
IRELAND	0.0000	0.0165	0.0336	0.0351	0.0162	0.0192	0.0140	0.1412
ITALY	0.0301	0.0000	0.0442	0.0525	0.0482	0.0842	0.0344	0.0516
LUXEMBOURG	0.1081	0.0543	0.0000	0.0891	0.0597	0.0581	0.0559	0.0747
NETHERLANDS	0.1074	0.1263	0.1144	0.0000	0.1516	0.1228	0.1152	0.1873
PORTUGAL	0.0064	0.0130	0.0377	0.0107	0.0000	0.0657	0.0063	0.0112
SPAIN	0.0278	0.0722	0.0295	0.0476	0.2405	0.0000	0.0333	0.0803
SWEDEN	0.0121	0.0140	0.0147	0.0257	0.0109	0.0131	0.0000	0.0255
UNITED KINGDOM	0.4405	0.0827	0.1456	0.1737	0.0597	0.1311	0.1114	0.0000

H Regional weights

Region	Country	ly	r	mq	pov	Dp
hvulnerable	hun				0.8864	0.3726
hvulnerable	est	1.0000	1.0000		0.1136	0.0478
hvulnerable	grc					0.5796
vulnerable	prt	0.1151	0.0718	0.0718	0.0718	0.0718
vulnerable	ita	0.8849	0.5516	0.5516	0.5516	0.5516
vulnerable	esp		0.3766	0.3766	0.3766	0.3766
unbalanced	fra	0.4969	0.4777	0.4969	0.4777	0.4777
unbalanced	gbr	0.5031	0.4837	0.5031	0.4837	0.4837
unbalanced	ire		0.0386		0.0386	0.0386
balanced	swe	0.0890	0.0890	0.0890	0.0890	0.0890
balanced	fin	0.0477	0.0477	0.0477	0.0477	0.0477
balanced	deu	0.7630	0.7630	0.7630	0.7630	0.7630
balanced	bel	0.1003	0.1003	0.1003	0.1003	0.1003
leading	nld	0.5346	0.5512	0.5346	0.7252	0.5512
leading	dnk	0.1725	0.1778	0.1725	0.2340	0.1778
leading	lux	0.0300		0.0300	0.0408	
leading	aut	0.2629	0.2710	0.2629		0.2710

I Solution of the global system

To construct the global VAR model from the individual country specific models, domestic and foreign variables for each country are grouped together. Define:

$$z_{it} = \begin{bmatrix} x_{it} \\ x^*_{it} \end{bmatrix}_{(k_i+k^*_i)\times 1} \tag{I.1}$$

Given this renaming, system can be written as:

$$A_{i0}Z_{it} = a_{i0} + a_{i1}t + A_{i1}Z_{i,t-1} + u_{it} \tag{I.2}$$

where $A_{i0} = (I_{ki}, -\Lambda_{i0})$, $A_{i1} = (\phi_{i1}, -\phi_{i1})$.[33] To arrive at the global solution of the interconnected system, the countries are tied together via stacking the estimated individual country specific models and linking them with a matrix of multidimensional cross country linkages. This link matrix will allow the country specific models to be written in terms of a global variable vector x_t. The identity below will be obtained by using multidimensional weights $Z_{it} = W_iX_t$ where $x_t = [x'_{1t}, ..., x'_{Nt}]$ is the $k \times 1$ vector which collects all the endogenous variables of the system, and W_i is a $(k_i + k^*_i) \times k$ matrix. Given $Z_{it} = W_iX_t$, it follows that:

$$A_{i0}W_iX_t = a_{i0} + a_{i1t}t + A_{i1}W_iX_{t-1} + u_t \tag{I.3}$$

These individual country models are stacked to yield global solution of the interconnected system and for X_t is given by

$$G_0X_t = \mathbf{a}_0 + \mathbf{a}_{1t}t + G_1X_{t-1} + \mathbf{u}_t \tag{I.4}$$

$$G_1 = \begin{bmatrix} \mathbf{A}_{10}\mathbf{W}_1 \\ . \\ . \\ . \\ . \\ \mathbf{A}_N\mathbf{W}_N \end{bmatrix} \mathbf{a}_0 = \begin{bmatrix} \mathbf{a}_{00} \\ . \\ . \\ . \\ . \\ \mathbf{a}_{N0} \end{bmatrix}, \mathbf{a}_1 = \begin{bmatrix} \mathbf{a}_{11} \\ . \\ . \\ . \\ . \\ \mathbf{a}_{N1} \end{bmatrix} \mathbf{u}_t = \begin{bmatrix} \mathbf{u}_{1t} \\ . \\ . \\ . \\ . \\ \mathbf{a}_{N1} \end{bmatrix}$$

Premultiply (3.13) by $\mathbf{G}_0^{-1}$ that is a non-singular matrix that depends on the multidimensional composite weights and parameter estimates to obtain GVAR(1) model.

$$\mathbf{G}_0^{-1}G_0X_t = \mathbf{G}_0^{-1}\mathbf{a}_0 + \mathbf{G}_0^{-1}\mathbf{a}_{1t}t + \mathbf{G}_0^{-1}G_1X_{t-1} + \mathbf{G}_0^{-1}\mathbf{u}_t \tag{I.5}$$

$$X_t = \mathbf{b}_0 + \mathbf{b}_{1t}t + F_1X_{t-1} + \varepsilon_t \tag{I.6}$$

where

$$\mathbf{b}_0 = \mathbf{G}_0^{-1}\mathbf{a}_0 \qquad \mathbf{b}_{1t}t = \mathbf{G}_0^{-1}\mathbf{a}_{1t}t \qquad \mathbf{F}_1 = \mathbf{G}_0^{-1}G_1 \qquad \varepsilon_t = \mathbf{G}_0^{-1}\mathbf{u}_t \tag{I.7}$$

Equation (3.15) is a high dimensional global model that can be solved recursively and used for dynamic analysis in the usual manner for Europe as a whole, where domestic and foreign

[33] Matrix A involves country parameter estimates of domestic and foreign variables.

variables interact simultaneously. Dynamic properties of the global model are examined through Generalized Impulse Response Functions (GIRFs).[34]

J Contemporaneous effects of foreign variables on their domestic counterparts

Country	Statistics	ly	r	mq	pov	Dp
AUSTRIA	Coefficient	**0.3865***	**0.9878**	**0.5328**		**0.8361**
	Newey-West t-ratio	3.0518	43.355	5.0930		6.5317
BELGIUM	Coefficient	**0.4029**	**0.9697**	**0.9427**	-0.3451	**0.9892**
	Newey-West t-ratio	5.0125	77.3768	9.0327	-0.9059	15.4025
DENMARK	Coefficient	**1.2458**			-0.2531	**0.8486**
	Newey-West t-ratio	8.9735			-1.4633	10.7354
ESTONIA	Coefficient	**1.1705**	**1.3586**		**1.1933**	**0.7844**
	Newey-West t-ratio	3.3372	2.3028		2.2618	2.4343
FINLAND	Coefficient	**0.7423**	**0.8597**	**0.9431**	0.0730	**0.7798**
	Newey-West t-ratio	5.6900	11.5932	7.8217	0.5563	11.2354
FRANCE	Coefficient	**0.5819**	**0.9476**			**0.9290**
	Newey-West t-ratio	7.9848	17.4731			21.7522
GERMANY	Coefficient	**0.8264**	**0.9605**	**0.6962**		
	Newey-West t-ratio	9.1990	15.9707	8.2607		
GREECE	Coefficient					**1.1829**
	Newey-West t-ratio					4.6401
HUNGARY	Coefficient					**1.3756**
	Newey-West t-ratio					8.8723
IRELAND	Coefficient		**1.0946**		-0.2542	**1.3690**
	Newey-West t-ratio		7.4025		-0.2542	**1.3690**
ITALY	Coefficient	**0.8648**	**1.0335**	**2.1194**		**0.3990**
	Newey-West t-ratio	10.1280	17.5399	9.3086		7.8401
LUXEMBOURG	Coefficient	**2.7466**		**1.6099**		
	Newey-West t-ratio	5.1620		17.0581		
NETHERLANDS	Coefficient	**0.5789**	**0.9284**	0.4421		
	Newey-West t-ratio	4.7703	13.3184	1.9647		
PORTUGAL	Coefficient	**0.7881**	**1.0221**		**0.8263**	**1.0791**
	Newey-West t-ratio	3.4172	66.7643		2.1448	11.5658
SPAIN	Coefficient		**1.0044**	**2.0026**	-0.6092	**0.4679**
	Newey-West t-ratio		25.1938	4.0892	-1.1572	2.4557
SWEDEN	Coefficient	**1.1118**	**0.4570**	**0.8665**	**-0.8404**	
	Newey-West t-ratio	4.5528	3.7270	4.0981	-2.2093	
UK	Coefficient	**0.5731**	**0.7102**	**-0.3365**	**-0.7009**	**0.7114**
	Newey-West t-ratio	4.0946	4.5328	-2.2526	-4.3663	6.3057

*Significant coefficients at the 5 percent level are marked in bold.

[34]The GVAR literature largely relies on GIRF proposed in Koop, Pesaran and Potter (1996) for non-linear models. For a mathematical exposition of the GIRF applied to VARX and formal proof of cointegrating VAR models see, Garratt, Lee, Pesaran and Shin (2006, Chs. 6 10.)

K Average pair-wise cross-section correlations

Country	Real Output (log)		
	Levels	First Differences	VECMX Residuals
AUSTRIA	0.97	0.63	0.03
BELGIUM	0.97	0.64	-0.03
DENMARK	0.95	0.43	-0.02
ESTONIA	0.96	0.53	0.00
FINLAND	0.98	0.62	-0.04
FRANCE	0.98	0.67	-0.07
GERMANY	0.94	0.60	-0.14
GREECE			
HUNGARY			
IRELAND			
ITALY	0.91	0.66	-0.01
LUXEMBOURG	0.97	0.43	-0.03
NETHERLANDS	0.97	0.62	-0.03
PORTUGAL	0.93	0.48	0.02
SPAIN			
SWEDEN	0.97	0.57	-0.01
UNITED KINGDOM	0.97	0.61	-0.07

Country	Interest rate		
	Levels	First Differences	VECMX Residuals
AUSTRIA	0.90	0.87	0.07
BELGIUM	0.90	0.86	0.02
DENMARK	0.87	0.75	0.01
ESTONIA	0.54	0.13	-0.12
FINLAND	0.89	0.86	0.07
FRANCE	0.90	0.87	0.07
GERMANY	0.89	0.86	0.04
GREECE			
HUNGARY			
IRELAND	0.87	0.73	0.03
ITALY	0.85	0.82	-0.03
LUXEMBOURG			
NETHERLANDS	0.89	0.86	0.10
PORTUGAL	0.89	0.84	0.04
SPAIN	0.90	0.85	0.02
SWEDEN	0.84	0.70	-0.07
UNITED KINGDOM	0.82	0.75	-0.19

Country	Modified Quintile ratio		
	Levels	First Differences	VECMX Residuals
AUSTRIA	0.14	0.38	0.07
BELGIUM	-0.14	0.30	0.03
DENMARK	0.06	0.28	0.08
ESTONIA			
FINLAND	0.10	0.49	0.03
FRANCE	-0.19	0.16	-0.06
GERMANY	0.02	0.31	0.01
GREECE			
HUNGARY			
IRELAND			
ITALY	0.05	0.53	0.04
LUXEMBOURG	0.15	0.53	0.09
NETHERLANDS	-0.07	0.41	-0.01
PORTUGAL	-0.06	0.52	0.07
SPAIN	-0.16	0.49	-0.08
SWEDEN	0.09	0.43	0.00
UNITED KINGDOM	0.03	-0.15	-0.09

Country	Poverty		
	Levels	First Differences	VECMX Residuals
AUSTRIA			
BELGIUM	0.20	-0.07	-0.05
DENMARK	0.21	-0.10	-0.10
ESTONIA	0.05	0.07	0.04
FINLAND	0.21	0.03	0.06
FRANCE	-0.26	0.00	0.03
GERMANY	0.17	-0.07	-0.02
GREECE			
HUNGARY	0.24	0.04	0.03
IRELAND	-0.25	-0.06	-0.03
ITALY	0.11	0.04	0.07
LUXEMBOURG	0.19	-0.03	-0.03
NETHERLANDS	-0.05	0.04	0.05
PORTUGAL	-0.36	-0.03	-0.04
SPAIN	0.20	-0.03	-0.06
SWEDEN	0.22	0.04	0.06
UNITED KINGDOM	-0.17	-0.11	-0.01

Country	Inflation		
	Levels	First Differences	VECMX Residuals
AUSTRIA	0.55	0.54	0.03
BELGIUM	0.47	0.35	-0.06
DENMARK	0.55	0.58	0.07
ESTONIA	0.35	0.24	0.03
FINLAND	0.55	0.54	0.04
FRANCE	0.62	0.64	0.05
GERMANY	0.35	0.16	-0.02
GREECE	0.39	0.46	0.05
HUNGARY	0.20	0.30	0.02
IRELAND	0.47	0.50	0.01
ITALY	0.50	0.40	0.09
LUXEMBOURG			
NETHERLANDS	0.50	0.54	0.01
PORTUGAL	0.56	0.55	-0.03
SPAIN	0.45	0.43	0.01
SWEDEN	0.51	0.51	0.07
UNITED KINGDOM	0.44	0.53	0.06

L Variance Decompositions

Proportion of the N-step ahead Forecast Error Variance of BALANCED MQ Explained by Conditioning on Contemporaneous and Future Innovations of the Country Equations

		Horizon																				
Region	**Variable**	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Vulnerable	MQ	0.0377	0.0199	0.0137	0.0125	0.0122	0.0111	0.0100	0.0091	0.0082	0.0075	0.0069	0.0064	0.0060	0.0056	0.0054	0.0051	0.0050	0.0048	0.0047	0.0046	0.0045
Unbalanced	MQ	0.0200	0.0188	0.0166	0.0147	0.0140	0.0143	0.0154	0.0169	0.0186	0.0202	0.0217	0.0229	0.0239	0.0246	0.0252	0.0256	0.0259	0.0261	0.0263	0.0264	0.0265
Balanced	MQ	0.4930	0.4508	0.4099	0.3953	0.3863	0.3810	0.3777	0.3771	0.3773	0.3780	0.3790	0.3803	0.3816	0.3831	0.3845	0.3860	0.3874	0.3887	0.3899	0.3909	0.3918
Leading	MQ	0.0157	0.0209	0.0254	0.0269	0.0278	0.0285	0.0285	0.0284	0.0280	0.0276	0.0271	0.0267	0.0262	0.0259	0.0256	0.0253	0.0251	0.0250	0.0249	0.0248	0.0248

Proportion of the N-step ahead Forecast Error Variance of UNBALANCED MQ Explained by Conditioning on Contemporaneous and Future Innovations of the Country Equations

		Horizon																				
Region	**Variable**	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Vulnerable	MQ	0.0512	0.0350	0.0338	0.0350	0.0342	0.0329	0.0322	0.0318	0.0314	0.0311	0.0310	0.0308	0.0307	0.0306	0.0305	0.0304	0.0303	0.0302	0.0301	0.0300	0.0300
Unbalanced	MQ	0.3432	0.3161	0.2934	0.2587	0.2283	0.2057	0.1892	0.1757	0.1651	0.1569	0.1505	0.1453	0.1412	0.1378	0.1353	0.1332	0.1315	0.1302	0.1291	0.1282	0.1273
Balanced	MQ	0.0213	0.0221	0.0216	0.0287	0.0363	0.0427	0.0484	0.0548	0.0609	0.0665	0.0715	0.0762	0.0801	0.0835	0.0864	0.0888	0.0908	0.0925	0.0939	0.0951	0.0962
Leading	MQ	0.0363	0.0308	0.0316	0.0368	0.0413	0.0442	0.0464	0.0485	0.0504	0.0519	0.0532	0.0542	0.0550	0.0556	0.0559	0.0563	0.0565	0.0567	0.0568	0.0570	0.0572

Proportion of the N-step ahead Forecast Error Variance of LEADING MQ Explained by Conditioning on Contemporaneous and Future Innovations of the Country Equations

		Horizon																				
Region	**Variable**	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Vulnerable	MQ	0.0233	0.0163	0.0137	0.0132	0.0125	0.0119	0.0111	0.0107	0.0102	0.0101	0.0101	0.0103	0.0105	0.0108	0.0111	0.0115	0.0118	0.0121	0.0123	0.0125	0.0127
Unbalanced	MQ	0.0182	0.0234	0.0285	0.0317	0.0382	0.0445	0.0512	0.0563	0.0604	0.0629	0.0647	0.0656	0.0662	0.0665	0.0666	0.0666	0.0665	0.0664	0.0663	0.0662	0.0661
Balanced	MQ	0.0726	0.0906	0.1051	0.1065	0.1203	0.1285	0.1367	0.1396	0.1432	0.1436	0.1441	0.1430	0.1421	0.1403	0.1389	0.1371	0.1356	0.1341	0.1329	0.1317	0.1308
Leading	MQ	0.3418	0.2710	0.2233	0.1907	0.1615	0.1386	0.1195	0.1062	0.0955	0.0879	0.0819	0.0776	0.0740	0.0714	0.0692	0.0675	0.0662	0.0651	0.0643	0.0637	0.0631

Proportion of the N-step ahead Forecast Error Variance of LEADING S RATE Explained by Conditioning on Contemporaneous and Future Innovations of the Country Equations

		Horizon																				
Region	**Variable**	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Vulnerable	MQ	0.0123	0.0325	0.0384	0.0397	0.0393	0.0381	0.0361	0.0339	0.0320	0.0303	0.0289	0.0277	0.0268	0.0260	0.0255	0.0251	0.0248	0.0245	0.0243	0.0242	0.0241
Unbalanced	MQ	0.0036	0.0065	0.0078	0.0082	0.0075	0.0061	0.0051	0.0048	0.0051	0.0058	0.0066	0.0074	0.0080	0.0084	0.0087	0.0089	0.0090	0.0090	0.0089	0.0088	0.0088
Balanced	MQ	0.0024	0.0164	0.0328	0.0464	0.0593	0.0738	0.0882	0.1018	0.1140	0.1249	0.1342	0.1420	0.1483	0.1536	0.1578	0.1613	0.1641	0.1664	0.1683	0.1699	0.1712
Leading	MQ	0.0083	0.0227	0.0298	0.0333	0.0352	0.0371	0.0388	0.0401	0.0410	0.0415	0.0418	0.0420	0.0420	0.0420	0.0420	0.0420	0.0421	0.0422	0.0423	0.0424	0.0426

Proportion of the N-step ahead Forecast Error Variance of REAL OUTPUT Explained by Conditioning on Contemporaneous and Future Innovations of the Country Equations

		Horizon																				
Region	**Variable**	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Vulnerable	MQ	0.0135	0.0248	0.0243	0.0243	0.0220	0.0202	0.0181	0.0166	0.0152	0.0141	0.0132	0.0126	0.0121	0.0117	0.0114	0.0112	0.0110	0.0108	0.0107	0.0106	0.0105
Unbalanced	MQ	0.0054	0.0028	0.0024	0.0028	0.0042	0.0060	0.0083	0.0106	0.0129	0.0148	0.0164	0.0176	0.0185	0.0191	0.0196	0.0198	0.0200	0.0201	0.0201	0.0201	0.0201
Balanced	MQ	0.0184	0.0359	0.0542	0.0707	0.0850	0.0980	0.1092	0.1190	0.1270	0.1336	0.1386	0.1426	0.1455	0.1478	0.1495	0.1508	0.1518	0.1527	0.1533	0.1539	0.1544
Leading	MQ	0.0051	0.0202	0.0247	0.0297	0.0319	0.0338	0.0347	0.0354	0.0356	0.0357	0.0355	0.0354	0.0353	0.0352	0.0351	0.0352	0.0353	0.0354	0.0356	0.0359	0.0361

Proportion of the N-step ahead Forecast Error Variance of Regional MQ Explained by Conditioning on Contemporaneous and Future Innovations of the Country Equations

		Horizon																				
Region	**Variable**	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Vulnerable	Poverty	0.0149	0.0304	0.0340	0.0405	0.0412	0.0425	0.0418	0.0422	0.0418	0.0420	0.0419	0.0422	0.0423	0.0427	0.0429	0.0434	0.0437	0.0441	0.0444	0.0448	0.0450
Unbalanced	Poverty	0.0064	0.0030	0.0028	0.0020	0.0015	0.0017	0.0025	0.0037	0.0049	0.0061	0.0072	0.0082	0.0090	0.0096	0.0102	0.0106	0.0110	0.0113	0.0116	0.0118	0.0120
Balanced	Poverty	0.2186	0.3516	0.4094	0.4382	0.4505	0.4623	0.4708	0.4784	0.4838	0.4887	0.4924	0.4957	0.4984	0.5008	0.5030	0.5050	0.5069	0.5086	0.5102	0.5116	0.5129
Leading	Poverty	0.0862	0.1635	0.1654	0.1809	0.1737	0.1608	0.1417	0.1274	0.1138	0.1040	0.0957	0.0898	0.0847	0.0810	0.0776	0.0751	0.0728	0.0711	0.0695	0.0683	0.0672