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EUROPEAN MONETARY INTEGRATION AND AGGREGATE RELATIVE DEPRIVATION: THE DULL SIDE OF THE SHINY EURO

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Drawing on the premise that the integration of economies revises people's social space and their comparators, we quantify social stress by aggregate relative deprivation, *ARD*; we calculate the effect of monetary mergers on *ARD*; and we document the validity of the superadditivity property of *ARD* for successive adoptions of a common currency by European countries. One feature of monetary unification, which replaces diverse currencies with a common currency, is that it brings about a change in the comparison environment, expanding the reference space of individuals in a given country to encompass individuals from the joining countries. Overall, calculations regarding six enlargements of the Economic and Monetary Union between 1999 and 2011 reveal an increase of *ARD* on six occasions when we hold incomes constant, and on five when we take into consideration changes in incomes. In addition, we observe an uneven distribution of the costs and benefits from monetary integration among the participating countries when these costs and benefits are measured in terms of *ARD*.

1. INTRODUCTION

Economies can be integrated in a variety of ways. The starting point of this article is that the elimination of political and economic borders also revises people's social space and their comparators. In large measure, the speed of this revision depends on the manner of integration. Here we review a unique form of integration – currency unification in Europe – in sequence of enlargements of the Economic and Monetary Union (EMU). The introduction of a common currency is an instrument of fundamental change in economic and social relations in general, and in interpersonal comparisons of earnings, pay, and incomes in particular. Although, prior to the introduction of the euro as a common currency, individuals in specific European countries were able to compare their incomes with the incomes of individuals in other European countries, the comparison was not immediate, it required effort to convert incomes denominated in different currencies, and it was presumably not done very often. (We return to this point both below in this section, and in our concluding remarks). When a single currency is introduced, the comparison environment changes, enabling, indeed inviting, simpler comparisons with others. For example, with currency unification, workers who perform the same task and who are employed by a manufacturer with plants located in different EMU countries can compare their earnings with each other directly, effortlessly, and routinely. Such comparisons, implicit or explicit, bear on wellbeing.

The purpose of this article is to link empirically the superadditivity property of aggregate relative deprivation, *ARD*, which is a measure of social stress, with monetary integration. Holding individuals' incomes constant, the superadditivity

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theorem of *ARD* states that a merger of populations increases the *ARD* of the merged population as compared to the sum of the levels of *ARD* of the constituent populations when apart (Stark, 2013). Accordingly, we document the superadditivity of *ARD* when incomes are held constant. Admitting, however, that incomes can change upon integration (for example as a result of increased efficiency), we also inquire whether superadditivity of *ARD* still arises when incomes change.

Our usage of *ARD* as a measure of social stress builds on the notion that relative deprivation is a source of, and constitutes a measure of, individual stress. Support for this link comes from a large empirical literature in domains ranging from economics to physiology (for a review, see the Appendix in Stark, 2013). We do not contend that a monetary merger is a cause of rising stress *in and by itself*; rather, we consider a monetary merger to constitute an act that pushes out the boundary of the sphere of comparisons; and we maintain that this expansion brings about aggregate (social) loss: while upon expansion there can well be losers and gainers, the sum of the losses is larger than the sum of the gains. A simple example serves to illustrate. To this end, and as formally displayed below, let the stress (relative deprivation) of an individual with a given income be the sum of the excesses of incomes divided by the size of the population, and let the aggregate stress (*ARD*) of a population be the sum of the levels of stress of the individuals. When a setting in which an individual whose income is 1, henceforth "1," (and similarly for other individuals) compares himself only with 2 (with an aggregate stress in population (1,2) of 1/2), and 3 compares himself only with 4 (with an aggregate stress in population (3,4) of 1/2) changes to a setting in which each of 1, 2, and 3 compares himself to all those who are to his right in the income hierarchy, the aggregate stress in population (1,2,3,4) is higher than 1/2 + 1/2 (it is now 5/2), even though the stress of 3 is lowered (from 1/2 to 1/4) yet the levels of stress of 1 and 2 increase by more (from 1/2 to 3/2 in the case of 1, and from zero to 3/4 in the case of 2), and this combined change lowers aggregate wellbeing. Relative deprivation as a cause of individual stress may help explain several empirically noted tendencies. For example, surveys reveal that people from countries that have not as yet adopted the euro expect the consequences of a common currency to bear more positively on their country than on themselves personally (European Commission, 2007). Likewise, a majority of respondents expect that conversion into the euro will have negative consequences at the personal level (European Commission, 2014).

Our main claim then is that there is a downside, a cost, to monetary unification, and we seek to identify the range within which this cost falls. This claim rests on the assumption that currency integration revises and expands the comparison domain. If monetary unification had no impact on the intensity of inter-country comparisons, the cost to individuals would be nil. If prior to monetary unification no inter-country comparisons were made, whereas post-unification comparisons are made by all, then the cost is at its maximal value. In reality, the cost is likely to be in-between. Moreover, to the extent that adaptation to and usage of a new currency as a benchmark for calculating costs and comparing incomes is a gradual process, the full brunt of monetary unification on *ARD* will take time to be felt, so unification in a given year will have its full impact only years later. In principle, we can define a parameter $\alpha \in [0, 1]$ and find out its value, for example by asking what proportion of (a sample of) people in a given country compared their earnings with people in another country both before and after unification, and then use the difference between the two shares as an estimate of α. Correspondingly, our reported changes in *ARD* could be recalibrated upon being multiplied by α. The parameter α may well change (presumably increase) over time. Surveys investigating the extent to which the euro plays the role of a mental benchmark for price calculations (albeit international income comparisons within the EMU have not been investigated this way) reveal that people in the EMU stop converting sums from the euro to their former national currency only gradually. For instance, in 2013, 68% of the respondents did not usually convert from the euro into the old national currency when making routine purchases, and 50% behaved likewise when making exceptional purchases such as the acquisition of a car or a house (European Commission, 2013). In comparison, the euro was treated as a mental benchmark for routine purchases by 59% of the respondents in 2008, and by 46% in 2003, while for exceptional purchases it was 34% of the respondents in 2008, and by 16% in 2003 (European Commission, 2010). We can likewise conjecture that α depends on a variety of socio-demographic characteristics, and on the respondents' country of origin.

In the remainder of this article we proceed as follows. In Sub-section 2.1 we introduce our measure of *ARD*. In Sub-section 2.2 we allude to the data that we use. In Sub-section 2.3 we present the methodology that we employ. In Section 3 we display the results of our calculations of the impact of six monetary unifications on *ARD*. We conclude in Section 4.

2. MEASURING AGGREGATE SOCIAL STRESS, DATA, AND METHODOLOGY

2.1 Measurement

As in Stark (2013), we define the *ARD* of a population – an index of its level of social stress – by the sum of the levels of stress experienced by the individuals who constitute the population. We refer to income-based comparisons, and we quantify the stress of an individual by the sum of the extra income units that others in the population have, normalized by the size of the population (assuming that the comparison group of each individual consists of all the co-members of his population).

The *ARD* of a population of n members with an ordered vector of incomes $x = (x_1, \ldots, x_n)$ such that $x_i \leq x_j$ for $i < j$, is defined as

$$ARD(x) \equiv \frac{1}{n}\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}(x_j - x_i) = \sum_{i=1}^{n-1} RD(x_i)$$

where $RD(x_i)$ is the relative deprivation experienced by individual i.

In order to assess empirically whether or not the superadditivity of *ARD* holds in the EMU context, we will compare the *ARD* of the euro area following monetary unification with the sum of the pre-merger levels of *ARD* of the countries forming the union. In the calculations reported below, we resort to an equivalent expression of *ARD*:

$$ARD(x) = \sum_{i=1}^{n-1} RD(x_i) = \sum_{i=1}^{n-1}[1 - F(x_i)] \cdot E(x - x_i | x > x_i), \tag{1}$$

where $F(x_i)$ is the fraction of those in a population of n members whose incomes are smaller than or equal to x_i, and $E(x - x_i | x > x_i)$ is the mean excess income. (For a formal proof of this equivalence see, for example, Stark, 2010.) Intuitively, the relative deprivation of an individual i whose income is x_i is defined as the aggregate of the excesses of incomes, divided by the size of the comparison group. Multiplying and dividing this measure by the number of individuals whose incomes are higher than x_i transforms the measure into the product of two ratios: the fraction of those whose incomes are higher, and mean excess income. For example, this representation nicely reveals that when people who are "poorer" than i are added in, the *fraction* of those whose incomes are higher than the income of i declines, in which case individual i experiences less relative deprivation.

Because the EMU enlargements involved integration of more than two populations (countries), we need to check whether the superadditivity property presented in Stark (2013) for two populations applies to $l \geq 2$ populations.

Consider then $l \geq 2$ merged populations (where l is a natural number). The size of population P_i is n_i, and the corresponding ordered vector of incomes is $x^i = (x^i_j)^{n_i}_{j=1}$. The merged population is then of size $n = n_1 + \ldots + n_l$, and the ordered income vector is denoted by $x = x^1 \circ x^2 \circ \ldots \circ x^l$.

Claim The aggregate relative deprivation of the merged population exhibits the superadditivity property, namely

$$ARD\left(x^1 \circ \ldots \circ x^l \circ x^{l+1}\right) \geq ARD\left(x^1 \circ \ldots \circ x^l\right) + ARD\left(x^{l+1}\right).$$

Proof The proof is by induction with respect to the number of merged populations.

From Stark (2013) we know that the superadditivity property holds for $l = 2$. We assume that the property holds also for some $l > 2$ merged populations. We show that it holds for $l + 1$ merged populations. The $l + 1$ populations can be merged sequentially; namely, we first merge the first l populations and subsequently merge this new population with the $(l + 1)th$ population:

$$\begin{aligned} &ARD(x^1) + ARD(x^2) + \ldots + ARD(x^l) + ARD(x^{l+1}) \\ &= [ARD(x^1) + ARD(x^2) + \ldots + ARD(x^l)] + ARD(x^{l+1}). \end{aligned}$$

By assumption, the ARD function is superadditive for l merged populations:

$$ARD\left(x^1 \circ \ldots \circ x^l\right) \geq ARD\left(x^1\right) + ARD\left(x^2\right) + \ldots + ARD\left(x^l\right).$$

Therefore,

$$\begin{aligned} &ARD\left(x^1 \circ \ldots \circ x^l\right) + ARD\left(x^{l+1}\right) \geq ARD\left(x^1\right) + ARD\left(x^2\right) + \ldots + ARD\left(x^l\right) \\ &\quad + ARD\left(x^{l+1}\right). \end{aligned}$$

From the first step of the proof we know that the superadditivity property holds for any two merged populations, so upon merging population $P_1 \cup P_2 \cup \ldots \cup P_l$ with population P_{l+1}, we obtain the superadditivity of ARD, namely

$$ARD\left(x^1 \circ \ldots \circ x^l \circ x^{l+1}\right) \geq ARD\left(x^1 \circ \ldots \circ x^l\right) + ARD\left(x^{l+1}\right),$$

which completes the proof. □

Because of Eurostat data limitations, we will calculate the ARD drawing on aggregate data of the Gini coefficient, G; of population size, n; and of selected measures used as proxies of mean income, $\bar{x}$.

One way of defining the Gini coefficient is as follows:

$$G = \frac{\frac{1}{2n^2}\sum_{i=1}^{n}\sum_{j=1}^{n}|x_i - x_j|}{\bar{x}}$$

where

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i.$$

Because

$$\sum_{i=1}^{n}\sum_{j=1}^{n}|x_i - x_j| = 2\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}(x_j - x_i),$$

it follows that

$$\bar{x}G = \frac{1}{2n^2}2\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}(x_j - x_i) = \frac{1}{n^2}\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}(x_j - x_i),$$

or that

$$\left(\sum_{i=1}^{n} x_i\right)G = \frac{1}{n}\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}\left(x_j - x_i\right) = ARD(x),$$

or, equivalently, that

$$ARD(x) = G \cdot n \cdot \bar{x}. \tag{2}$$

Thus, we harness data on the three terms in equation (2). It is worth noting that, as already shown in Stark (2013), the superadditivity result is robust with respect to measures of ARD other than $ARD(x) \equiv \frac{1}{n}\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}(x_j - x_i)$, such as the aggregate of the excesses of incomes, and the distance from the highest income.

2.2 *Data*

We use data for 1998–2011 taken from the Eurostat Statistics Database for 17 EMU member countries. (Because of data unavailability at the time of writing this article, we do not include Latvia which in 2014 became the 18th EMU member state. However, see our remarks concerning Latvia in Section 4.) Guided by equation (2), we extract annual data on the Gini coefficient of "equivalized" disposable income;[1] on population size as of January 1 of each year preceding and each year following the EMU enlargements; and on selected measures of mean income (including nominal GDP per capita, GDP per capita in Purchasing Power

[1]Eurostat calculates the equivalized income attributed to each member of a household by dividing the total disposable income of the household by the equivalization factor. Eurostat applies an equivalization factor based on the OECD-modified scale giving a weight of 1.0 to the first person aged 14 or more, a weight of 0.5 to other persons aged 14 or more, and a weight of 0.3 to persons aged 13 or younger (Eurostat, 2013).

Standards, mean equivalized net income, and mean equivalized net income in Purchasing Power Standards) for each analyzed year.[2] (We thus base our calculations on data from 1998–2001, and from 2006–2011). As seen in Table 1, the 17 analyzed EMU member countries were quite diverse in terms of their Gini coefficient, population size, and selected measures of mean income, both before and after the adoption of the euro.

Although we calculate the values of *ARD* for each country [following equation (2)], we are unable to calculate values of *ARD* for the EMU as a whole, because Eurostat does not provide values of the Gini coefficient for the EMU as a composite entity on account of the changing composition of the EMU (albeit data for the 17 countries as a block are available for 2005–2011). Therefore, to inquire whether the superadditivity property holds, we reconstruct income vectors for each country and each measure of mean income. We assume a log-normal income distribution for the entire population of each country, with its expected value given by analyzed measures of mean income.[3] This allows us to calculate the Gini coefficient as:

$$G = 2\Phi\left(\frac{\sigma}{\sqrt{2}}\right) - 1 \tag{3}$$

where Φ is the standard normal cumulative distribution function, and σ is the standard deviation (cf. Aitchison and Brown, 1963). Having calculated the parameters of the log-normal distribution for each country and each measure of mean income,[4] we are able to calculate the fraction of the population with incomes higher than or equal to x_k [cf. equation (1)], where x_k stands for the upper limit of the analyzed income brackets. For our calculations, we select x_k = 50; 100; 150; ...; 400,000 euro and, thus, we disaggregate the cumulative distribution of income into 8,000 income brackets. We then calculate the number of individuals and their relative deprivation in each income bracket on the basis of equation (1) and, consequently, we obtain aggregate relative deprivation for each country as a sum of the levels of relative deprivation of the individuals. With this procedure in place, we obtain the EMU income vector as the sum of the income vectors of the constituent countries for each analyzed year, and we calculate the *ARD* for the EMU, following equation (1). We are also able to estimate each country's input to the *ARD* of the EMU.

To check the robustness of our calculations, we compare the results of the calculations based on equation (1), with calculations based on equation (2) both at the country level and at the EMU level for each measure of mean income (see Table 2 and the note below the Table).

[2]This choice of variables is dictated both by data availability and the fact that GDP per capita (both in nominal and in real terms) is the most popular and the most often used measure for international comparisons, whereas mean equivalized net income is a measure that seems to be closest to the mean equivalized disposable income.

[3]We are aware of the fact that income distributions usually follow an exponential (Boltzmann-Gibbs) distribution for low and middle-class incomes, and power-law (Pareto) distribution for top incomes (about 3% of the population; Wlodarczyk, 2013). One way of responding to this consideration would be to employ a log-normal distribution for the bottom 97% of incomes, and a Pareto distribution for the top 3% of incomes. Especially for income comparisons, the top 3% might affect our calculations. However due to lack of data on incomes in both distributions across European countries, we found it is impossible to follow such an approach.

[4]Standard deviations of incomes, σ, are calculated on the basis of equation (3), and average log incomes are calculated as $\mu = \ln \bar{x} - \frac{1}{2}\sigma^2$ (cf. Aitchison and Brown, 1963).

TABLE 1 GINI COEFFICIENT, POPULATION SIZE, AND SELECTED MEASURES OF MEAN INCOME FOR 17 EMU MEMBER COUNTRIES IN THE YEAR PRECEDING ACCESSION TO THE EMU AND IN THE YEAR OF ACCESSION

Country/ Descriptive statistics (17 countries)	Year of accession to the EMU (t)	Gini coefficient, G		Population (in millions), n		Measures of mean income (in euro), $\bar{x}$: (a) GDP PC		(b) GDP PC PPS		(c) MENI		(d) MENI PPS	
		$t-1$	t	$t-1$	t	$t-1$	t	$t-1$	t	$t-1$	t	$t-1$	t
Austria	1999	24.0	26.0	7.971	7.982	23,900	24,900	22,400	23,500	15,343	15,860	14,517	15,009
Belgium	1999	27.0	29.0	10.192	10.214	22,400	23,400	20,800	21,900	15,644	16,415	15,793	16,661
Finland	1999	22.0	24.0	5.147	5.160	22,500	23,700	19,300	20,400	14,383	14,766	12,109	12,533
France	1999	28.0	29.0	59.935	60.159	21,900	22,700	19,500	20,400	15,249	15,809	14,453	15,151
Germany	1999	25.0	25.0	82.057	82.037	23,700	24,400	20,700	21,600	15,918	16,366	14,947	15,398
Ireland	1999	34.0	32.0	3.693	3.732	21,200	24,100	20,500	22,400	13,005	13,021	13,406	13,149
Italy	1999	31.0	30.0	56.904	56.909	19,200	19,900	20,400	21,000	10,068	10,484	11,280	11,896
Luxembourg	1999	26.0	27.0	0.422	0.427	40,700	46,100	36,900	42,300	23,313	24,277	23,223	23,924
Netherlands	1999	25.0	26.0	15.654	15.760	22,900	24,400	21,800	23,300	13,776	14,466	14,285	15,218
Portugal	1999	37.0	36.0	10.110	10.149	10,800	11,700	13,400	14,500	6,259	6,572	8,620	9,129
Spain	1999	34.0	33.0	39.639	39.803	13,500	14,500	16,200	17,100	8,235	8,905	10,104	10,604
Greece	2001	33.0	33.0	10.904	10.931	12,600	13,400	16,000	17,100	8,119	8,262	10,343	10,546
Slovenia	2007	23.7	23.2	2.003	2.010	15,500	17,100	20,700	22,100	10,112	10,724	13,189	13,988
Cyprus	2008	29.8	29.0	0.779	0.789	20,700	21,800	23,500	24,800	18,565	18,571	21,158	21,140
Malta	2008	26.3	27.9	0.408	0.410	13,700	14,500	19,600	20,300	10,200	11,165	13,641	14,797
Slovakia	2009	23.7	24.8	5.401	5.412	11,900	11,600	18,100	17,000	5,180	6,290	7,310	8,710
Estonia	2011	31.3	31.9	1.340	1.340	10,700	11,900	15,600	17,400	6,782	6,570	8,779	8,785
Mean		28.3	28.6	18.386	18.425	19,282	20,594	20,318	21,594	12,362	12,854	13,362	13,920
Median		27.0	29.0	7.971	7.982	20,700	21,800	20,400	21,000	13,005	13,021	13,406	13,988
Minimum		22.0	23.2	0.408	0.410	10,700	11,600	13,400	14,500	5,180	6,290	7,310	8,710
Maximum		37.0	36.0	82.057	82.037	40,700	46,100	36,900	42,300	23,313	24,277	23,223	23,924
Standard deviation		4.43	3.65	25.12	25.15	7,369	8,322	5,031	6,025	4,845	4,899	4,151	4,127
Coefficient of variation		0.16	0.13	1.37	1.36	0.38	0.40	0.25	0.28	0.39	0.38	0.31	0.30

Note: Measures of mean income include: (a) GDP PC – nominal GDP per capita, (b) GDP PC PPS – GDP per capita in Purchasing Power Standards, (c) MENI – nominal mean equivalized net income, (d) MENI PPS – mean equivalized net income in Purchasing Power Standards.
Source: Eurostat (2013), and authors' calculations.

For each measure of mean income, *ARD* values obtained from the income vectors reconstruction and equation (1) are lower than values based on equation (2). For example, during the entire analyzed period, the relative difference between pairs of these values calculated for GDP per capita for individual EMU member countries falls in the range [−0.61%, −0.12%]. Consequently, our calculations are slightly downward biased.

2.3 Methodology

As noted in the Introduction, the approach taken in this article draws on the assumption that the adoption of a common currency revises the social comparison space. Our first take on the data aims at establishing an upper bound: to calculate this upper limit, we assume that prior to joining the EMU, individuals in a country engage only in in-country income comparisons and that, after the merger, individuals switch to (or also make) EMU-wide comparisons. (We comment further on this assumption in the concluding section.) An empirical depiction of the superadditivity property comes down to measuring the difference between the *ARD* calculated for the EMU as a whole (after the merger), and the sum of the levels of *ARD* calculated for each merged-in population, when both calculations are based on the reconstructed income vectors.

3. AGGREGATE RELATIVE DEPRIVATION IN THE EMU ENLARGEMENTS

The EMU was created in 1999 by eleven countries, with other countries joining in 2001, 2007, 2008, 2009, 2011, 2014, and 2015. Thus, until 2011 we have six occasions of EMU

TABLE 2 RELATIVE DIFFERENCE BETWEEN *ARD* VALUES OBTAINED FROM INCOME VECTOR RECONSTRUCTION [EQUATION (1)] AND FROM EQUATION (2) FOR SIX EMU ENLARGEMENTS AND SELECTED MEASURES OF MEAN INCOME

	Relative difference at the country level (%)				Aggregate relative difference at the EMU level (%)	
	minimum value		maximum value			
Measures of mean income, $\bar{x}$	t	$t-1$	t	$t-1$	t	$t-1$
1999 – EMU creation by Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain						
(a) GDP PC	−0.15	−0.24	−0.51	−0.54	−0.32	−0.33
(b) GDP PC PPS	−0.16	−0.26	−0.41	−0.44	−0.33	−0.34
(c) MENI	−0.28	−0.36	−0.90	−0.93	−0.50	−0.51
(d) MENI PPS	−0.28	−0.36	−0.65	−0.68	−0.49	−0.50
2001 – Accession of Greece						
(a) GDP PC	−0.14	−0.14	−0.46	−0.47	−0.30	−0.30
(b) GDP PC PPS	−0.15	−0.15	−0.37	−0.39	−0.30	−0.31
(c) MENI	−0.25	−0.27	−0.77	−0.85	−0.47	−0.47
(d) MENI PPS	−0.24	−0.27	−0.58	−0.62	−0.44	−0.46
2007 – Accession of Slovenia						
(a) GDP PC	−0.21	−0.22	−0.49	−0.40	−0.27	−0.27
(b) GDP PC PPS	−0.22	−0.19	−0.43	−0.36	−0.27	−0.28
(c) MENI	−0.21	−0.22	−0.71	−0.59	−0.40	−0.42
(d) MENI PPS	−0.23	−0.24	−0.62	−0.53	−0.41	−0.43
2008 – Accession of Cyprus and Malta						
(a) GDP PC	−0.20	−0.21	−0.47	−0.49	−0.26	−0.27
(b) GDP PC PPS	−0.22	−0.22	−0.41	−0.43	−0.27	−0.27
(c) MENI	−0.21	−0.21	−0.68	−0.71	−0.37	−0.40
(d) MENI PPS	−0.23	−0.23	−0.62	−0.62	−0.38	−0.41
2009 – Accession of Slovakia						
(a) GDP PC	−0.21	−0.20	−0.61	−0.47	−0.28	−0.26
(b) GDP PC PPS	−0.23	−0.22	−0.42	−0.41	−0.29	−0.27
(c) MENI	−0.21	−0.21	−1.12	−0.68	−0.37	−0.37
(d) MENI PPS	−0.24	−0.23	−0.81	−0.60	−0.38	−0.41
2011 – Accession of Estonia						
(a) GDP PC	−0.18	−0.12	−0.57	−0.53	−0.26	−0.23
(b) GDP PC PPS	−0.15	−0.14	−0.41	−0.37	−0.27	−0.23
(c) MENI	−0.20	−0.18	−0.99	−1.00	−0.36	−0.32
(d) MENI PPS	−0.24	−0.22	−0.75	−0.73	−0.38	−0.34

Note: The calculations are conducted for the following measures of mean income: (a) GDP PC – nominal GDP per capita, (b) GDP PC PPS – GDP per capita in Purchasing Power Standards, (c) MENI – nominal mean equivalized net income, (d) MENI PPS – mean equivalized net income in Purchasing Power Standards. Relative difference at the country level for country j is calculated as:

$$d_j = \frac{ARD_{\text{eq.1}}(x^j) - ARD_{\text{eq.2}}(x^j)}{ARD_{\text{eq.2}}(x^j)} = \frac{\sum_{i=1}^{n}\left[1 - F(x_i^j)\right] \cdot E\left(x - x_i^j | x > x_i^j\right) - G_j \cdot n_j \cdot \bar{x}_j}{G_j \cdot n_j \cdot \bar{x}_j}$$

where $\bar{x}_j$ stands for a selected measure of mean income in population j.
Aggregate relative difference at the EMU level is calculated as:

$$\mathrm{D} = \frac{\sum_{j=1}^{m} ARD_{\text{eq.1}}(x^j) - \sum_{j=1}^{m} ARD_{\text{eq.2}}(x^j)}{\sum_{j=1}^{m} ARD_{\text{eq.2}}(x^j)} = \frac{\sum_{j=1}^{m}\sum_{i=1}^{n}\left[1 - F(x_i^j)\right] \cdot E\left(x - x_i^j | x > x_i^j\right) - \sum_{j=1}^{m} G_j \cdot n_j \cdot \bar{x}_j}{\sum_{j=1}^{m} G_j \cdot n_j \cdot \bar{x}_j}$$

where m is the number of EMU member countries at time t.
Source: Authors' calculations based on Eurostat (2013) data.

creation and enlargement. We calculate the change in *ARD* following these six monetary unifications for each measure of mean income. We look at data for the nearest point in time which, in our case, is the subsequent year. This time lag is long enough to give people the opportunity to endogenize the change. The results are displayed in Table 3.

Taking into account that changing population size may also impinge both on the combined and net effect, we also replicate the calculations assuming that population size does not change between time *t*-1 and time *t* (see Table 4).

Columns 4 and 5 in Table 3 and 4 show that on five out of the six enlargements, the combined effect on *ARD* of the revision of social space and economic growth within the EMU was positive. In 2009, due to exogenous factors associated with the global financial crisis which affected Europe strongly, the combined effect on *ARD* of the revision of social space and economic growth was negative for both measures of income based on GDP. However, when we factor out the influence of the 2009 contraction of nominal GDP in the EMU, we obtain an effect similar to those prevailing in the other five enlargements. Therefore, we infer that for the "pure" (namely, purged of GDP change) *ARD*, superadditivity obtains throughout (column 7), notwithstanding the three (negative) "outliers" that are quite close to zero and presumably could be linked to fuzzy data, especially in the case of Greece.

The largest increase in *ARD* occurred when the EMU was created in 1999. For example, for GDP per capita (with changing population size) the *ARD* of the combined eleven EMU members was 12.8 percent higher than the sum of the levels of *ARD* of the constituent countries just prior to the formation of the EMU.

The experience of individual countries notably varied, especially because joining a monetary union can bear on a country's *ARD* positively or negatively. For example, given our measure of relative deprivation, when a low-income country joins a group of richer countries such that there is no overlap between the income distribution of the low-income country and the income distributions of the rich countries, all the individuals in the rich countries (except for the richest) gain in terms of relative deprivation, whereas all the individuals in the low-income country suffer. Thus, in the aftermath of joining the EMU (namely, a year after joining), seven countries experienced a decline in *ARD* in terms of at least three of the four analyzed measures of mean income (Germany, France, Netherlands, Belgium, Austria, Ireland, and Luxembourg in 1999). For ten other member countries, adoption of the euro was *ARD*-detrimental in terms of at least three of the four analyzed measures of mean income (Italy, Spain, Portugal, Finland in 1999, and later on for all subsequent entrants). The evolution of *ARD* values for each of the 17 EMU member countries in terms of nominal GDP per capita and GDP per capita in Purchasing Power Standards during the entire period 1998–2011 is portrayed in the Appendix.[5] As anticipated, countries characterized by relatively high levels of analyzed measures of mean income benefit from monetary integration (an expanded comparison environment reduces their *ARD*), whereas poorer countries incur a social cost of increased *ARD*. This is a demonstration of an uneven distribution of the costs and benefits from monetary integration over EMU countries when these costs and benefits are evaluated in terms of *ARD*.

[5]Consistent data for all 17 EMU member countries regarding two other analyzed measures of mean income are not available for the entire 1998–2011 period, and are therefore not included in the Appendix.

TABLE 3 SUPERADDITIVITY RESULT FOR EMU ENLARGEMENTS AND SELECTED MEASURES OF MEAN INCOME

Measures of mean income, $\bar{x}$ (1)	*ARD* of the EMU after the merger (billions of euros) (2)	Sum of levels of *ARD* of merging economies (billions of euros) (3)	Combined effect: in absolute terms (billions of euros) (4) = (2) − (3)	Combined effect: in relative terms (%) (5) = (4)/(3)	Aggregate income growth rate (%) (6)	Superadditivity (net effect) (7) = (5) − (6)
1999 – EMU creation by Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain						
(a) GDP PC	1,875.7	1,662.8	212.9	12.80	4.46	8.34
(b) GDP PC PPS	1,740.6	1,611.8	128.8	7.99	4.88	3.11
(c) MENI	1,234.8	1,050.5	184.3	17.54	4.11	13.43
(d) MENI PPS	1,187.6	1,071.4	116.2	10.85	4.58	6.27
2001 – Accession of Greece						
(a) GDP PC	2,075.4	1,981.8	93.6	4.72	4.43	0.30
(b) GDP PC PPS	1,961.7	1,890.3	71.3	3.77	4.01	−0.23
(c) MENI	1,353.3	1,295.8	57.5	4.44	4.46	−0.02
(d) MENI PPS	1,353.1	1,264.6	88.5	7.00	6.42	0.58
2007 – Accession of Slovenia						
(a) GDP PC	2,773.2	2,558.7	214.4	8.38	5.25	3.13
(b) GDP PC PPS	2,657.1	2,434.5	222.6	9.14	6.01	3.13
(c) MENI	1,774.4	1,593.1	181.2	11.38	7.46	3.92
(d) MENI PPS	1,668.2	1,509.9	178.3	11.81	7.62	4.19
2008 – Accession of Cyprus and Malta						
(a) GDP PC	2,870.3	2,779.4	90.9	3.27	2.25	1.02
(b) GDP PC PPS	2,702.9	2,664.7	38.2	1.43	0.51	0.92
(c) MENI	1,968.1	1,779.8	188.4	10.58	8.80	1.79
(d) MENI PPS	1,876.8	1,694.6	182.3	10.76	8.41	2.34
2009 – Accession of Slovakia						
(a) GDP PC	2,804.8	2,885.5	−80.7	−2.80	−3.31	0.51
(b) GDP PC PPS	2,560.1	2,726.0	−165.8	−6.08	−5.83	−0.26
(c) MENI	2,044.3	1,974.7	69.6	3.52	2.50	1.03
(d) MENI PPS	1,904.6	1,886.1	18.5	0.98	0.64	0.34
2011 – Accession of Estonia						
(a) GDP PC	3,042.8	2,916.5	126.3	4.33	2.67	1.66
(b) GDP PC PPS	2,839.2	2,713.0	126.2	4.65	3.16	1.50
(c) MENI	2,123.0	2,077.5	45.4	2.19	0.34	1.84
(d) MENI PPS	1,977.9	1,894.7	83.2	4.39	2.67	1.72

Note: The calculations are conducted for the following measures of mean income: (a) GDP PC – nominal GDP per capita, (b) GDP PC PPS – GDP per capita in Purchasing Power Standards, (c) MENI – nominal mean equivalized net income, (d) MENI PPS – mean equivalized net income in Purchasing Power Standards. Calculations are conducted in euro and then rounded.
The Table includes aggregate values and does not depict differences in the rate of growth of income in particular countries, nor differences in the rate of growth of individual incomes.
Aggregate income growth rate refers to the aggregate increase in income of all countries participating in particular EMU enlargements calculated as:

$$g_t = \frac{\sum_{j=1}^{m_t^*} n_{jt}\bar{x}_{jt} - \sum_{j=1}^{m_t^*} n_{jt-1}\bar{x}_{jt-1}}{\sum_{j=1}^{m_t^*} n_{jt-1}\bar{x}_{jt-1}}$$

where $\bar{x}_{jt}$ stands for a selected measure of mean income in population j at time t, and m_t^* is the number of countries participating in the EMU event at time t. Combined effect refers to a situation, whereby both a revision of social space takes place, and incomes are allowed to change. Superadditivity (net effect) is the "pure" effect of the revision of social space when income growth is netted out.
Source: Authors' calculations based on Eurostat (2013) data.

Table 4 Superadditivity Result for EMU Enlargements and Selected Measures of Mean Income (Under Assumption of Constant Population)

Measures of mean income, $\bar{x}$ (1)	*ARD* of the EMU after the merger (billions of euros) (2)	Sum of levels of *ARD* of merging economies (billions of euros) (3)	Combined effect: in absolute terms (billions of euros) (4) = (2) − (3)	Combined effect: in relative terms (%) (5) = (4)/(3)	Aggregate income growth rate (%) (6)	Superadditivity (net effect) (7) = (5) − (6)
1999 – EMU creation by Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain						
(a) GDP PC	1,875.7	1,666.2	209.5	12.57	4.36	8.31
(b) GDP PC PPS	1,740.6	1,615.2	125.4	7.76	4.67	3.10
(c) MENI	1,234.8	1,052.7	182.1	17.30	3.91	13.39
(d) MENI PPS	1,187.6	1,073.7	113.9	10.61	4.36	6.25
2001 – Accession of Greece						
(a) GDP PC	2,075.4	1,990.7	84.7	4.26	4.00	0.26
(b) GDP PC PPS	1,961.7	1,898.4	62.8	3.31	3.57	−0.26
(c) MENI	1,353.3	1,301.4	51.8	3.98	4.03	−0.05
(d) MENI PPS	1,353.1	1,270.2	82.9	6.53	5.98	0.55
2007 – Accession of Slovenia						
(a) GDP PC	2,773.2	2,573.3	199.8	7.77	4.07	3.07
(b) GDP PC PPS	2,657.1	2,448.4	208.8	8.53	5.45	3.08
(c) MENI	1,774.4	1,602.1	172.3	10.75	6.90	3.85
(d) MENI PPS	1,688.2	1,518.3	169.9	11.19	7.06	4.13
2008 – Accession of Cyprus and Malta						
(a) GDP PC	2,870.3	2,795.9	74.4	2.66	1.66	1.00
(b) GDP PC PPS	2,702.9	2,680.7	22.2	0.83	−0.08	0.91
(c) MENI	1,968.1	1,789.9	178.3	9.96	8.20	1.76
(d) MENI PPS	1,876.8	1,704.1	172.8	10.14	8.67	1.47
2009 – Accession of Slovakia						
(a) GDP PC	2,804.8	2,898.5	−93.7	−3.23	−3.73	0.50
(b) GDP PC PPS	2,560.1	2,738.2	−178.1	−6.50	−6.24	−0.26
(c) MENI	2,044.3	1,983.2	61.0	3.08	2.07	1.01
(d) MENI PPS	1,904.6	1,894.2	10.4	0.55	0.21	0.34
2011 – Accession of Estonia						
(a) GDP PC	3,042.8	2,926.6	116.1	3.97	2.30	1.67
(b) GDP PC PPS	2,839.2	2,722.2	117.0	4.30	2.80	1.50
(c) MENI	2,123.0	2,084.5	38.4	1.84	−0.02	1.86
(d) MENI PPS	1,977.9	1,901.0	76.9	4.05	2.32	1.73

Note: The sum of the levels of *ARD* of merging economies is calculated for population size at time t. Aggregate income growth rate refers to the aggregate increase in income of all countries participating in particular EMU enlargements calculated as:

$$g_t' = \frac{\sum_{j=1}^{m_t^*} n_{jt}\bar{x}_{jt} - \sum_{j=1}^{m_t^*} n_{jt}\bar{x}_{jt-1}}{\sum_{j=1}^{m_t^*} n_{jt}\bar{x}_{jt-1}}$$

where $\bar{x}_{jt}$ stands for a selected measure of mean income in population j at time t, and m_t^* is the number of countries participating in the EMU event at time t.
See also the Note below Table 3.
Source: Authors' calculations based on Eurostat (2013) data.

4. CONCLUDING REMARKS

In this article we document the superadditivity of *ARD* in a setting in which diverse currencies were replaced by a common currency, an act that enabled and invited an expanded comparison environment. Tracking the sequence of EMU changes from its initial creation in 1999, reveals both higher post-merger levels of *ARD* and a non-uniform distribution of *ARD* costs and benefits. (In *ARD* terms, monetary integration favors the richest countries.)

Two general comments are in order. First, the adoption of the euro as a common currency is perhaps the starkest act that entails revision of the set of comparators, but it is not the only one; conversion to the euro is associated with an entire set of standardizations, all rendering comparison with other people more compelling, and almost unavoidable. Second, our numerical results are based on the assumption that prior to monetary unification individuals did not compare themselves with individuals in other countries, and that within a year after unification they did. To the extent that reality is less cut-dried than this dichotomy, our results constitute upper limits.

What are the economic consequences of the observed increase of *ARD* for the EMU countries? For instance, is it the case that in the wake of the EMU, intensified cross-country wage comparisons contributed to higher wage demands in countries inflicted with rising (sharply rising) *ARD* than in countries not experiencing rising (or only mildly rising) *ARD*? Should policy makers consider and implement measures aimed at redressing the uneven distribution of *ARD* costs and benefits among EMU member countries? Are the increasing social stress and uneven distribution of *ARD* costs and benefits among EMU countries a good enough reason to dull significantly the shine of the euro? Further research could test whether the results generated by the *ARD* measure correlate with feelings of individual deprivation reported in surveys. The relationship between *ARD* and intra-EMU migration will also be worth investigating because labor mobility is, to an extent, linked to wage differentiation and can be accentuated by increased wage transparency.

Finally, it is tempting to speculate about the consequences of recent EMU enlargements such as Latvia becoming the 18th EMU member state in 2014. Latvia is a small country characterized by the lowest levels of all analyzed measures of mean income in the EMU. If Latvia had joined the EMU in 2011, its *ARD* would have risen by multiples (see Table 5).

TABLE 5 HYPOTHETICAL CONSEQUENCES OF LATVIA BECOMING AN EMU MEMBER COUNTRY IN 2011 FOR SELECTED MEASURES OF MEAN INCOME

Measures of mean income, $\bar{x}$ (1)	Latvian *ARD* for inter-country comparisons in 2011 (billions of euros) (2)	Theoretical value of Latvian *ARD* when in the EMU in 2011 (billions of euros) (3)	Theoretical increase in the EMU *ARD* when with Latvia in 2011 (billions of euros) (4)	Theoretical value of other EMU countries' gains (billions of euros) (5) = (3) − (4)
(a) GDP PC	7.1	39.9	22.6	17.3
(b) GDP PC PPS	11.0	30.5	17.8	12.7
(c) MENI	3.7	30.2	17.5	12.7
(d) MENI PPS	5.2	25.2	14.2	10.9

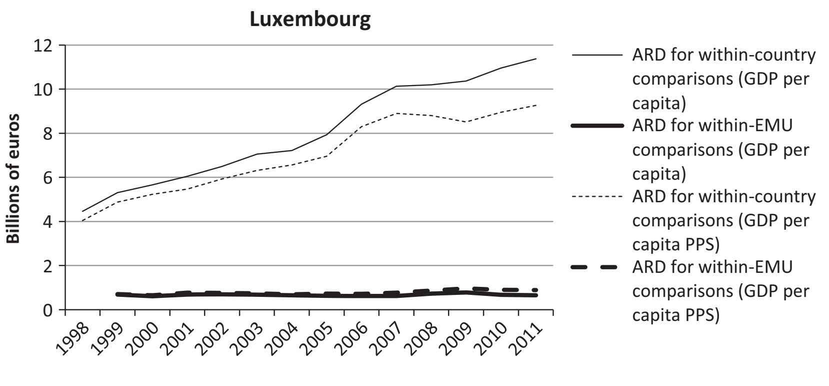
Source: Authors' calculations based on Eurostat (2013) data.

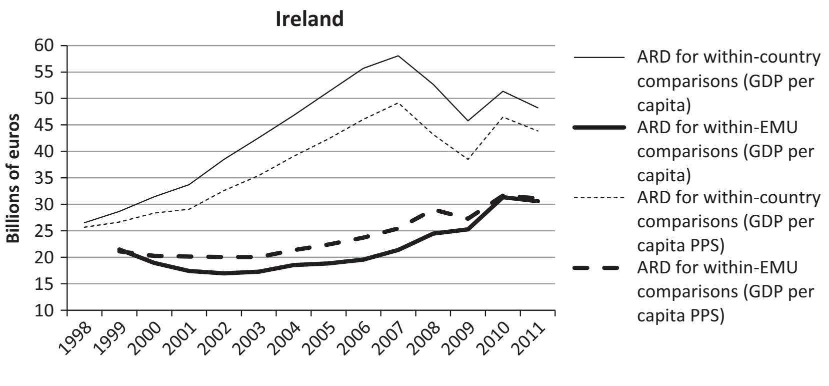
For example, reading through the a) line in Table 5, we see that in 2011 Latvia's *ARD* calculated on the basis of GDP per capita was about 7.1 billion euro. If Latvia had joined the EMU in 2011, its *ARD* would have been equal to 39.9 billion euro. And after encompassing Latvia, the current EMU countries would have gained an *ARD* equivalent of 17.3 billion euro. Altogether, the *ARD* of the EMU as a composite entity would have risen by 22.6 billion euro. (This is Latvia's input of *ARD* upon the enlargement (39.9 billion euro) minus the other countries' *ARD* gains (17.3 billion euro).) The increase of *ARD* shown in column 4 indicates that if Latvia had joined the EMU in 2011, superadditivity would obtain regardless of the choice of measure of mean income. Furthermore, it is worth noting that for all analyzed measures of mean income, about 75% of the other EMU countries' gain exhibited in column 5 would have accrued to Germany, Italy, France, and Spain. The changes in *ARD* when Latvia joined the EMU in 2014 could be expected to be in the same ballpark.

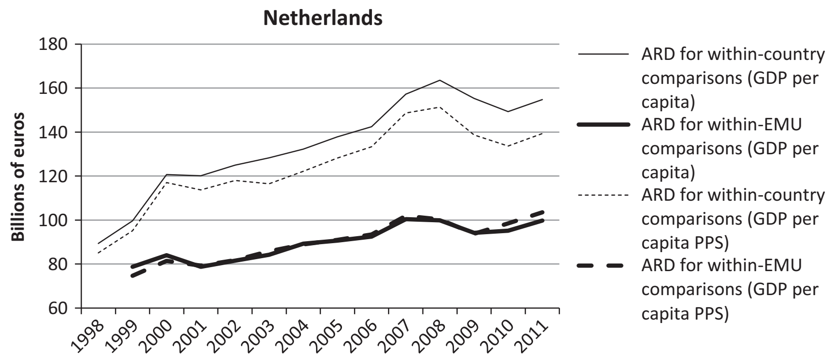
APPENDIX: THE EVOLUTION OF *ARD* FOR EACH OF THE 17 EMU COUNTRIES

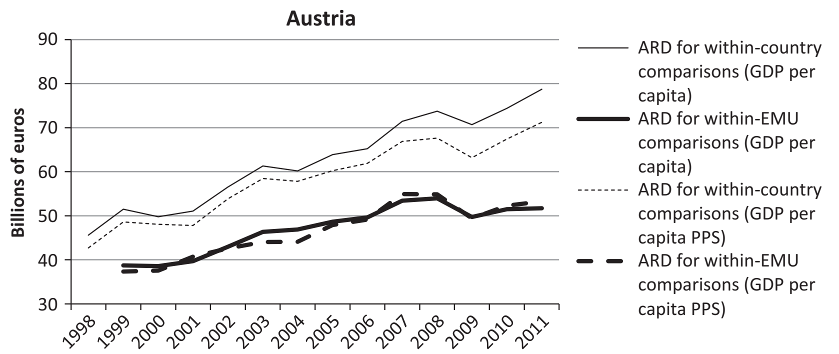
Note: Gains from monetary integration occur when a country's *ARD* calculated for within-EMU comparisons is lower than the *ARD* calculated for within-country comparisons (graphically, bold lines are below thin lines for both measures of mean income). Otherwise a country incurs losses.

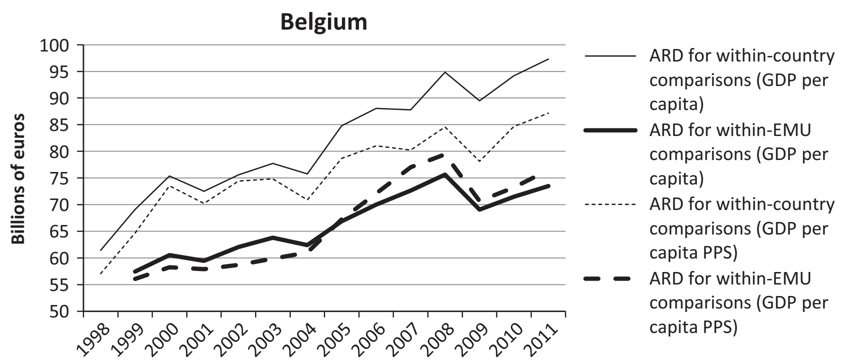
(a) Countries that gained from monetary integration and an expanded comparison environment

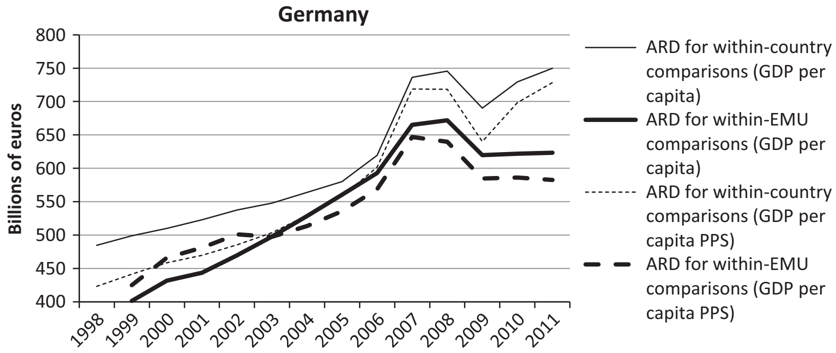


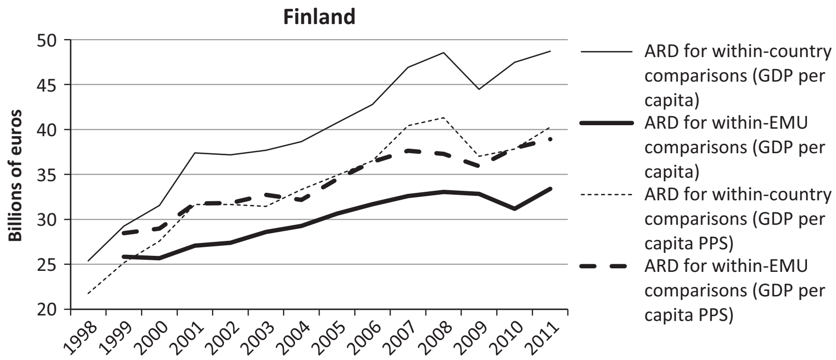



Netherlands
Billions of euros
180
160
140
120
100
80
60
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
ARD for within-country comparisons (GDP per capita)
ARD for within-EMU comparisons (GDP per capita)
ARD for within-country comparisons (GDP per capita PPS)
ARD for within-EMU comparisons (GDP per capita PPS)

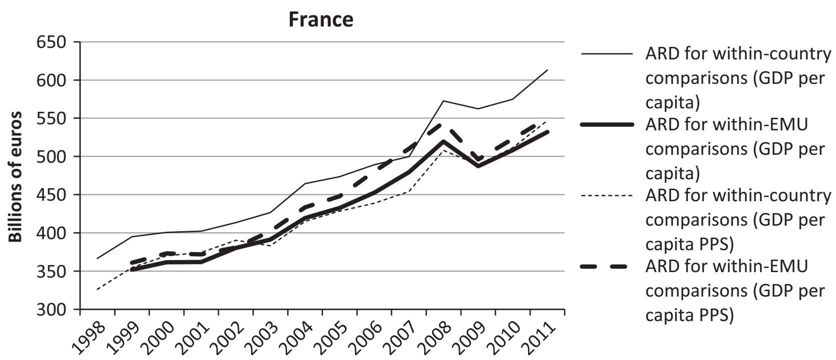

Austria
Billions of euros
90
80
70
60
50
40
30
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
ARD for within-country comparisons (GDP per capita)
ARD for within-EMU comparisons (GDP per capita)
ARD for within-country comparisons (GDP per capita PPS)
ARD for within-EMU comparisons (GDP per capita PPS)


Belgium
Billions of euros
100
95
90
85
80
75
70
65
60
55
50
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
ARD for within-country comparisons (GDP per capita)
ARD for within-EMU comparisons (GDP per capita)
ARD for within-country comparisons (GDP per capita PPS)
ARD for within-EMU comparisons (GDP per capita PPS)



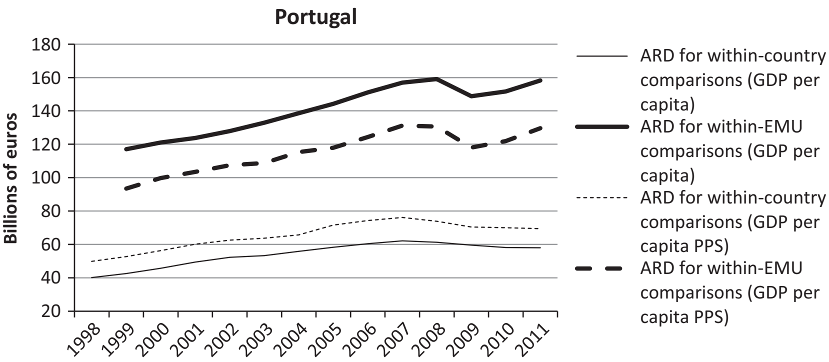


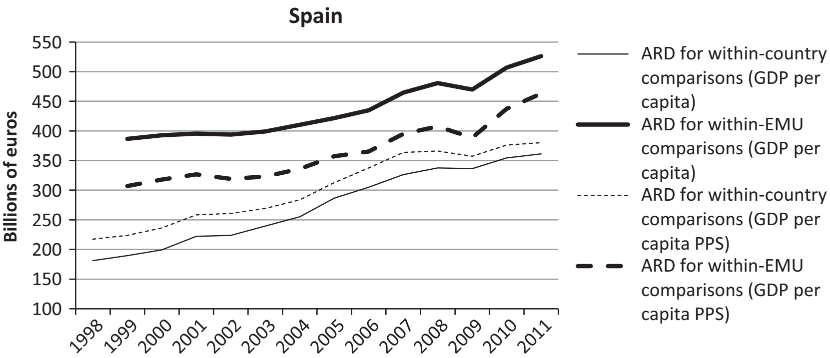
(b) A country that gained in terms of GDP per capita and lost in terms of GDP per capita in Purchasing Power Standards[6]

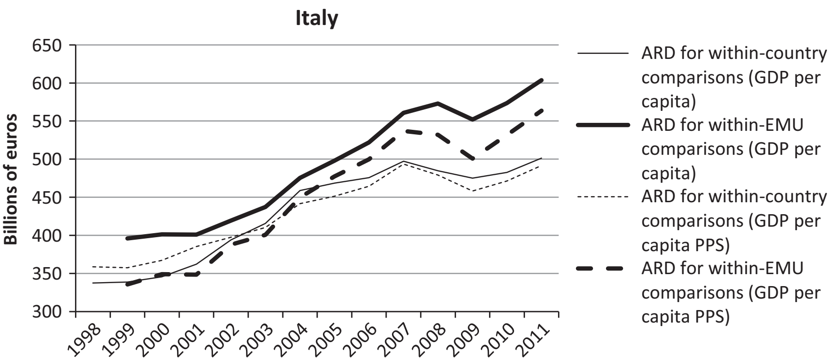


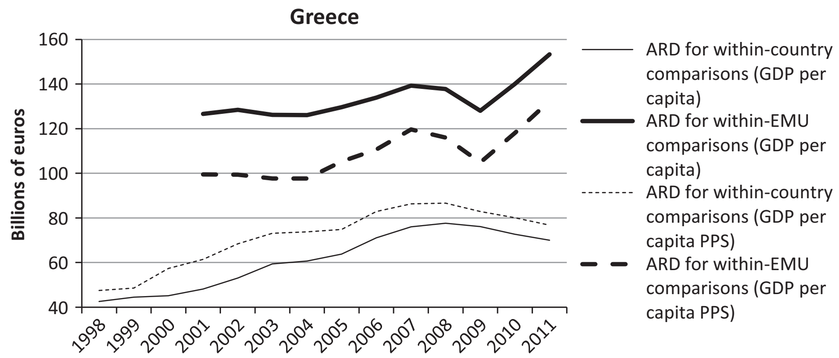
[6]To aid interpretation: as per the Note above, gains in terms of GDP per capita occur – the thin solid line is above the thick solid line – which means that if individuals in France switch from within-country to within-EMU comparisons, they will feel less relatively deprived in aggregate terms. On the other hand, a thick dotted line above thin dotted line means that if individuals in France base their income comparisons on GDP per capita PPS, switching to within-EMU comparisons increases their *ARD*.

(c) Countries that incurred losses from monetary integration and an expanded comparison environment








Greece
160
140
120
100
80
60
40
Billions of euros
1998
1999
2000
2001
2002
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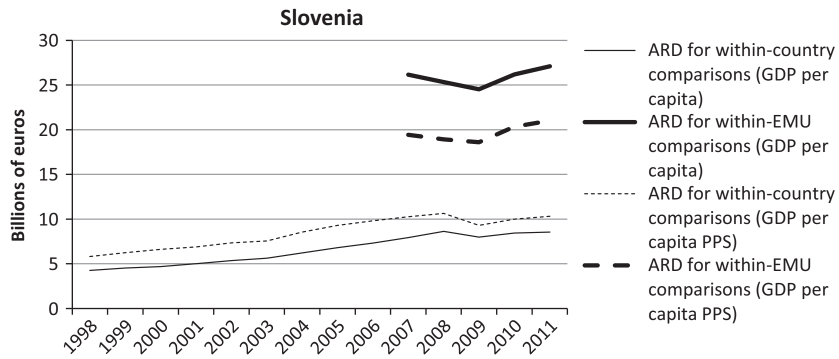
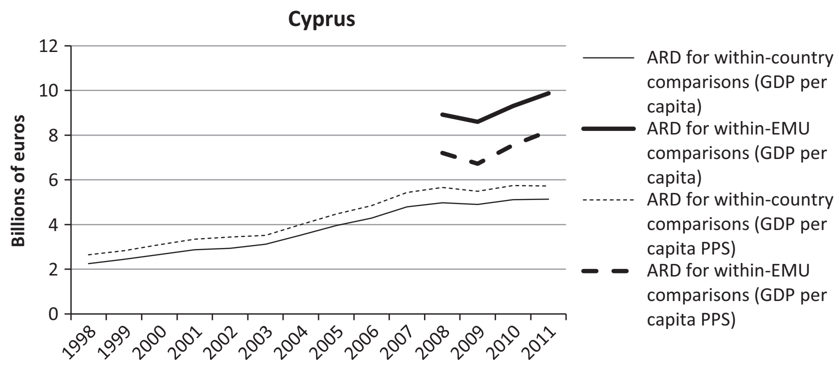
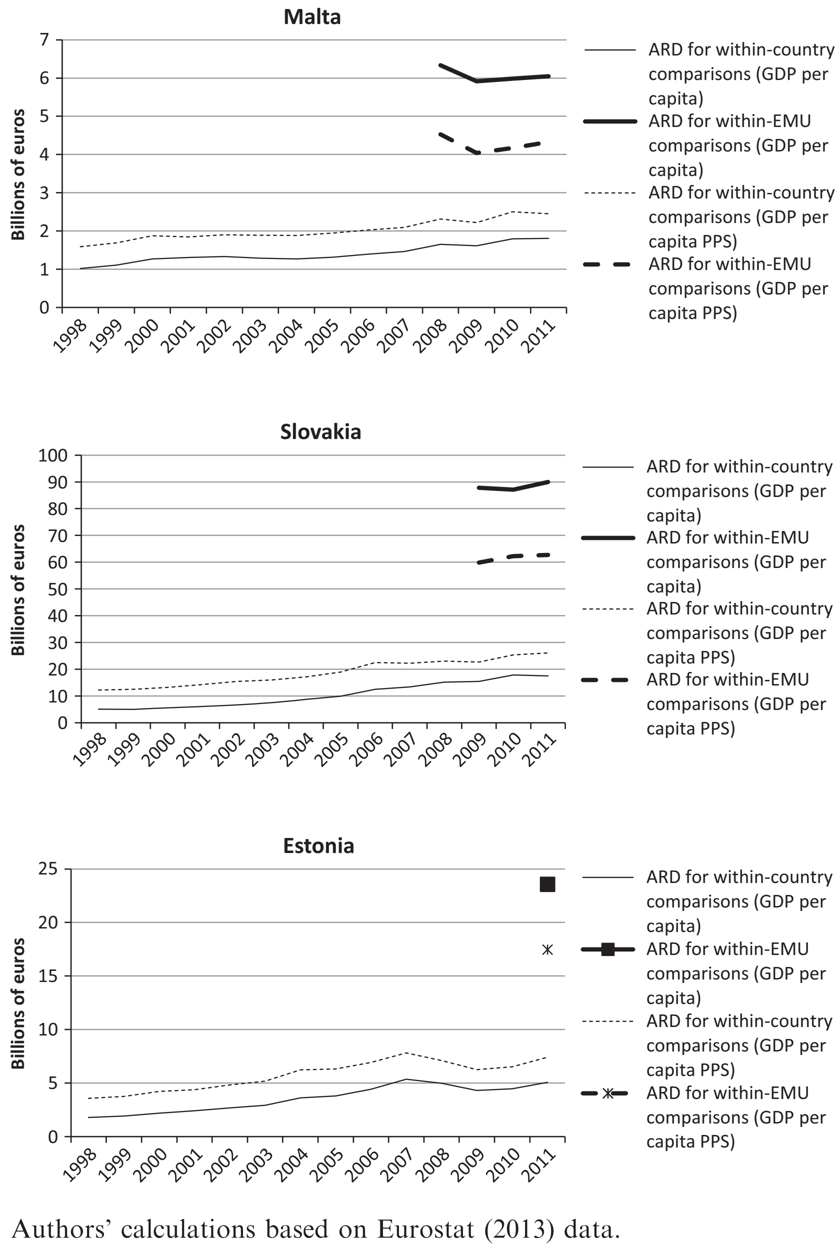
2004
2005
2006
2007
2008
2009
2010
2011
ARD for within-country comparisons (GDP per capita)
ARD for within-EMU comparisons (GDP per capita)
ARD for within-country comparisons (GDP per capita PPS)
ARD for within-EMU comparisons (GDP per capita PPS)


Slovenia
30
25
20
15
10
5
0
Billions of euros
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
ARD for within-country comparisons (GDP per capita)
ARD for within-EMU comparisons (GDP per capita)
ARD for within-country comparisons (GDP per capita PPS)
ARD for within-EMU comparisons (GDP per capita PPS)


Cyprus
12
10
8
6
4
2
0
Billions of euros
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
ARD for within-country comparisons (GDP per capita)
ARD for within-EMU comparisons (GDP per capita)
ARD for within-country comparisons (GDP per capita PPS)
ARD for within-EMU comparisons (GDP per capita PPS)



Source: Authors' calculations based on Eurostat (2013) data.

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