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Regional well-being in the OECD

Disparities and convergence profiles

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Abstract
This paper analyses convergence in well-being across 395 OECD regions in the period 2000–2014 using data from the Regional Well-being Dataset. It is widely known that well-being is a concept that goes far beyond income. However, whereas papers analysing convergence on income abound, the literature considering convergence in well-being is virtually nonexistent, especially at the regional level. Convergence is approached following the distribution dynamics technique and conditional density estimation (CDE), well-established data-driven methods that allow for the assessment of the shape and the time evolution of the kernel distribution of well-being. Moreover, the paper also assesses the role of a set of potential well-being determinants. Results show great disparities across the OECD regions, and no signs of convergence in the studied period. On the contrary, regions polarised into two clubs of low and high well-being, and country level factors explain in a large extent the observed tendencies.

Keywords Convergence · Distribution dynamics · OECD regions · Well-being

1 Introduction and motivation

Well-being has attracted scholar's attention in the last decades. Although GDP per capita has been used to measure wealth and quality of life, since the early seventies claims have been made that several dimensions other than income are related to general well-being (Easterlin 1974). More recently, authors including Rojas (2011), Ven (2015), Fleurbaey (2015) and Rojas and García-Vega (2017) define well-being as a multifaceted concept encompassing several dimensions that define living conditions beyond purely monetary and macroeconomic indicators. Indeed, while income is important, increased per capita income levels are

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not necessarily related to greater experienced well-being (Easterlin 1974; Frey et al. 2002; Rojas 2008). Public policies should then focus not only on income poverty and inequality, but also on disparities in aggregate well-being across economies.

Regarding well-being indicators, a well-known example is the Human Development Index (HDI), taking into account income, education and life expectancy. More recently, the OECD developed a comprehensive well-being framework providing a selection of indicators, based on the guidelines established by the Commission on the Measurement of Economic Performance and Social Progress (CMEPSP) (see Stiglitz et al. 2009). The indicators cover the domains of material conditions, quality of life and sustainability. Information is provided by the Regional Well-being Dataset (RWD), an open access dataset that is complemented by a series of regular reports and an interactive web page, allowing for a variety of online analyses.[1]

In parallel, the issues of inequality and convergence have given rise to a large body of literature, mainly based on GDP per capita. Results are heavily conditioned to the geographical frame and the time span. For the particular context of the OECD and for a relatively recent period, Walheer (2016) found the emergence of two diverging groups. One group made up of eastern and central European countries, and the second is formed by the EU-15 and Korea. These results are in line with seminal contributions from the nineties (see Quah 1996), suggesting the existence of two groups (or clubs) of poor and rich economies, known as the twin peaks. However, an exclusive focus on income could result in a partial view of the actual evolution of well-being, as other dimensions might behave differently. For this reason, the study of the convergence trends of multidimensional well-being indicators could be much more appealing for assessing and identifying development challenges and for the design of appropriate policies, which should be aimed at both improving well-being and narrowing territorial gaps.

This paper combines the traditional literature on convergence with the recent work providing more comprehensive well-being measures. As commented on, these two topics have developed separately, but contributions assessing convergence in well-being are still scant and mostly based on subjective indicators such as happiness or life satisfaction. In that regard, Goff et al. (2016) argued that the dispersion of self-reported life satisfaction can be used as a measure of inequality. Indeed, the study of the evolution of the standard deviation has been the most common practice, whereas only a few exceptions such as Helliwell et al. (2016) analysed the entire distribution, showing that happiness in the world is normally distributed. In addition, studies follow either a within-country or a cross-country perspective, but any of them have tackled the issue using regional data from several countries, which is a common approach adopted by income convergence analyses. Considering within-country analyses, Stevenson and Wolfers (2008) and Dutta and Foster (2013) found a decline in happiness inequality among groups of people in the USA, in contrast with the increase in income inequality. From the side of cross-country studies, Veenhoven (2005) concluded that happiness inequality declined from the 70s and Clark et al. (2016) showed that the decline can be attributed to modern growth.

Much less evidence is available for the case of objective well-being measures. Decancq et al. (2009) considered income, health and education and proposed a flexible multidimensional well-being inequality index, which adopts different trends that hinge on the parameters chosen for its construction. Kenny (2005) adopted a historical perspective and concluded that while there is a general absence of cross-country convergence in income,

[1] https://www.oecdregionalwellbeing.org/

convergence has actually taken place in other indicators of quality of life.[2] Other authors such as Konya and Guisan (2008), Mayer-Foulkes (2010) or Jordá and Sarabia (2015) provide some country level evidence using the HDI. Although conclusions are far from unanimous and the index is rather limited in terms of dimensions covered, there seems that each HDI component has followed a distinct pattern over time. If we focus on regions and from a transnational perspective, empirical evidence is, to the best of my knowledge, still yet to come. However, based on the previous results at the country level, finding a different evolution for income and a multidimensional well-being measure is perfectly plausible.

Against this background, this paper attempts to contribute in two ways. First, it provides a pioneering regional perspective on the existing inequalities and convergence tendencies in well-being for a sample of 395 OECD regions,[3] considering the comprehensive OECD regional well-being dataset for the period 2000–2014. Second, it assesses a set of potential determinants of the observed convergence/divergence tendencies at both the country and the regional level. In doing so, non-parametric methods to analyse convergence are applied. Although there is a wide variety of approaches (see Islam 2003, for a review), the non-parametric methods introduced by Danny Quah (see Quah 1993, 1996, 1997), based on the study of the *dynamics of distributions*, are today widely supported.[4] Finally, regional disparities in population are also accounted for, and population weighted distributions allow for assessing how many people actually enjoy high well-being levels.[5]

The results suggest a polarisation process in which regions cluster into two groups of high and low well-being. This is compatible with the existence of convergence clubs, aligned with the results by Jordá and Sarabia (2015) using the HDI for the country level. This concept implies that convergence takes place, but economies do not converge to a common steady state but to different steady states shared by regions with similar attributes. In that regard, results show that great part of the well-being disparities could be explained by country level socio-demographic features such as religious or ethnic fractionalisation and, most importantly, by regional expenditure and institutional quality. These factors seem to be important to define the steady states of the clubs. However, despite the general relevance of the country effect, in some developing countries such as Mexico or Turkey, within-country disparities are still remarkable. Accordingly, in these countries policies should pursue not only the improvement of well-being standards but also the reduction of the regional gap.

The remainder of the paper is structured as follows. Section 2 provides the data, their sources and some descriptive statistics. Technical notes on the methodology are reported in

[2]The time span considered differs for each indicator and some of the periods are so long that behind the general tendency of convergence, long periods of divergence may remain hidden.

[3]The OECD classifies regions as the first administrative tier of sub-national government. This classification is used by National Statistical Offices to collect information and, in many countries forms the bases for regional policies.

[4]A great deal of the success of these methods is due to their nature, which emphasises the data structure and avoids any preliminary assumptions about their distribution, providing a more flexible framework than parametric approaches such as the classical regression for analysing *beta convergence*. They are also preferred over *sigma convergence*, since the latter only focuses on the standard deviation of the distribution, whereas distribution dynamics considers the entire distribution. See Sala-i-Martin (1996) for an excellent explanation of the classical convergence approaches.

[5]There are remarkable disparities in terms of population. For example, while only 28,666 people lived in the region of Aland (Finland) in year 2014, the state of California in the USA had more than 38,792,300 inhabitants.

Section 3, while Section 4 summarises the results. Finally, Section 5 concludes and provides some guidelines for future research in this field.

2 Data and descriptive statistics

2.1 Variable description and sources

Data on well-being are taken from the OECD Regional Well-being Database. Information is available for years 2000 and 2014. Despite data constrains are a limitation – it would be preferable having yearly data - this is not necessarily a problem when applying distribution dynamics techniques. As it will be shown in the methodology section, the technique takes the initial and the final year of the analysed period to evaluate how the distributions evolve; in this case 2000 and 2014, respectively.[6] Moreover, similarly to income or even happiness levels, one might expect well-being dimensions to oscillate around long run steady state levels, the oscillations being the result of external elements such as business cycles. This would be the case of this particular scenario, affected by the economic crisis, which had a negative impact on economic dimensions such as income or jobs in several regions. In terms of studying convergence/divergence trends, however, the changes that the crisis may have induced in some indicators are not as relevant as changes in the disparities across regions. For example, it is possible that income in two given regions reduced while the gap between them remained unaltered.

The OECD Regional Well-being Database provides information for the following dimensions, each of them measured by one or several indicators:

- Income: household disposable income per capita (in real USD PPP)
- Jobs: employment rate and unemployment rate (%)
- Health: life expectancy at birth (years) and age adjusted mortality rate (per 1,000 people)
- Education: share of labour force with at least secondary education (%)
- Environment: estimated average exposure to air pollution (μg /m^3)
- Safety: homicide rate (per 100,000 people)
- Civic engagement: voter turnout (%)
- Accessibility of services: share of households with broadband access (%)
- Housing: number of rooms per person (ratio)

These dimensions – also the indicators used to measure them – are debatable, and it is likely that results could be different if other dimensions were considered. In any case, the OECD framework is an interesting approach, built on solid theoretical pillars and providing homogenous regional data that makes cross-regional comparison feasible. Also, its increasing use and expected future updates will enable comparison with other researches at the regional level in the years to come.

Apart from the above-mentioned dimensions, in 2014 there are data on community life and life satisfaction. These additional dimensions were not measured in 2000 and are therefore excluded from the analysis, since their evolution cannot be examined. The database supplies two different types of information for each indicator; data on their respective units

[6] Another limitation is the short temporal dimension, driven by the availability of data at the regional level. Yet the length of period is similar to other studies assessing convergence in terms of income at the regional level (see Ezcurra et al. 2005; Fischer and Stumpner 2008; Peiró-Palomino 2016).

of measure, described above; and normalised scores ($\widehat{x}_i$) on a scale from 0 to 10, allowing for a direct comparison across indicators. Dimensions containing more than one indicator (jobs and health) are constructed by averaging the scaled individual indicators. The higher the value, the higher the performance in the particular dimension. Indicators corresponding to lower well-being outcomes (unemployment rate, mortality rate, air pollution and homicide rate) are inversely coded ($\check{x}_i$). After assigning the values 0 and 10 to those observations of each indicator with values below and above percentiles 4th and 96th, respectively, the rest of values are calculated as follows:[7]

$$\widehat{x}_i = \left(\frac{x_i - min(x)}{max(x) - min(x)}\right) \cdot 10 \qquad \check{x}_i = \left(\frac{max(x) - x_i}{max(x) - min(x)}\right) \cdot 10 \tag{1}$$

In order to obtain a regional aggregate well-being indicator, data should be considered in their scaled form, since this is unfeasible using the variables expressed in their original units of measure. The adopted criteria for the construction of aggregate indicators is always controversial. Recent works such as Veneri and Murtin (2016) developed a methodology based on the computation of shadow prices, although there are some drawbacks to its implementation. First, a preliminary regression must be estimated in which self-reported life satisfaction is used as a dependent variable and the independent variables are the well-being dimensions. Regional data on life satisfaction have only recently been made available, and only for 2014,[8] so the panel regression the methodology proposes cannot be applied. Moreover, including all the dimensions in a single equation might be troublesome. Apart from being highly sensitive to the variables included, the estimated coefficients might be inconsistent because of collinearity or endogeneity issues. Other authors such as Mizobuchi (2014) or Peiró-Palomino and Picazo-Tadeo (2018) computed synthetic indexes for the OECD countries using Data Envelopment Analysis (DEA), while Cavapozzi et al. (2015) and Lorenz et al. (2017) focused on finding the most appropriate weighting scheme for well-being domains in the construction of composite indexes, although the consensus on which scheme of weights is preferable is rather limited.

Against this background, this paper is based on an equally weighted indicator. The measure of aggregate well-being is simply the arithmetic mean of the normalised 0–10 scores of each domain. Even though this alternative also has limitations, it seems quite reasonable in light of the difficulties and the lack of consensus. The simple average does not allow us to identify what matters most for overall well-being but provides a normalised single score of well-being that allows objective regional comparison.[9]

2.2 Descriptive statistics

Table 1 contains some descriptive statistics for all the dimensions in their respective units. With some exceptions, including unemployment rate, homicide rate and voter turnout, all the indicators improved on average. The standard deviation can be used as a prelimi-

[7] The OECD collects data at the regional level from different official data sources. Additional details on the construction of the scores and the nature of the indicators can be found at the user's guide of the OECD dataset, freely available online jointly with the data. For more details, see also OECD (2016).

[8] Data on life satisfaction in the 2014 database were actually collected between 2006 and 2014, depending on the region.

[9] In Section 4.4 results using alternative weights are provided as a robustness check.

Table 1 Well-being indicators, descriptive statistics

Dimension	Indicator (unit of measure)	Year	Mean	S.d.	Min.	1st quartile	Median	3rd quartile	Max.
Education	Labour force with secondary studies (%)	2000	65.96	20.31	9.50	52.83	71.95	82.08	95.10
		2014	74.21	18.88	19.90	65.78	81.65	87.95	97.70
Jobs	Employment (%)	2000	63.89	10.40	24.90	57.40	65.20	71.00	87.60
		2014	66.33	10.31	29.60	60.55	67.00	74.20	86.50
	Unemployment (%)	2000	7.61	5.25	0.80	3.70	5.80	10.20	27.90
		2014	8.60	5.94	1.50	5.00	6.80	9.75	34.80
Income	Household disposable income pc (real USD PPP)	2000	16,847	8,562	1,763	11,192	16,505	21,417	44,471
		2014	19,130	10,529	1,786	11,865	18,729	23,243	61,738
Safety	Homicide rate (per 100,000 people)	2000	3.30	3.91	0.00	1.20	2.00	3.90	41.80
		2014	3.45	6.73	0.00	0.80	1.50	3.10	64.80
Health	Mortality rate (per 1,000 people)	2000	10.21	1.70	6.60	9.10	9.90	10.95	17.00
		2014	8.35	1.48	5.80	7.20	8.20	9.40	15.60
	Life expectancy (years)	2000	77.38	2.51	67.80	75.80	78.10	79.30	81.60
		2014	79.93	2.74	71.30	78.10	80.60	82.10	84.80
Environment	Exposure to air pollution ($\mu g/m3$)	2000	13.59	6.31	1.20	9.00	14.30	18.10	31.60
		2014	10.45	5.32	0.40	6.45	10.30	14.45	27.00
Civic engagement	Voter turnout (%)	2000	69.46	11.87	39.80	60.75	70.70	78.60	96.20
		2014	68.12	12.49	38.80	59.80	68.20	77.05	95.10
Accessibility of services	Households with broadband access (%)	2000	39.34	18.53	5.00	24.50	38.00	53.00	84.90
		2014	71.03	18.98	9.50	66.00	76.00	83.00	99.20
Housing	Rooms per person (number)	2000	1.62	0.59	0.40	1.00	1.70	2.10	2.80
		2014	1.75	0.59	0.60	1.10	1.80	2.20	3.10

nary approach to examine whether disparities increased or decreased. Results are mixed. It decreased for some indicators such as labour force with secondary studies, mortality rate and exposure to air pollution. It increased slightly for household disposable income per capita and homicide rate, and it remained relatively constant for the rest of indicators. Minimum and maximum values show large regional disparities within the OECD for all the indicators. For some of the indicators such as disposable income, the minimum values in 2000 and 2014 are virtually the same, while the maximum rose by 40%, widening the differences. Labour force with secondary studies, however, shows the opposite tendency. The maximum varied slightly, while the minimum increased notably. Substantial improvements in both the minimum and the maximum are found for households with broadband access, exposure to air pollution and rooms per person, while for the indicators of employment and unemployment rates, mortality rate, life expectancy and voter turnout, differences are only slight.

Despite representing only two particular observations, such great differences between the minimum and the maximum values might give an initial idea of the real importance of regional disparities within the OECD. Country level features might have a decisive influence in explaining regional differences. Table 2 provides country level information for 2000 and 2014. The table reports the regional average for each country, the standard deviation and the Theil index to examine well-being inequality. For the sake of comparison with a subjective measure of well-being, the table also includes self-reported life satisfaction.

Looking at the figures, important disparities are observed in both 2000 and 2014, which mirror the large differences reported in Table 1. In global terms, the standard deviation reduced from 0.58 in 2000 to 0.47 in 2014, showing a global decrease of inequality. Nevertheless, as happens with the descriptive statistics from Table 1, that single figure may hide particular trends and the global reduction is still compatible with a scenario of different clusters or clubs of well-being.

Regarding well-being levels, in 2000 Norway, Luxembourg and Iceland ranked highest with scores above 7.7, followed by Sweden, Canada, Denmark and Australia. The Slovak Republic, Poland, Turkey and Mexico had the lowest scores. In 2014, the ranking showed very little variation, although there are some changes that merit further attention. For example, in 2014, Australia headed the list, following a 24% improvement. In Poland, well-being increased by 23%, although the score was still one of the lowest in the OECD. Great improvements are also observed in Germany (17%), New Zealand (15%) and the United Kingdom (15%). In contrast, well-being declined dramatically in Chile (38%), Mexico (29%), Greece (26%), Hungary (17%) and Italy (15%). Other relatively well-positioned countries such as Netherlands, Sweden or Belgium show no relevant changes. Well-being in Portugal and Israel, which are in relatively low positions, remained quite stable.

The Theil index shows within-country inequality, remarkable in countries such as Canada, Italy, USA, Turkey or Mexico. Other countries, including Denmark, Sweden, Norway and Greece are more homogenous. In Belgium, Germany, Korea, New Zealand and Slovenia significant reductions took place, whereas in other countries such as Estonia, the Slovak Republic and Portugal within-country differences rose. Considering all the sample, the decomposition of the Theil index for 2000 indicates that the country effect (between component) accounts for 84.90% of the variation of well-being inequality, whereas the remaining 15.10% can be attributed to the regional component. In 2014, these percentages are 89.40% and 10.60%, respectively, reflecting a slight increase of the size of the country effect, although there are cases such as Mexico, Canada or Turkey with large and persistent within-country disparities.

Table 2 Well-being by country

Country (# of regions)	Aggregate well-being indicator 2000			Aggregate well-being indicator 2014			Life satisfaction 2014		Aggregate well-being change
	Score	S.d.	Theil index	Score	S.d.	Theil index	Score	S.d.	(%)
Australia (8)	7.1	0.81	0.005	8.8	0.84	0.005	7.4	0.25	23.94
Austria (9)	6.2	0.52	0.003	7.0	0.35	0.001	7.3	0.12	12.90
Belgium (3)	6.5	0.90	0.009	6.6	0.72	0.004	6.9	0.23	1.54
Canada (13)	7.2	1.22	0.018	7.6	1.15	0.014	7.6	0.28	5.56
Chile (15)	5.2	0.46	0.004	3.2	0.30	0.003	6.7	0.56	–38.46
Czech Republic (8)	4.3	0.54	0.010	4.7	0.49	0.004	6.5	0.21	9.30
Denmark (5)	7.2	0.28	0.001	7.2	0.15	0.000	7.6	0.10	0.00
Estonia (5)	4.0	0.55	0.011	4.3	0.85	0.013	5.4	0.18	7.50
Finland (5)	6.6	0.40	0.001	7.4	0.23	0.000	7.5	0.00	12.12
France (22)	6.0	0.76	0.008	6.8	0.53	0.003	6.7	0.23	13.13
Germany (16)	6.4	0.63	0.005	7.5	0.27	0.001	6.6	0.32	17.19
Greece (13)	4.7	0.37	0.003	3.5	0.33	0.003	5.4	0.44	–25.53
Hungary (7)	4.6	0.52	0.008	3.8	0.43	0.004	4.9	0.27	–17.39
Iceland (2)	7.8	0.53	0.001	7.7	0.10	0.000	7.2	0.14	–1.28
Ireland (2)	6.1	0.36	0.001	6.7	0.18	0.000	7.1	0.14	9.84
Israel (6)	4.9	0.71	0.009	5.0	0.70	0.007	7.3	0.17	2.04
Italy (21)	6.5	1.00	0.015	5.5	0.81	0.009	6.2	0.37	–15.38
Japan (10)	6.2	0.18	0.000	7.0	0.23	0.001	6.0	0.14	12.90
Korea (7)	5.6	0.53	0.004	6.1	0.18	0.000	5.9	0.16	8.93
Luxembourg (1)	7.7	–	–	8.2	–	–	6.9	–	6.49
Mexico (33)	2.4	0.94	0.020	1.7	0.92	0.022	7.2	0.64	–29.17

Table 2 (continued)

Country (# of regions)	Aggregate well-being indicator 2000			Aggregate well-being indicator 2014			Life satisfaction 2014		Aggregate well-being change
	Score	S.d.	Theil index	Score	S.d.	Theil index	Score	S.d.	(%)
Netherlands (11)	6.7	0.29	0.001	7.0	0.28	0.001	7.5	0.17	4.48
New Zealand (14)	6.6	0.75	0.007	7.6	0.42	0.002	7.3	0.18	15.15
Norway (7)	7.8	0.30	0.001	8.3	0.19	0.000	7.6	0.10	6.41
Poland (16)	3.0	0.48	0.017	3.7	0.34	0.003	5.9	0.28	23.33
Portugal (7)	4.8	0.36	0.003	4.9	0.54	0.005	5.3	0.12	2.08
Slovak Republic (4)	3.5	0.35	0.004	4.0	0.54	0.006	6.2	0.24	14.29
Slovenia (2)	5.3	0.65	0.005	4.8	0.44	0.002	6.0	0.21	–9.43
Spain (19)	5.3	0.87	0.014	5.9	0.84	0.010	6.5	0.29	11.32
Sweden (8)	7.6	0.23	0.000	7.8	0.19	0.000	7.4	0.10	2.63
Switzerland (7)	6.4	0.36	0.001	6.8	0.24	0.001	7.6	0.21	6.25
Turkey (26)	2.8	0.75	0.029	2.5	0.63	0.018	5.3	0.45	–10.71
United Kingdom (12)	6.2	0.54	0.004	7.1	0.32	0.001	6.9	0.12	14.52
United States (51)	6.1	0.90	0.009	6.6	0.77	0.006	7.2	0.35	8.20
All sample	5.7	0.58	0.055	6.0	0.47	0.049	6.7	0.24	3.20
Theil between (%)			84.90			89.40			
Theil within (%)			15.10			10.60			

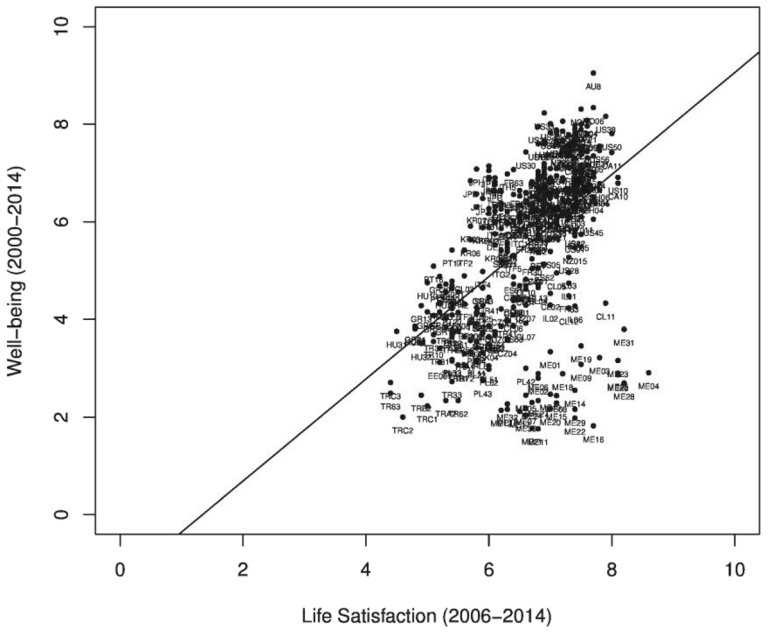


Fig. 1 Regional well-being and life satisfaction

Finally, the table reports information on life satisfaction at the country level,[10] showing large disparities across the OECD countries. The highest scores are found in Denmark, Norway, Switzerland and Canada, whereas the lowest are for Estonia, Greece, Portugal, Turkey and Hungary. The largest within-country differences take place in Mexico, Chile, Greece and Turkey. Other countries such as Denmark, Austria, Sweden or Portugal are relatively homogeneous. Comparing objective with subjective well-being measures, Fig. 1 displays the scatter plot for life satisfaction and the OECD well-being index (equally weighted, average value of 2000 and 2014), showing a general positive correlation (Spearman correlation is 0.55, significant at the 1% level).

3 Empirical methodology

Distribution dynamics has been widely used in the convergence literature, especially to analyse country and regional convergence in income per capita or productivity levels (see Fischer and Stumpner 2008; Peiró-Palomino 2016). In practice, however, because it is flexible and well supported in this field this technique is a useful tool to analyse other issues

[10] As commented on in the Introduction, several papers have considered that subjective variable as a proxy for well-being. Availability constrains at the regional level prevent us to make a more effective use of this variable, although it was used in some parts of the analysis for either comparability or robustness checks.

in economics.[11] In this paper we apply the technique to examine convergence in well-being using the indicators presented in the previous section.

The approach consists of estimating the following kernel density function for the variable of interest at different periods t:

$$\hat{f}_t(y) = \frac{1}{nh} \sum_{i=1}^{n} K\left(\frac{1}{h} \| y - Y_i \|\right) \tag{2}$$

where n is the number of regions, Y_i is the target variable, K is a kernel function and h is the bandwidth parameter. Finally, $||.||$ is the Euclidean distance. Weighted densities are also feasible. A weighting element can be introduced in Eq. 2 as follows:

$$\hat{f}_t(y) = \frac{1}{nh} \sum_{i=1}^{n} w_i K\left(\frac{1}{h} \| y - Y_i \|\right) \tag{3}$$

where w_i is an appropriate weight. For example, for population weighted densities, w_i is the share of the sample population living in region i.

The kernel selected is the Gaussian kernel, although in practice, the choice of kernel is not an essential issue in non-parametric methodologies.[12] Bandwidth (h) selection is a much more crucial issue, since it determines the size of the bumps (Silverman 1986). If h is too small it produces an excessive number of bumps (undersmoothing), which severely hinders understanding of the data structure. In contrast, a too large h (oversmoothing) produces an excessive degree of smoothing and some peculiarities of the data might remain hidden. Of the automated procedures for bandwidth selection the method proposed by Silverman (1986) is used, which for reasons of computability is the default option in most statistical software.[13]

From Eq. 2, evidence of convergence is found when the probability mass in the distribution of the variable accumulates around a certain value. It is common practice to standardise the data before the analysis by, for instance, dividing each observation by the sample mean. This implies dealing with relative data instead of their original units of measure. If that is the case, regions converge "to the mean" when the probability mass concentrates around the unity.

Analysing the distributions at different t periods is a good strategy to study disparities in given years. However, this *static* approach does not allow us to study the internal *dynamics* of the distribution, i.e. whether regions have remained stable in their respective relative positions or, on the contrary, they have moved to a different stage of well-being over time. This issue is tackled by means of conditional density estimation (CDE). This allows us to examine the law of motion that describes how F_t (the distribution at time t), converts into

[11] For instance, Tortosa-Ausina (2002) used distribution dynamics to study the evolution of bank efficiency while Herrerías (2012) focused on convergence in energy use.

[12] In fact, there are only marginal differences between competing alternatives such as the rectangular, the triangular or the Epanechkinov kernel.

[13] To ensure the robustness of the results, densities were computed with alternative bandwidths. Additional details are provided in Section 4.4.

F_{t+s} after s periods, subject to the relative position of each economy in t. The transition is defined by an n-th order Markov process:

$$\forall s \geq 1 : F_{t+s} = M^s F_t \tag{4}$$

where M is a representation of a stochastic kernel mapping the transition.

Let us denote the regional cross-section distribution at time t and $t + s$ as $f_t(y)$ and $f_{t+s}(m)$, respectively. Their time evolution is represented by:

$$f_{t+s}(m) = \int_0^\infty v_s(m|y) f_t(y) dy \tag{5}$$

where $v_s(m|y)$ is the conditional density which shows the probability of a region transiting between two specific well-being states, given its relative well-being level at period t. The conditional density is estimated dividing the bivariate density function by the marginal:

$$\hat{v}_s(m|y) = \frac{\hat{f}_{t,t+s}(y, m)}{\hat{f}_t(y)} \tag{6}$$

where

$$\hat{f}_{t,t+s}(y, m) = \frac{1}{nh_y h_m} \sum_{i=1}^{n} K\left(\frac{1}{h_y} \|y - Y_i\|_y\right) K\left(\frac{1}{h_m} \|m - M_i\|_m\right) \tag{7}$$

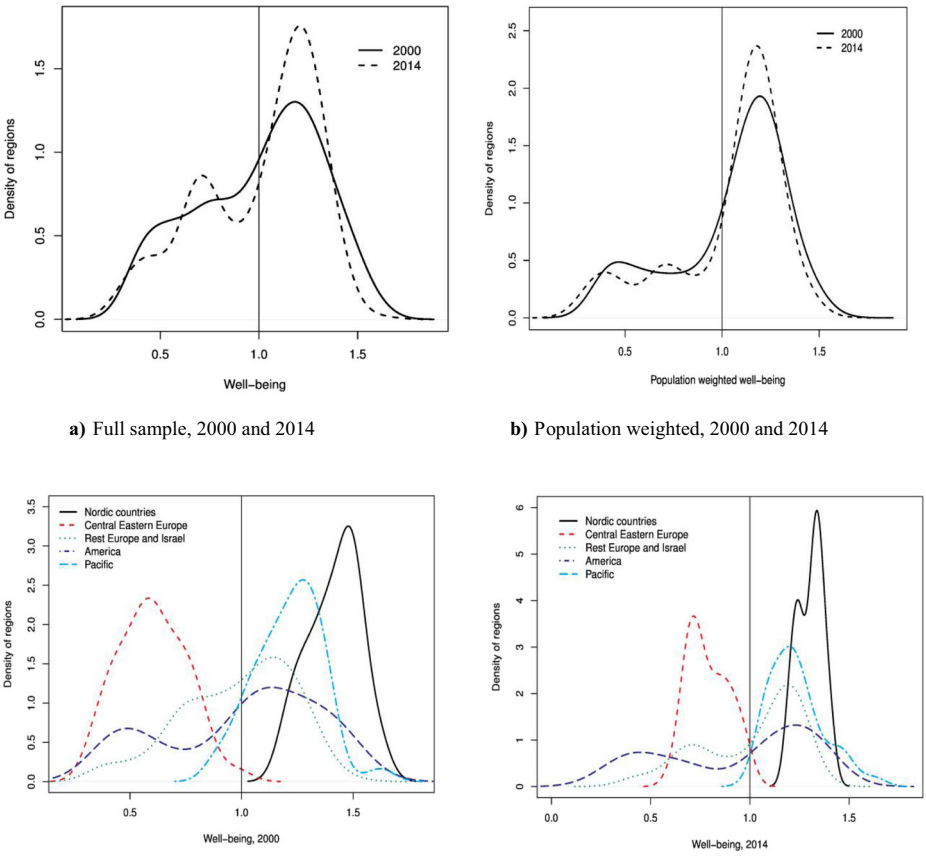
is the joint density of (M, Y), $\hat{f}_t(y)$ (see Eq. 2) the marginal density of Y, and h_y and h_m their respective associated bandwidths.

The results are entirely graphical and provided using Hyndman et al.'s (1996) visualisation tools. They consist of three-dimensional plots that show the stacked conditional densities for a grid of values of the conditioning variable, that is, the relative position at year t. The stacked densities plot the intra-distribution mobility (or *churning*) of the regions in the sample, conditioned on their initial relative position. The interpretation of the results from the plots is straightforward. If the probability mass in the graphs concentrates along the main diagonal it means that regions have remained stable in the same relative position, that is, there are no signs of convergence. In contrast, if the probability mass was widespread in year t (Y axis) but accumulates around a certain value in year $t+s$ (X axis) then convergence to that value has taken place. The methodology also admits the inclusion of conditioning elements such as geographical factors. In the latter case, geography acts as a conditioning variable and the stochastic kernel shows the transition from the original to the conditioned density. When probability distributes along the main diagonal the relative position of the economies remains unaltered, that is, geography has no influence. On the contrary, when probability accumulates toward the conditioned series in the X axis, this conditioning element is relevant. Additional details on the methodology can be found in the seminal papers (Quah 1993, 1996, 1997), and in empirical applications (Ezcurra et al. 2005; Poletti Laurini and Valls Pereira 2009; Peiró-Palomino 2016).

4 Results

4.1 Regional well-being disparities and convergence profiles

This section provides the results of applying distribution dynamics' methods. Figure 2a displays the kernel densities for the regional average well-being scores in 2000 and 2014. As explained in the methodological section, data are relativised to the sample mean, so that



a) Full sample, 2000 and 2014

b) Population weighted, 2000 and 2014

c) Geographical areas, 2000

d) Geographical areas, 2014

Fig. 2 Regional well-being, kernel densities

unity represents the average. The density for 2000 shows a main mode above the unity and a large proportion of the probability mass widespread below the mean. In 2014, however, the density is quite different, showing two well-defined modes above and below the unity. This change in the shape describes a polarisation process in which regions cluster into two clubs of high and low well-being. Individual results for each of the well-being indicators are available in Appendix A1. The plots show that the main drivers of the exacerbation of the polarisation process are education (labour force with secondary studies), environment (exposure to air pollution) and access to services (broadband access). Interestingly, the densities for the indicators of economic dimensions such as income and jobs remained relatively stable, while rooms per person, the indicator for the housing dimension shows a marked polarisation in both years.

As well-being directly affects people, population-weighted densities have been computed applying Eq. 3. These are available in Fig. 2b, and reveal interesting differences in comparison with the original (unweighted) densities. In particular, the density in 2000 has a more defined shape than the original. More regions are agglutinated above the mean, and the second mode far below the mean is more prominent, indicating an agglomeration of regions

around 0.5 times the average well-being. Considering the weighted density in 2014, it is observed that the main mode is more pointed, while the left mode divides into two approximately symmetrical bumps on the left and the right of 0.5, respectively. We can therefore distinguish three groups of people, being the largest that enjoying the highest well-being level and showing that, in terms of population, the polarisation process is more moderated.

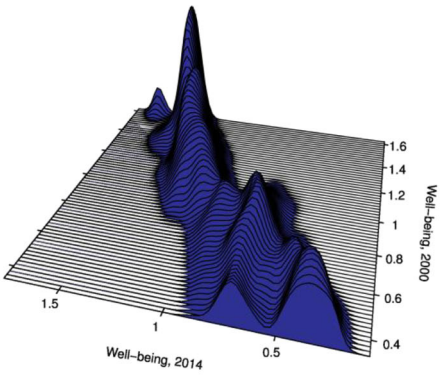
In order to explore differences by geographical area, regions are classified into five geographical areas, each one including the following countries:

- Nordic countries: Denmark, Norway, Iceland, Finland and Sweden
- Central and Eastern Europe: Czech Republic, Estonia, Hungary, Poland, Slovak Republic, Slovenia and Turkey
- Rest of Europe and Israel: Austria, Belgium, France, Germany, Greece, Ireland, Israel, Italy, Luxembourg, Netherlands, Portugal, Spain, Switzerland and United Kingdom
- America: United States, Canada, Mexico and Chile
- Pacific: Australia, New Zealand, Korea and Japan

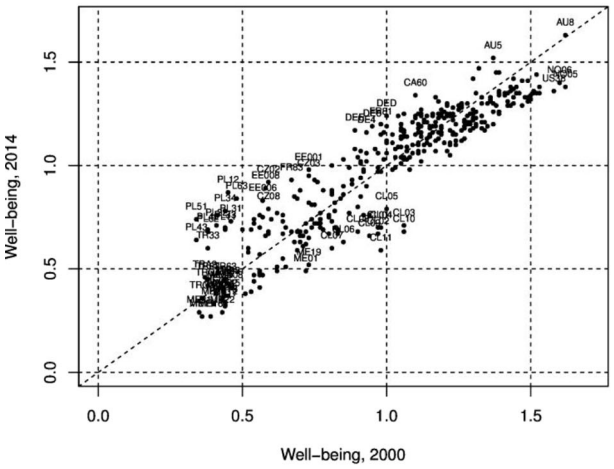
Figure 2c and d display these results for 2000 and 2014. The picture is similar in both years, suggesting persistent disparities across groups. In particular, regions from the Nordic countries (black solid) and the Pacific area (light blue dashed dotted) have well-being levels above the average, showing also low dispersion. For the groups of Rest of Europe and Israel (green dotted) and America (blue long dashed) the densities are bimodal, with modes above and below the unity. In the American group, the regions with low well-being are Mexican and Chilean, whereas in the Rest of Europe and Israel group regions in the left mode are mainly from Greece, Portugal, Turkey and Israel. Finally, regions from the Central and Eastern Europe group (red short dashed) are all below the average. From the previous analysis three preliminary conclusions can be drawn: i) regions polarise into groups of high and low well-being; ii) the patterns found are persistent; and iii) most of the sample population enjoy well-being levels above the mean, although this is heavily influenced by the USA, largely populated.

So far the analysis has focused on the external shape of the distributions. Nonetheless, the shape might have prevailed even though regions have experienced intra-distribution movements.[14] Accordingly, the next step in the analysis is to study the intra-distribution mobility. As explained in Section 2, this is examined by means of conditional density estimation (CDE), whose results are displayed by Fig. 3. Panel a shows the intra-distribution movements in the original well-being density. The CDE analysis reveals that regions above the average remained stable in their relative positions. However, mobility is substantial among those below the mean. In particular, some regions concentrate around 0.7, which corresponds to the left mode in the static analysis of the previous section, while others accumulate in an incipient third mode below 0.5 times the average that makes very timid appearances in the static density. The general conclusion is that while some of the regions with the lowest well-being levels experienced some catching up, giving rise to a more marked left mode, another large group remained static. Panel b in Fig. 3 offers a complementary view of the results and allows for identifying which regions experienced the

[14] For example, an extreme case would be represented by a bimodal distribution in the two temporal periods, considering that regions in one mode in the first period move to the other mode in the second and vice versa. In this hypothetical case, the external shape would remain invariant but the internal composition of the distribution would be completely different.



a) CDE, sample relative well-being



b) Scatter plot, sample relative well-being

Fig. 3 Regional well-being, intra-distribution mobility

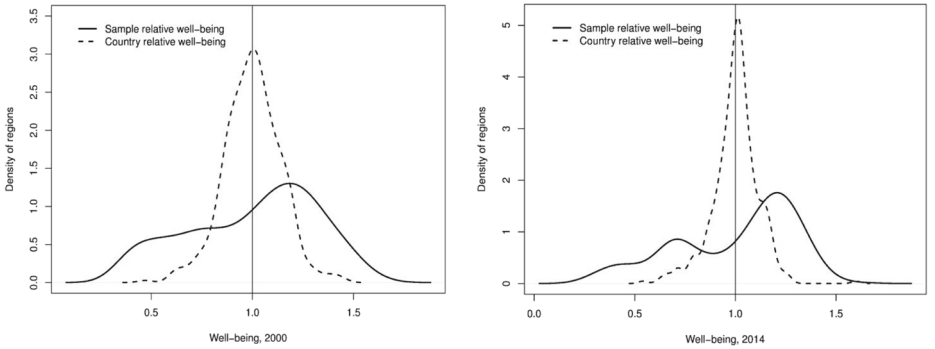
greatest movements. Regarding the group of the lowest well-being, regions from Mexico and Turkey are those which remained static. However, most of the Polish, Estonian and Czech regions improved notably, giving rise to the left mode in the 2014 density. In contrast, the Chilean regions, below the main diagonal, clearly worsened their relative position.

Individual results for all the indicators are available in Appendix A2. In particular, for income, life expectancy and rooms per person regions have remained approximately in the same relative position (probability mass is distributed along the main diagonal), whereas indicators for other dimensions such as education and broadband access present more noticeable changes that mainly drove the polarisation into the two clubs observed at the aggregate level. More specifically, there is a group of regions with low values in 2000 that actually catched up in 2014, whereas another group remained clearly stagnated. In contrast,

for the case of air pollution (environment dimension) or civic engagement (voter turnout) regions above the average are those that worsened in relative terms.

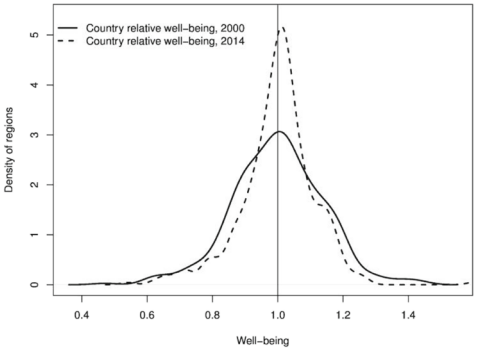
4.2 Country effects

Although regions are different in many aspects, it is likely that those located in the same country share common attributes. For a deeper analysis of the role of geography, the relevance of the country effect is explicitly considered. In doing so, regional well-being scores are not relativised to the sample mean but to the corresponding country mean, limiting differences to within-country factors. Figure 4 displays the results. Panels a and b compare the original sample relative well-being density with the country relative counterpart in years 2000 and 2014, respectively. In both years the country component is remarkable. Once regions are compared to their corresponding country means, they are much more similar, being the distributions sharper and unimodal, suggesting that well-being can be largely explained by country level features, in accordance with the Theil index. Figure 4c



a) Kernel densities, 2000

b) Kernel densities , 2014

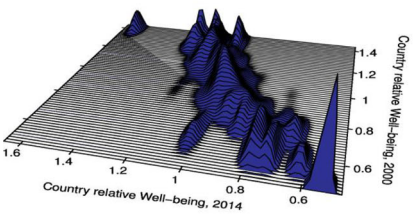


c) Country relative well -being, kernel densities 2000 and 2014

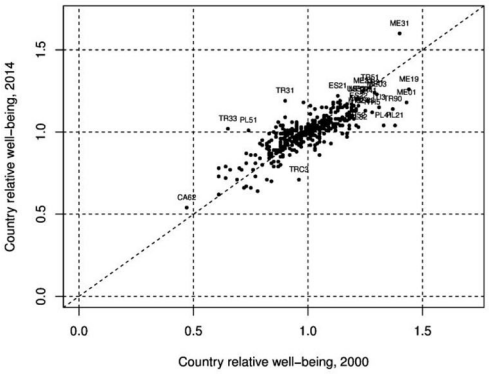
Fig. 4 Country effects, kernel densities

superimposes the country relative distributions in 2000 and 2014, revealing only slight changes. In particular, the distribution is sharper in 2014, suggesting some signs of convergence, although admittedly weak. Therefore, within-country disparities are persistent over the period.

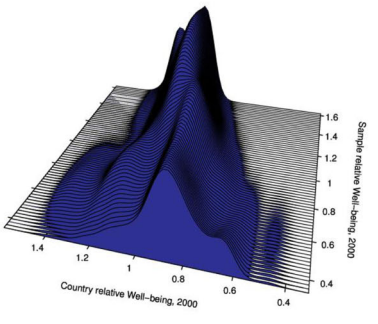
Considering the dynamics of the distributions, Fig. 5a suggests little evidence of internal movements, as the probability mass is along the main diagonal in the plot. In comparison with the sample relative data, regions remain more static. Therefore, not only the distributions in 2000 and 2014 are almost identical in shape, but the internal composition of the densities remained virtually unaltered, which indicates that a reduction of within-country inequalities did not take place. The result is no surprise, given that within-country differences were much lower than those at the sample level. This is corroborated by the scatter plot in panel b, showing most of the regions along the main diagonal. The exceptions are some regions from Mexico and Turkey, which experienced more noteworthy movements.



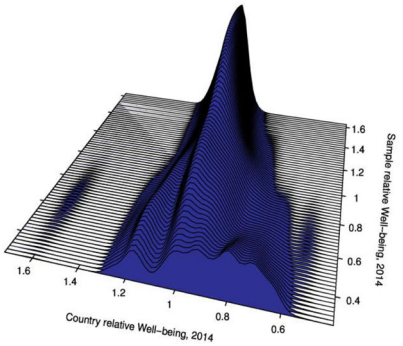
a) CDE, country relative well-being



b) Scatter plot, country relative well-being



c) CDE, country effect in 2000



d) CDE, country effect in 2014

Fig. 5 Country effects, intra-distribution mobility

The particular influence of the country effect in separate years can be also studied by means of CDE.[15] In this case the plot does not show the internal mobility over time, but the change due to the country effect, which acts as a conditioning element. The country relative distribution is, therefore, a conditioned distribution. Specifically, the plots show how the sample relative distribution in the Y axis converts into the country relative distribution in the X axis. Panels c and d in Fig. 5 provide these results. The probability mass is clearly off the main diagonal, and it is approximately centered at unity in the country relative density. In other words, there is a large country effect, given that the position in the country relative density (X axis) is virtually independent from the sample relative position (Y axis). This process is observable in both years. The CDE analysis reinforces the conclusions derived from the external shape of the densities, that is, the national component largely explain well-being disparities. Despite the general importance of the country effect, however, there are countries where within-country disparities are still notable, as shown by the analysis of the standard deviations and Theil indexes already commented on Section 2.

4.3 Determinants of well-being

This section provides some insights on the determinants of well-being and its temporal evolution. Following previous contributions such as Inglehart et al. (2008) and Clark et al. (2016) potential determinants at both the regional and the country level are selected and included in several regression models. At the regional level are considered population growth (%), population density (inhabitants/km^2), dependency ratio (% population>65), innovative performance (patents per 1,000,000 inhabitants) and well-being in the initial year. At the country level are included indexes of ethnic and religion fractionalisation, regional expenditure (% of regional expenditure over total government expenditure) and institutional quality (index considering corruption, law and order and bureaucracy quality). All the data are provided by the OECD dataset and the Quality of Government Dataset (University of Gothenburg), and correspond in all cases to average values for the period 2000–2014. In order to avoid as much as possible reverse causality, the dependent variable is well-being in 2014. Also, the growth of well-being 2000-2014 is considered. Finally, and for comparability reasons, the last model uses life satisfaction as a dependent variable.[16]

The results, shown in Table 3, suggest that regional factors such as population growth, the innovative performance and the dependency rate are positively associated to well-being. Country level variables are all significant. While ethnic fractionalisation is negative, religion fractionalisation, the regional expenditure and institutional quality are positively associated to regional well-being.

When considering the growth of well-being as a dependent variable the results are slightly different, being only significant the dependency rate (again positive) and the well-being level in 2000 (negative). Regarding country level factors, their signs and significance remain the same than in the model in levels. As we include control variables, the negative result for initial well-being in the growth model can be compatible with the idea of conditional convergence (see Islam 2003), which entails regions to converge to their own steady state. Also, and aligned with the results obtained from the distribution analysis suggesting

[15] See, for related examples, Fischer and Stumpner (2008), Mora (2008) and Peiró-Palomino (2016).

[16] Note that despite the dependent variable is truncated in the interval 0–10, there is no region with these extreme levels. Then, models can be estimated via ordinary least squares.

Table 3 Determinants of well-being

	Wb 2014	Wb 2014	Δ Wb 2000-2014	Δ Wb 2000-2014	Life satisfaction 2014
Intercept	1.573***	− 1.534***	0.175***	−0.051	4.132***
	(0.293)	(0.255)	(0.034)	(0.050)	(0.205)
Population growth	5.913***	3.494***	− 0.370	− 0.035	2.351***
	(0.890)	(0.475)	(0.110)	(0.098)	(0.383)
Population density	−0.024	− 0.048	0.012	0.0008	− 0.029
	(0.081)	(0.042)	(0.009)	(0.007)	(0.033)
Dependency rate	0.159***	0.062***	0.006***	0.005***	− 0.017***
	(0.010)	(0.006)	(0.001)	(0.001)	(0.005)
Patents per capita	0.247***	0.043	0.001	− 0.001	− 0.035
	(0.070)	(0.037)	(0.008)	(0.006)	(0.029)
Well-being 2000			− 0.038***	− 0.112***	
			(0.005)	(0.007)	
Ethnic fractionalisation		− 1.114***		− 0.194***	0.624***
		(0.247)		(0.046)	(0.199)
Religion fractionalisation		1.161***		0.132***	0.105
		(0.201)		(0.037)	(0.163)
Regional expenditure		0.020***		0.003***	0.027***
		(0.006)		(0.001)	(0.005)
Institutional quality		6.490***		0.723***	2.761***
		(0.387)		(0.089)	(0.313)
N*	394	394	394	394	390
R^2 (Adjusted)	0.408	0.843	0.227	0.447	0.544
F-Statistic	68.78***	264.90***	24.19***	36.30***	59.03***

*Some information is not available for the 395 regions of the sample

***denotes significance at the 1% level

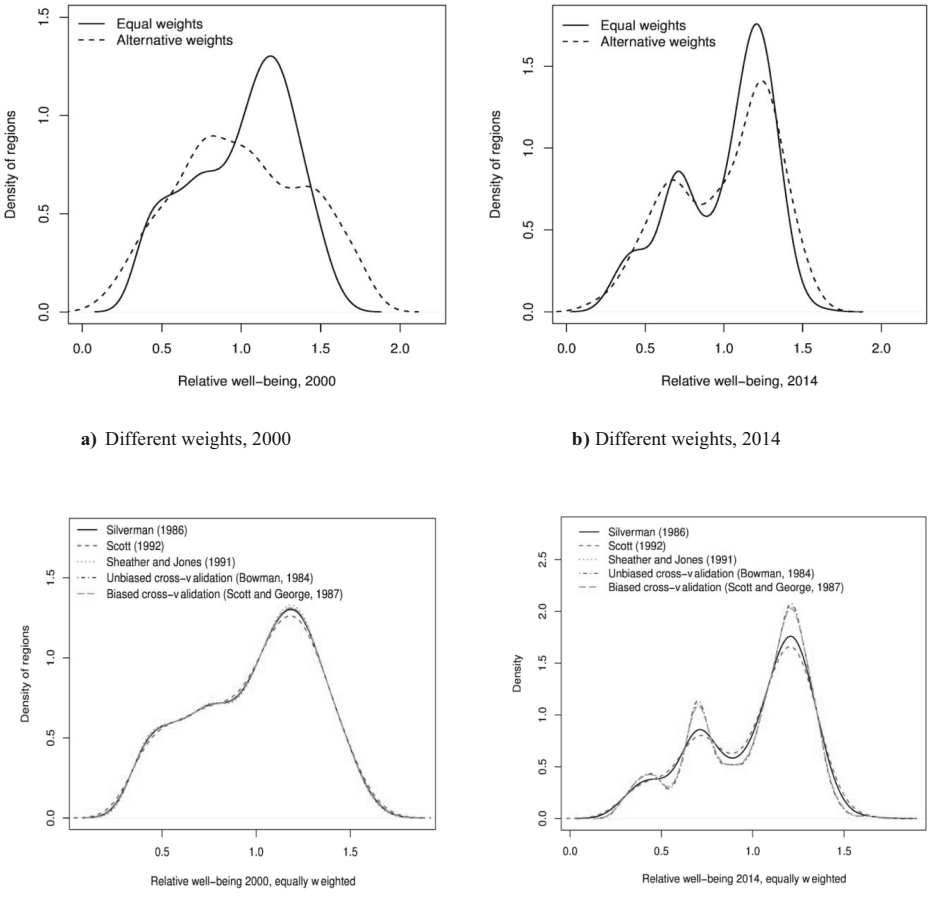
an increase in polarisation, the results may point to club convergence, indicating that regions with similar characteristics might have similar steady states. According to the estimations, some of these characteristics are country level features. From the policy point of view, whereas it is more difficult to modify socio-demographic features –at least in the short term – the positive signs for regional expenditure and institutional quality are particularly relevant, as these two variables seem to play a notable role for both explaining well-being levels and short term improvements.

The last model focuses on the determinants of life satisfaction. Whereas results are to some extent similar to those for the well-being models, they present also some expected differences, as these two indicators are different in nature and the descriptive analysis showed that, despite the general positive correlation, in some regions (mostly Mexican) there are some differences between them. Population growth is positively related, but the dependency rate is negative, which suggests that younger populations report higher levels of life satisfaction. Ethnic fractionalisation is in this case positive, whereas no effect is found for religion fractionalisation. In contrast, regional expenditure and institutional

quality have positive coefficients, in line with the objective well-being models. This highlights the importance of investing in regions and having a solid and reliable institutional framework to promote well-being, both objective and subjective. In all cases models are jointly significant.

4.4 Robustness tests

In order to check the robustness of the results some additional tests were performed. First, results for the well-being densities using a different scheme of weights are provided. It can be argued that the equally weighted option is, despite being neutral and comparable across regions, too arbitrary. Considering that the global index of well-being can be linked, to some extent, to self-reported levels of life satisfaction, it is possible to calculate an alternative set of weights using that variable. In doing so, the correlation of each dimension with life satisfaction was computed. Then, each dimension received a weight proportional to that



a) Different weights, 2000

b) Different weights, 2014

c) Different bandwidths, 2000

d) Different bandwidths, 2014

Fig. 6 Robustness tests

correlation.[17] These weights are the following: education (0.10), jobs (0.20), income (0.14), safety (0.02), health (0.07), environment (0.15), civic engagement (0.03), accessibility to services (0.12) and housing (0.17).[18] Panels a and b in Fig. 6 display the densities for years 2000 and 2014 using this alternative scheme of weights. Although there are changes, these are only slight and the main features remain virtually unaltered, especially the bimodality for year 2014, thus providing some robustness to the idea of polarisation into two convergence clubs.

In second place, as the shape of the densities can be driven by the selected bandwidths, results with different bandwidth selection procedures are provided. In particular, five different methods were considered: the original, i.e. Silverman (1986), Scott (1992), Sheather and Jones (1991), Bowman (1984), and Scott and Terrell (1987). Panels c and d in Fig. 6 display the results for years 2000 and 2014, respectively. In all cases the results hold, showing that the structure of the data is robust to alternative smoothing procedures.

5 Concluding remarks and prospects for future research

This paper has studied convergence in well-being for 395 OECD regions between 2000 and 2014 following the distribution dynamics approach. Although much research has been conducted on convergence, the OECD regional context remains largely unexplored. In addition, most research has focused on convergence in terms of income, but no evidence was hitherto available on people's well-being for a recent period. The results show a bimodal well-being distribution, which indicates that regions are polarising into two convergence clubs of low and high well-being with different steady states.

Although not directly comparable, such results are contrary to those by Kenny (2005), suggesting convergence in dimensions other than income. They are, however, aligned to more recent papers such as Jordá and Sarabia (2015), finding a bimodal distribution for the Human Development Index at the country level. Here, we consider an aggregate indicator including nine objective well-being domains. However, it must be said that having an accurate global well-being indicator for such a wide sample of regions is at the cost of data availability, and only a period of 14 years was analysed, whereas other country level studies adopt a long run perspective.

Results for geographical areas indicate that regions from the Nordic countries have the highest well-being levels, while those from countries in eastern and central Europe, Turkey and from some American economies such as Mexico and Chile report the lowest scores. As regions widely differ in population, weighted results by population were also reported, showing that, in fact, the largest proportion of people in the sample enjoy well-being levels above the mean. Behind this result is the influence of the USA, largely populated and with well-being levels above the average. Finally, we found that the country effect is remarkable,

[17] Another possibility for assigning weights is considering the estimates from a regression where all the objective well-being dimensions are regressed on life satisfaction. However, as explained in Section 2, this option was discarded for correlation problems among well-being dimensions and the possibility of biased estimates due to omitted variables affecting life satisfaction and not incorporated for availability reasons. All in all, the alternative of two-by-two correlations used in this paper is not free from limitations and results should be taken cautiously.

[18] Correlations with life satisfaction are: education (0.31), jobs (0.60), income (0.40), safety (0.05), health (0.22), environment (0.45), civic engagement (0.07), accessibility of services (0.35), housing (0.48).

explaining a large proportion of the regional disparities. Nevertheless, it is still important to take into account the regional level, as results revealed that within-country inequality is particularly important in some countries such as Mexico and Turkey, which encourages the necessity for policies to mitigate such great disparities.

The assessment of the determinants of well-being points to a series of candidates that might define the different steady states. At the regional level, important drivers are population growth and the rate of dependency, while at the country level ethnic and religious factors as well as the regional expenditure and institutional quality are found to have an impact on well-being. These two latter elements can be powerful policy tools to alleviate the polarisation process, given that socio-demographic features are more difficult to be modified. In addition, efforts should be addressed to improve education levels, housing conditions and access to services in the less favoured areas, as these elements seem to be important drivers of the observed polarisation.

When designing policies, one-size-fits-all approaches should be avoided in favour of place-sensitive strategies, considering the particular features and conditions of the different convergence clubs. Unfortunately, to draw more concise implications and provide sound policy advice, a better understanding of the interactions, synergies and trade-offs among different policies and well-being dimensions is first required.

The results from this paper should be taken as a first step in the analysis of this new generation of indicators and their regional convergence patterns. Although insightful, they could be extended and complemented on some fronts. For instance, it would be desirable to extend the period of analysis in order to examine regional convergence patterns in the long run, which is perhaps the main limitation of this paper. The OECD database used is also being updated with additional well-being dimensions such as perceived social network support and life satisfaction. These are important dimensions corresponding to higher priorities in Maslow's hierarchy of needs, especially for self-achieving and perceived well-being. In that regard, further availability of regional levels of life satisfaction will allow for the use of this variable as a single indicator of well-being, which will be useful for a more effective comparison with objective measures as the one used in this paper. In addition, future efforts should be addressed to the elaboration of more accurate synthetic well-being measures. There exist in the last years several initiatives in that regard, although there is hitherto a generalised lack of consensus on an appropriate and representative scheme of weights. These are only some of the challenging research ideas for the future research agenda.

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