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The EU Regional Human Development Index

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Abstract

This report follows from a project entitled "Regional Human Development" on request of the Directorate-General Regional and Urban Policy (DG REGIO) of the European Commission. The objective of the project was to develop indicators that are capable of measuring patterns and trends in human development across the regions of the EU member states. The main contribution of this report lies in a proposal for conceptualizing and measuring human development at the European regional level across multiple years using. The results of the EU-RHDI show a clear north-west/south-east divide across EU regions when it comes to the overall index. Within countries differences exist as to regional performance in human development. In general, capital city regions seem to outperform non-capital city regions within countries. This is readily seen across regions in eastern EU member states where the large intra-country differences in scores are largely driven by the capital city outperforming other regions by a length. Zooming in on the results of the individual dimensions, we find in general that the EU is especially characterized by a west/east divide. In health, southern regions are often outperforming northern regions. However, southern regions' relative good performance in health contrasts sharply with their underperformance in income and especially knowledge.

The EU Regional Human Development Index (EU-RHDI)

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Executive summary

This report follows from a project titled "Regional Human Development" on request of the Directorate-General Regional and Urban Policy (DG REGIO) of the European Commission. The main objective of the overall project is to develop indicators that are capable of measuring and monitoring patterns and trends in human development across the regions of the EU member states. The measurement of human development goes well beyond measuring Gross Domestic Product (GDP). This has been recognized not only by the European Commission with its communication on "GDP and beyond" but also by such organizations like the OECD with its "Global Project on Measuring the Progress of Societies".

Since the early 1990s the United Nations Human Development Index (UN-HDI) has been proposed as a viable alternative to GDP per capita to measure human development. Within the European context, however, the UN-HDI may not suffice for two reasons. One reason is that it measures human development at the aggregate country level only, while disparities across regions within the same country might well be larger than disparities across countries at large. Another feature of the current UN-HDI is that it tends to start from a definition of human development that is especially suited to describe the performance of developing countries. Taking human development as a relative concept (i.e. meaning that a country or region is more or less developed as compared to another country or region), one might however question its applicability in a European context. In order to come to terms with the general call for a measure of human development that goes beyond GDP, as done by the UN-HDI, whilst taking into account the specificities of the European regional level, this report proposes a composite indicator on human development that (i) is based on the three-partite structure of the UN-HDI but (ii) is relevant to the European context, (iii) takes the region instead of the country as the basic unit of analysis, and (iv) enables one to compare regions both cross-sectional as well as over time.

It follows that the main contribution of this report lies in a proposal for conceptualizing and measuring human development at the European regional level across multiple years using a composite indicator approach. On the conceptual part, though intuitively appealing, there exists no general consensus about the nature of human development. Although the idea of human development is widely considered appraisive, due to its complex and open nature the concept of human development cannot be defined in a purely objective way. Instead, there exist multiple valid perspectives on human development.

This report takes into account three such perspectives: the basic needs perspective, the utilitarian perspective, and the perspective of freedom. The basic needs approach takes a narrow view on human development in that it is restricted to those concrete aspects of human life that form absolute requirements for human beings to stay alive. In contrast, the utilitarian approach is much more abstract and focuses on the sum of mental achievements (i.e. happiness) for all persons taken together. Again in contrast, the perspective of freedom focusses on the substantive freedoms that people have to live the life they have reason to live. From the three perspectives on human development it is clear that there exists no general and conclusive consensus about the nature of human development.

Table 1. Variables, dimensions, and perspectives

Variable	Description	Dimension	Perspective	Direction
Infant mortality	The ratio of the total number of deaths of children under one year of age during the year to the number of live births in that year. The value is expressed per 1000 live births.	Health	Basic needs	Negative
Healthy life expectancy	The number of years a person is expected to live in good perceived health. Indicator combines mortality data with data on self-perceived health.	Health	Functionings/utilitarian	Positive
NEET	The percentage of the population aged 18-24 that is not employed and not involved in further education or training.	Knowledge	Basic needs	Negative
General tertiary education	Persons aged 25-64 with tertiary education attainment (as the percentage of people of the given age class)	Knowledge	Functionings	Positive
Net adjusted disposable household income	A region's net disposable income weighted the region's country gross adjusted disposable income divided by the region's country net disposable income (per capita)	Income	Functionings	Positive
Employment	The share of employed persons of 15 year or older as a share of the population of 15 year or older	Income	Functionings/capabilities	Positive

Acknowledging that different perspectives on human development exist does not mean that there are no resemblances among these perspectives whatsoever. For one thing, the United Nations Human Development Index (UN-HDI), in an attempt to measure human development at the country level, has already proven to be highly successful in informing the human development debate by measuring different aspects of human development. As such, from the concern that measuring human development in terms of GDP per capita is too narrow, the UN-HDI has been proposed to measure human development not only in terms of income but also by including health and knowledge as additional dimensions to human development. This report goes one step further and proposes a set of individual variables that grasp these different aspects from multiple perspectives on human development simultaneously. Whilst the UN-HDI is arguably centered on a perspective of freedom on human development, we sought to include alternative variables that also cover the basic needs and utilitarian perspective on human development.

The extent to which multiple aspects of and perspectives on human development can actually be measured and aggregated into a single composite indicator crucially depends on the quality and

availability of data. In total we considered a set of 22 variables to be included in the composite indicator. All variables have been retrieved from Eurostat. We assessed the correlation structure of these 22 variables. Composite indicators cannot be constructed based on poorly or anti-correlating variables. Based on the magnitude of the correlations, we decided to exclude 16 variables from the proposed composite indicator. From both our conceptual and statistical considerations we decided to include 6 variables in the overall index; 2 variables in each dimension. The 6 variables are summarized in Table 1.

Methodologically, the construction of a composite indicator on human development involves three steps: (i) the computation of missing values whenever data for a particular variable, region, or year is absent; (ii) the transformation of variables as to make them comparable; and (iii) the aggregation and weighting of the variables as to render one overall index. All variables include missing data for some region-year combinations. We use a multiple imputation method to estimate missing data and obtain a complete time-series cross section data set at the regional level (7 years; 272 regions).

Table 2 Structure and methodology of the EU Regional Human Development Index

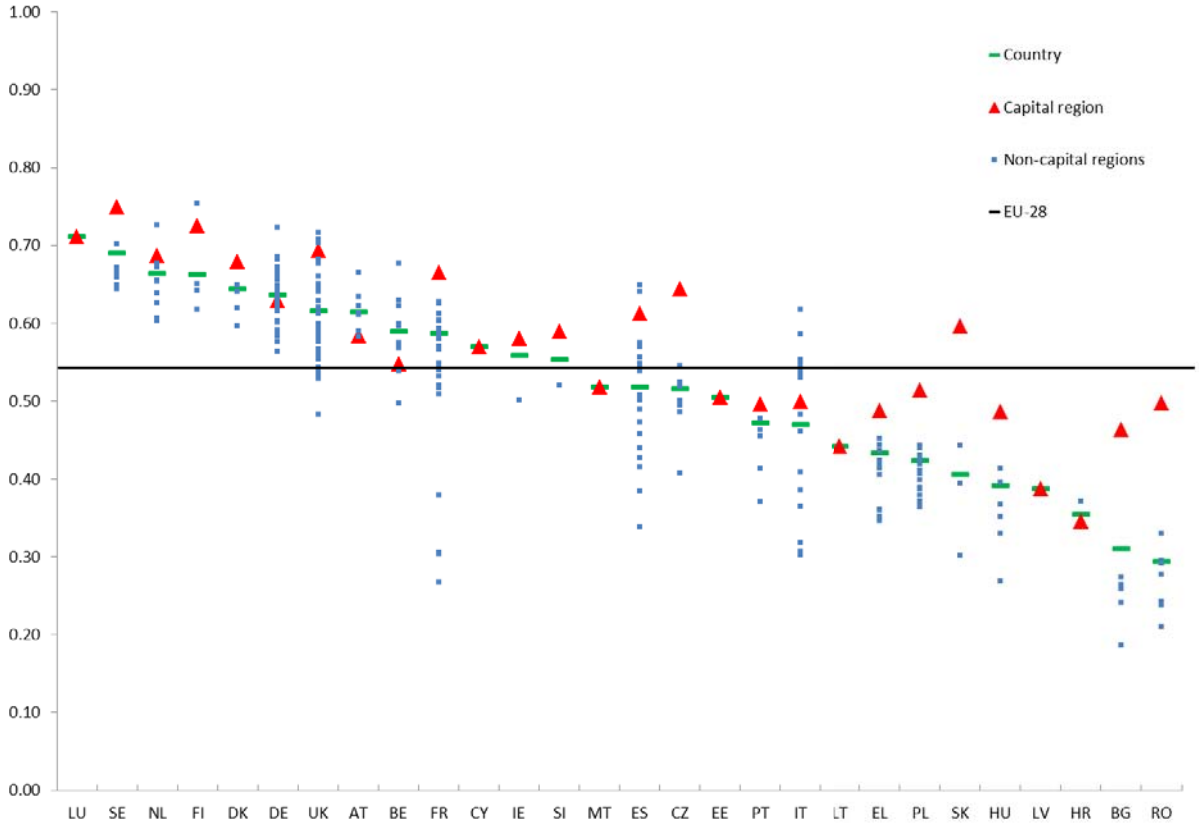
Variable	Transformation	Normalization	Weighting	Aggregation	
				Variables	Index
Healthy life expectancy	-	Min-max (based on forecasted values)	Equal weights	Arithmetic	Geometric
Infant mortality	Moving average; Winsorization				
NEET	Moving average				
General tertiary education	-				
Net adjusted household income	-				
Employment rate	-				

In order to render all variables comparable we transformed them in three steps. First, for those variables that show considerable fluctuations across time, we took the 3-year moving average. Variables that showed considerable fluctuations are infant mortality and NEET. Second, in order for outliers in the data not to drive the results of the composite indicator, we set the highest values to the next highest ones up until the point that their distributions were no longer skewed. This method, called Winsorization, is applied to infant mortality. Finally, we choose to normalize all variables using a min-max approach as to assure that all variables are to range between 0 and 1. Minimums and maximums are set to observed and forecasted values. In addition, we take the global minimums and maximums; that is, across all years and regions as to make the index comparable both across time and space.

Within the dimensions, variables have been aggregated using the arithmetic average. That is within a single dimension we allow for complete compensation of different aspects of that dimension. Instead, different dimensions are aggregated using the geometric average. That is, different dimensions are only partially compensatory vis-à-vis each other as we do not want to allow good performance in say

income to fully compensate for bad performance in health. Weights are assigned equally across variables within the dimensions and across the dimensions within the overall index (see Table 2 for a summary).

Figure 1. Comparison of EU-RHDI scores among EU regions (year 2010; 272 regions)



Note: the country regional average and the EU regional average have been calculated as the population weighted average of the scores of all regions in respectively that country and the EU.

The results of the EU-RHDI show a clear north-west/south-east divide across EU regions when it comes to the overall index (see Figure 1). Within countries differences exist as to regional performance in human development. This is especially for the United Kingdom, Spain, France, Italy, Germany, and Belgium. Capital city regions generally outperform non-capital city regions within countries. This is readily seen across regions in eastern EU member states where large intra-country differences are largely driven by the capital city outperforming other regions by a length. As to the ranking of the EU-RHDI, we find northern and western regions of the EU topping the rank while southern and especially eastern EU regions are found at the bottom. While the bottom-20 regions rank generally low on all dimensions and in all years, for the top-20 regions we find volatility in both the underlying dimensions and across years. Zooming in on the results of the individual dimensions, we find in general that the EU

is especially characterized by a west/east divide. In health, southern regions are often outperforming northern regions. However, southern regions' relative good performance in health contrasts sharply with their underperformance in income and especially knowledge.

The statistical coherence and robustness of the index is addressed in order to assess the volatility of the proposed composite indicator to the particular methodological choices made throughout its construction. As indicated by principal component analysis, within the overall index there is one latent component indicating that the different dimensions potentially describe one latent phenomenon; that is human development. Arguably, the composite indicator is volatile as to the choice of variables included. Although the EU-RHDI correlates extremely high with all alternatives considered, the ranking of individual regions might change when considering alternative sets of variables. Overall we believe that the proposed index is justified based on both conceptual and statistical considerations.

From the analysis and results presented in this report we make two recommendations. One recommendation revolves the use of the proposed composite indicator on human development as an input to the broader debate on measuring and monitoring human development at the regional level. We take the proposed composite indicator on human development as a necessary but also preliminary first step to inform development policymakers. Human development is an important issue, an issue that concerns each and every citizen of the EU. As it concerns everyone but at the same time is essentially contested, we deem it necessary if not inevitable to include different voices in the construction of a valid indicator on human development. The validity of an indicator does not just depend on its statistical soundness rather than on the indicator being accepted by the community of people it seeks to address.

Another recommendation concerns the necessity of collecting and using alternative data and methods for the analysis. Some data might be nearby; others further away, not to say out of range altogether. The proposed index still covers some perspectives on human development better than others mainly because of a lack of data. Most in particular, the utilitarian perspective is covered by one variable only and therein only partly, rendering that perspective virtually absent in our measurement of human development. However, and notwithstanding the difficulties in collecting alternative data that capture human development at the EU regional level, measuring and monitoring human development appropriately would greatly benefit from alternative data becoming available. As to using alternative methods, given that the results of the robustness analysis show that the proposed composite indicator is sensitive to particular methodological choices, these choices need to be discussed more thoroughly and might need to be revised in the future.

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1. Introduction

1.1. Background of the project

This report follows from a project entitled "Regional Human Development" on request of the Directorate-General Regional and Urban Policy (DG REGIO) of the European Commission. The main objective of the overall project is to develop indicators that are capable of measuring and monitoring patterns and trends in human development across the regions of the EU member states. Many aspects of human development have a straightforward link to policies most of which are defined at regional and local level. In order to inform policy properly, it is important to know how we can measure human development.

The measurement of human development goes well beyond measuring Gross Domestic Product (GDP). This has been recognized by many, including the Organization for Economic Co-operation and Development (OECD) with its Global Project on Measuring the Progress of Societies and the European Commission Communication 'GDP and Beyond: Measuring Progress in a Changing World'. One of the most influential initiatives was the "Commission on the Measurement of Economic Performance and Social Progress" headed by Professors Joseph Stiglitz, Amartya Sen and Jean-Paul Fitoussi which, in its final report from autumn 2009, called for a "*shift [of] emphasis from measuring economic production to measuring people's well-being*" (Stiglitz et al., 2009, p.10). Above all, and whatever notion one uses to describe human development, this is a call for going beyond monetary and market aspects alone in measuring it.

Since the early 1990s the United Nations Human Development Index (UN-HDI) has been proposed as a viable alternative to GDP per capita to measure human development. Within the European context, however, the UN-HDI may not suffice for two reasons. One reason is that it measures human development at the aggregate country level only, while disparities across regions within the same country might well be larger than disparities across countries at large. Hence we believe that an investigation of human development at the European regional level is warranted.

Another feature of the current UN-HDI is that it tends to start from a definition of human development that is especially suited to describe the performance of developing countries. Taking human development as a relative concept (i.e. meaning that a country or region is more or less developed as compared to another country or region), one might however question its applicability in a European context. For one thing, using for example life expectancy as the only variable measuring progress in health is less discriminatory on a European level than it is on a global level. In addition, what is considered as progress in health might be different on a European level as compared to the global level.

In order to come to terms with the general call for a measure of human development that goes beyond GDP, as done by the UN-HDI, whilst taking into account the specificities of a European regional level, the objective of this report is to develop a composite indicator on human development that (i) is based on the three-partite structure of the UN-HDI but (ii) is relevant to the European context, (iii) takes the

region instead of the country as the basic unit of analysis, and (iv) enables one to compare regions both cross-sectional as well as over time. In other words, our objective is to propose a regional human development index for the European Union (EU-RHDI) that covers multiple years.

1.2. Contribution of the report

The main contribution of this report lies in a proposal for conceptualizing and measuring human development at the European regional level across multiple years using a composite indicator approach. Composite indicators allow us to summarize complex phenomena like human development in a single metric without reducing the underlying information base of the phenomenon of interest and at same time leaving the underlying dimensions of human development analytically tractable. Consequently, composite indicators are easier to interpret than a set of many separate indicators. As such composite indicators allow us to communicate the state of affairs of complex phenomena like human development effectively and hence meet our demand for informing policy therein. Composite indicators are subject to strict statistical requirements, one of which is that the underlying dimensions and (on a lower level) the underlying variables of each dimension should not anti-correlate (OECD/JRC, 2008). Overall, what we propose then is a framework for measuring human development that is both conceptually and statistically sound.

The remainder of this report proceeds as follows. First, we discuss the concept of human development in section 2. Here, we pay especially attention to three different perspectives on human development; that is, the basic needs perspective, the utilitarian perspective, and the perspective of freedom. The main argument of section 2 holds that, recognizing that human development is an essentially contested concept, its measurement would be best served by including multiple perspectives on what constitutes human development simultaneously.

Throughout section 3 we address past attempts of measuring human development focusing on using GDP per capita and the UN-HDI and discuss to what extent these measures can be used at the European regional level. More in particular, we discuss to what extent these attempts succeed in including multiple perspectives in their account of human development. As such we depart from the existing UN-HDI and extend it whenever necessary to make it applicable within the context of European regions.

From this discussion, we propose a set of variables to measure human development for EU regions in section 4. That is, we make an attempt to come up with a set of variables that covers the three perspectives discussed in section 2. Following up on the discussion of this set of variables we present our framework for the EU-RHDI in section 5. Here we present the data and methodology used to construct a composite indicator for human development at the European regional level. Most in particular we go into the methodology of imputing missing data, transforming variables as to make them comparable, and the approach taken to weight and aggregate the variables and dimensions of the EU-RHDI.

Section 6 presents the main results of the analysis. First, the results are presented focusing on the geographical distribution of EU-RHDI scores and the scores of its underlying dimensions. Second, the comparative performance of regions is discussed in terms of rankings. Third, we discuss the relation between human development as measured by the proposed EU-RHDI and human development as measured by GDP per capita.

Section 7 extends this latter analysis by means of a robustness assessment of the EU-RHDI. Most in particular we address the robustness of the EU-RHDI by considering alternative weighting schemes and by considering including and excluding alternative variables in the composition of the index. Finally, section 8 concludes with a summary of the main approach taken and findings of this report, a discussion of the main results of this report, and recommendations for policy and further research.

2. Defining human development: three perspectives

Human development can be straightforwardly defined as "making a better life for everyone"(Peet and Hartwick, 2009, p. 1). However, straightforward and intuitively appealing as it may seem, this definition of human development merely shifts the issue of defining what is meant by human development towards what is meant by "a better life." Whereas people have a different understanding standing of "the good life", a seemingly straightforward and intuitively appealing definition of human development easily becomes disputed on normative grounds. In what follows, therefore, we will discuss three – in some ways competing, in others overlapping – perspectives on human development. The main argument of this section holds that none of these three perspectives is 'perfect' in the sense of making any of the other perspectives obsolete. Instead, all three perspectives have the potential of providing valuable insights on the nature of human development and hence its measurement.

2.1. The basic needs perspective

Although there are many versions of the basic needs approach available in the literature (see e.g. Streeten (1984) for a brief discussion of four of them), we limit ourselves to its most distinct and clearly spelled out variant, namely, the minimum basic needs approach. The minimum basic needs approach takes a narrow view on human development in that it is restricted to those aspects that form absolute requirements for human beings to stay alive. The approach has most often been associated with Maslow's hierarchy of needs (Maslow, 1943, Maslow, 1954) and – portrayed in the shape of a pyramid – it pictures the most essential and acute needs such as nutrition, shelter, and cloth at the bottom and the least essential and acute needs such as self-esteem and self-actualization at the top. Note, however, that Maslow (1943, 1954) proposed his hierarchy of needs as a positive theory of motivation, not as an explicit moral approach to human development. What holds, however, is that according to both Maslow's positive theory of motivation and the basic needs approach to human development, needs can be defined in objective and universally applicable terms. What is more, since its introduction in the context of human development at the International Labour Organization's World Employment Conference in 1976 it has become popular as a valid moral approach to human development (Jolly, 1976). Today, traces of a basic needs approach to human development can for example be found in the UN's (2005) "Millennium Development Goals" and Jeffrey Sachs's (2011) "End of Poverty". While (extreme) poverty is defined with reference to a lower boundary (i.e. minimum basic needs based on the World Bank's definition of earning less than 1 US$ a day), proposed solutions for tackling poverty focus on a highly restricted number of issues which – once addressed – should launch economies into a self-sustaining growth path.

In its most strict interpretation, the main (policy) implication of the basic needs approach holds that, in fostering human development, policy has to focus on a highly restricted set of issues only. In fact, given that basic needs are taken as the constitutive parts of human development itself, once these are fulfilled countries (or regions or people) are said to be (sufficiently) developed. There is no (extended)

case for human development beyond the basic needs thus defined and hence there is no necessity for human development policy whatsoever after basic needs are met. Alternative, less strict, interpretations of the basic need approach take the fulfillment of basic needs as a prerequisite for development in other domains. Here, the argument goes that once the absolute basic needs have been fulfilled or main challenges have been met, human development with respect to other (less essential and acute) issues can take off (Lomborg, 2004, Sachs, 2011).

A main criticism opposing the basic needs approach holds that basic needs cannot be objectively defined with universal applicability. Following critiques on Maslow's (1943, 1954) proposed hierarchy of needs (Hofstede, 1984), both the scope and scale of basic needs are contested. The contestability of the scope of basic needs holds that the list of needs is elusive; that is, what to and what not to include as a basic need cannot be defined objectively whilst maintaining universal applicability. Likewise, the contestability of the scale of basic needs holds that the required amount of a basic need in order for it to be fulfilled cannot be defined objectively with universal applicability. However, once we agree that basic needs having universal applicability cannot be objectively defined, we find ourselves on a slippery slope. How far should the notion of basic needs be stretched? In other words, what do we count as basic and what not? In addition, who decides on what does count as basic need and what does not? If basic needs cannot be objectively defined, what constitutes them crucially depends on the ideas of those who define them. As to its policy implications, the basic needs approach can be criticized for being overly reductionist and hence ignoring important systemic relations among causes and consequences of human development. In equating human development with basic needs as an end to be addressed by development policy directly, policies that follow from the basic needs approach run the risk of attacking symptoms instead of the causes to these symptoms; that is, it can be accused of being palliative instead of curative (Streeten, 1984).

2.2. The utilitarian perspective

According to Jeremy Bentham, the founding father of utilitarianism, the good and bad of all actions should be judged by their effects on human happiness (Veenhoven, 2010). As such, and recognizing that happiness is inherently a subjective concept, the effects of all behavior should be valued by "the sum of pleasures and pains". It follows that the utilitarian approach to human development is generally defined by "the greatest happiness to the greatest amount of people". Often, if not always, the exact definitions of the key concepts of utilitarianism (utility, pain, pleasure, and happiness) are left somewhat in the midst. This should come as no surprise given that utilitarianists do not want to place a moral judgment on what should count as the "good life." That is, what counts as pain, pleasure, happiness, and, hence, utility is what people take it to be (Veenhoven, 2012).

Utilitarianism is based on three main guiding principles (Sen, 1999, Sandel, 2010). One is that it is consequentialist in nature. That is, the utilitarian approach holds that all choices and behavior should be judged by the results that they bring about. In its strongest form then, the utilitarian approach attaches no value to the good (or bad) of behavior as such irrespective of its behavior. Another guiding

principle of the utilitarian approach holds that the state of affairs in human development should be judged according to welfare considerations only. This principle, known as welfarism, implies that there is no other basis to judge human development on than utility only (Sen, 1979). A final guiding principle of utilitarianism holds that the utilities of individuals can and should be added to arrive at a final judgment on the state of human development. This principle, known as the sum-ranking principle, means that human development should be valued with reference to the aggregate utility of all people summed together without taking into account the state of particular individuals therein. Taken together, the utilitarian approach is centered on the sum of mental achievements (i.e. utility; be it defined as happiness, the discounting of pleasures with pains or satisfaction) for all persons taken together.

Today, the utilitarian approach is (either implicitly or explicitly) broadly accepted within studies on economic growth and development (Veenhoven, 2010). Notwithstanding the differences in measuring utility (with on the one extreme those sticking to GDP figures as a valid indicator and on the other extreme those who turn to subjective measurements of happiness), what binds these studies are the three guiding principles of utilitarianism: (i) consequentialism, (ii) welfarism, and (iii) sum-ranking. The main policy implications of the utilitarian approach are twofold. One policy implication holds that development policy should be ambiguous about or even agnostic to the exact nature of utility. As long as overall utility increases it does not matter what the exact characteristics of utility are. Another policy implication, that follows naturally from the first one, holds that, without any reference to particular policy measures, development policy is justified in as far as it increases the total amount of utility of a group of people. That is, no matter how much harm a certain policy measure does to some people, it is justified as long as this harm increases the overall utility of the larger group of people. As such, any policy that aims for economic growth (without placing further restrictions on the exact nature of that growth) is clearly influenced by the merits of the utilitarian approach.

As opposed to the basic needs approach, the utilitarian approach to human development leaves in the midst the exact nature of human development as an end. As such, unlike the basic needs approach, the utilitarian approach (at least in its abstract formulation) does not run into difficulties of setting the boundaries to what does and what does not count as utility enhancing. However, at least three other forms of criticisms can be raised against the utilitarian perspective on human development (Sen, 1999, Sandel, 2010). One is that it ignores differences in the distribution of utility across people. It follows from the guiding principle of sum-ranking that distributional issues are not of particular concern to utilitarianists. No matter how bad the sorrow of some might be, if it does not jeopardize overall utility it does not jeopardize human development from a utilitarian perspective. Clearly, an account that allows for a compensation of pains experienced by some by an increase in happiness experienced by others runs counter to the general idea of human development as ensuring a better life for everyone. Another critique holds that in focusing on utility only, utilitarianism attaches no intrinsic importance to rights and freedoms of people. In an extreme case, utilitarianism would not necessarily dispense with slavery as long as it increases utility in general. For non-utilitarians this is morally unacceptable (Rawls, 1999, Sen, 1999, Sandel, 2010, Nozick, 2013). Finally, adaptation, mental conditioning, and diversity of people make utility for some an unlikely candidate to base interpersonal comparisons of human

development upon. Building upon insights from behavioral economics it is well known by now that people's judgments are not stable or context-independent (Sugden, 2008). This then also poses serious challenges to measuring utility based on self-reported data (Sen, 2002).

Some of the critiques might perhaps be incorporated within less strict interpretations of the utilitarian perspective on human development.[1] For example, loosening in one way or another the guiding principle of sum-ranking and therewith focusing more on individual utility (or happiness) rather than aggregate utility, opens up the possibility of taking into account distributional issues and (albeit perhaps indirectly) issues of rights and freedoms. Note, however, that by loosening these guiding principles one introduces ambiguities as to the general applicability of utilitarianism; therewith arguably diminishing its validity and main strength of not imposing any moral judgment on what counts as "the good life" a priori. As to the issue of measuring utility using self-reported data, it has been argued that these measurements at least add valuable information to existing accounts on well-being, welfare, and, hence, human development (Kahneman et al., 2004). For that matter, just like a good medical practitioner would be interested in both internal views of health (based on the patient's own perceptions) and external views (based on the observation of the experts) (Sen, 2002), so would the human development policy maker preferably be interested in both standard statistics provided by national statistical offices (e.g. those derived from national accounts) as well as in statistics derived from self-reported data.

2.3. The perspective of freedom: capabilities and functionings

The third perspective on human development is what we call the perspective of freedom and relates especially to the writings of Amartya Sen (see e.g. Sen, 1999, Sen, 2012, Sen, 2009). It is called the perspective of freedom whereas its main concern is with enlarging people's own choices to live the life that they want to live; that is, human development here is about "expanding the real freedoms that people enjoy" (Sen, 1999, p. 3).[2] The perspective of freedom focusses on two key concepts:

[1] One such adaptation would be to move from act (or extreme) utilitarianism to rule (or restricted) utilitarianism (see also: Smart, J. J. C. 1956. Extreme and restricted utilitarianism. *The Philosophical Quarterly,* 6**,** 344-354, Mccloskey, H. J. 1957. An examination of restricted utilitarianism. *The Philosophical Review,* 66**,** 466-485, Veenhoven, R. 2010. Greater Happiness for a Greater Number. *Journal of Happiness Studies,* 11**,** 605-629.).

[2] The perspective of freedom is most often referred to as the capabilities approach to human development (Nussbaum, M. 2003. Capabilities As Fundamental Entitlements: Sen And Social Justice. *Feminist Economics,* 9**,** 33-59, Robeyns, I. 2005. The Capability Approach: a theoretical survey. *Journal of Human Development,* 6**,** 93-117.). To our opinion, however, calling it the capabilities approach (or perspective) would overly stress the notion of capabilities, therewith somewhat neglecting the – to our opinion – equally important notion of functionings in this perspective. With reference to Sen's book "Development as freedom" (Sen, 1999) we therefore prefer to speak of the perspective of freedom on human development. What is more, and particularly in the current context towards measuring human development, focusing on capabilities only places serious if not insurmountable challenges to measuring human development (see also Annoni, P., Weziak-Bialowolska, D. & Dijkstra, L. 2012.

functionings and capabilities. While functionings refer to what one does or what one is (i.e. a person's actual achievements), capabilities refer to what one can do and can be (i.e. a person's real opportunities). Put different, "the distinction between achieved functionings and capabilities is between the realized and the effectively possible; in other words, between achievements on the one hand, and freedoms or valuable options from which one can choose on the other" (Robeyns, 2005, p. 95). As such, the perspective of freedom on human development shifts orientation from focusing on commodities and utility only to include other informational bases for evaluating human development as well.

In fact, in focusing on the dual notion of capabilities and functionings, Sen (Sen, 1999) explicitly distances the perspective of freedom from the utilitarian perspective. Herein, Sen (Sen, 1999) argues that the informational base of utilitarianism is extremely limited especially in that utilitarianism does not take into account the particular characteristics of the situation individuals find themselves in. For example, the extent to which a person can benefit from having a certain commodity (e.g. a bicycle) crucially depends upon her or his ability to be able to use it (i.e. to cycle) and hence achieve a particular functioning (i.e. to be mobile). In the extreme case, to someone who is disabled a bicycle will add little to nothing to her or his real opportunities for becoming mobile (Robeyns, 2005). Some have positioned the perspective of freedom on human development and its key concepts of capabilities and functionings between commodities on the one end and utility (or happiness) on the other (Clark, 2005). This, we believe however, misrepresents the crucial claim from the perspective of freedom that utility (or happiness) forms only one informational base to evaluate human development on.

In all, the perspective of freedom puts central emphasis on distinguishing means from ends (Streeten, 1994, Sen, 1999, Robeyns, 2005). Again, it is stressed that knowing the number of goods people have at their disposal does not suffice for knowing how well these people are off. It is argued that the former provides information only about the means – and some particular means only – for evaluating the higher and more encompassing end of human development more broadly. This is not to say that commodities play no role in human development at all. Rather, this is to say that they do so only with respect to and as part of the broader set of people's capabilities and functionings. To evaluate human development then, capabilities and functionings should be addressed simultaneously; that is, in conjunction with each other.

Quality of life at the sub-national level: an operational example for the EU. European Commission, JRC Scientific and Policy Reports. Brussels/Ispra: European Commission.). Though analytically a distinction between functionings and capabilities can perhaps be made (see e.g. Nussbaum, M. 2003. Capabilities As Fundamental Entitlements: Sen And Social Justice. *Feminist Economics,* 9**,** 33-59.), in practice (and hence in measurement) these two aspects often interrelate if not coincide. For example, measuring good health in terms of real opportunity (i.e. capability) is extremely hard without turning to actually measuring the achievement of good health (i.e. as a functioning). We will turn to issues of measuring human development in sections 3 and 4. For now we leave it to say that in thinking of human development from the perspective of freedom we take into account both the concept of functionings and the concept of capabilities.

Like the other perspectives on human development, the perspective of freedom has not only been endorsed but also criticized. One criticism holds that the perspective of freedom offers a rather abstract view on human development and therewith provides little concrete tools for operationalization; especially in the context of measuring human development comprehensively (Sugden, 1993, Fukuda-Parr, 2003). At least two issues are at play here. One is that, given the importance attached to capabilities and functionings at the individual level, addressing how "humanly developed" people are at an aggregate level (e.g. regions or countries) is not straightforward: how should we take into account the diversity of people when assessing human development at the level of groups of people rather than individuals? Another issue here is about the scope of the capabilities and functionings to be taken into account in our assessment of human development from the perspective of freedom. While the utilitarian perspective has clear answers to both issues (i.e. via the principle of sum-ranking and the idea that utility is whatever people take it to be), the perspective of freedom leaves it somewhat in the midst how capabilities and functionings should be added and which ones should be taken on board in the first place to be considered crucial in the context of human development.

Following up on this latter point, a second criticism is connected to the suggestion that Sen (1999) – in providing an overall account of freedom – might be taken to suggest that he takes all forms of freedom equally or pertinently important (Nussbaum, 2003).[3] This is obviously not true. Amartya Sen does, for example, clearly not endorse men's freedom to beat up women. In other words, though focusing on freedom, there are clear limits as to where freedom is and is not appropriate. However, Sen (1999) is very reluctant to come up with a definite and complete list of which freedoms count as worthwhile and which not (Nussbaum, 2003). For sure, in Sen (1999, p. 10) five such freedoms are listed (i.e. political freedoms, economic facilities, social opportunities, transparency guarantees, and protective security). However, Sen (1999) immediately stresses to add that this list is open to be complemented by other dimensions to freedom that might be considered crucially important as well. As such, Sen (1999) (1999) does not seem to (be willing to) come up with a list of essential freedoms. Note then that, as opposed to utilitarianism, the perspective of freedom has clear difficulties in setting the exact scope of dimensions to freedom that should be included and excluded as part of people's capabilities and functionings worthwhile striving for and, hence, to come up with a definite evaluation criterion for human development in general.

Finally, and as a solution to the previous criticism, Sen argues that the selection of specific capabilities and functionings should ultimately be made within the realm of the democratic process (Sen, 1999). However, as Robeyns (2005, p. 106) argues, selecting functionings and capabilities on the basis of a democratic process runs "*into dangers that are intrinsically related to democratic decision-making. In*

[3] Nussbaum (2003, p. 44) argues that "Sen speaks throughout the work of "the perspective of freedom" … suggesting that freedom is a general all-purpose social good, and that capabilities are to be seen as instances of this more general good of human freedom. Such a view is not incompatible with ranking some freedoms ahead of others for political purposes, of course. But it does seem to go in a problematic direction." (Nussbaum, M. 2003. Capabilities As Fundamental Entitlements: Sen And Social Justice. *Feminist Economics,* 9**,** 33-59.)

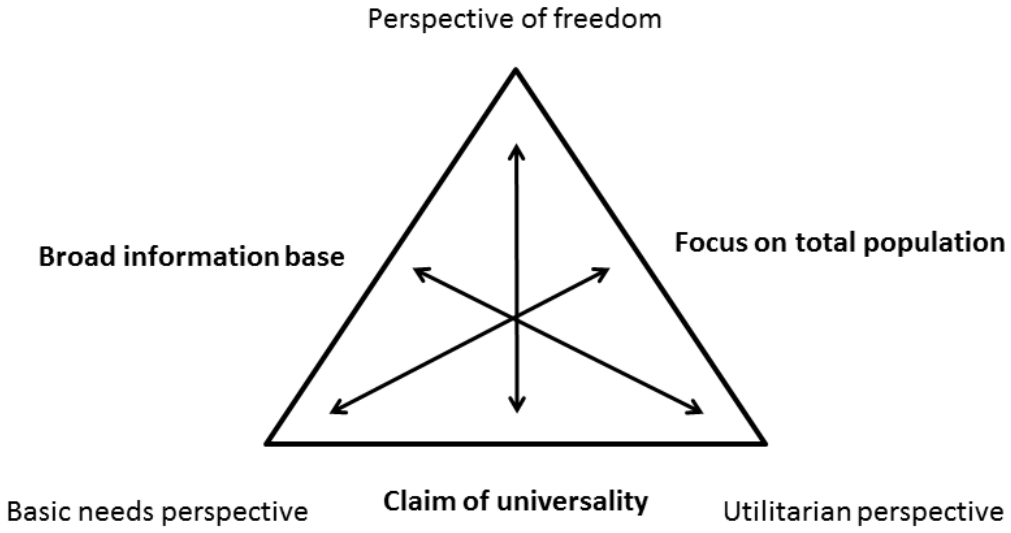
Sen's case, it is not at all clear how these processes of public reasoning and democracy are going to take place, and how we can make sure that minimal conditions of fair representation are guaranteed." What is more, stressing the importance of the democratic process, in fact might lead to a regress towards utilitarianism (Clark, 2005). Claiming that capabilities and functionings should be defined by the people themselves is very close to a utilitarian understanding of what counts as pain, pleasure, happiness, and, hence, utility is what people take it to be. Given the cautionary remarks made by Sen (2002) on taking into account internal views for evaluating health and for that matter human development, turning to utilitarianism is certainly not what he has mind when measuring human development.

Notwithstanding these critiques and open issues, the perspective of freedom has had a huge impact on current thinking on human development. Some even speak of this perspective in terms of characterizing the current human development paradigm (Haq, 1995, Fukuda-Parr, 2003). Perhaps one can argue about whether the perspective of freedom currently dominates development research. Yet, at the very least, the perspective of freedom definitely had (and still has) its impact on human development thinking within such organizations like the United Nations, which becomes vividly clear when reading their human development reports from 1990 onwards.

2.4. Without conceptual agreement, does measurement make sense?

From the three perspectives on human development it is clear that there exists no general consensus about the nature of human development. As such human development can be considered what has been called "*an essentially contested concept*" (Gallie, 1955, Collier et al., 2006): although the idea of human development is widely considered appraisive, due to its complex and open nature the concept of human development cannot be defined in a purely objective way. Given that there seems to be no single best way of defining human development, coming up with a good way of measuring human development across European regions is far from straightforward. Nevertheless, from the three perspectives on human development outlined above we believe that in principle we can come to measuring human development in which at least more than one perspective on human development is represented.

Figure 2. Mapping human development as an essentially contested concept



Acknowledging that different perspectives on human development exist does not mean that there are no resemblances among these perspectives whatsoever. In all, we can thus provide a mapping of human development as an essentially contested concept (Connelly, 2007). Figure 2 provides such a mapping. As shown, each perspective has something in common with another perspective that together makes these two perspectives distinct from the third perspective. [4]

First, what the basic needs perspective has in common with the perspective of freedom is that both perspectives have a broad information base. It has been argued by Sen (1984; cited in Clark, 2005) that while the basic needs perspective runs the risk of turning into a form of 'commodity fetishism', the

[4] Though or approach is different from his, the idea of mapping human development as an essentially contested concept comes from Connelly (2007) (Connelly, S. 2007. Mapping Sustainable Development as a Contested Concept. *Local Environment,* 12**,** 259-278.). For one thing, our focus of interest differs. While Connelly (2007) is interested in mapping *sustainable* development, we are primarily interested in mapping *human* development. Some might argue that true human development should and actually also be about sustainable development. Though we might agree in principle, as argued, for the moment we did not take on board the sustainability perspective on human development yet. A more important difference between Connelly's (2007) and our approach is that, in the actual mapping of human development, we focus on socio-epistemological similarities and differences between perspectives on what actually constitutes human development whilst Connelly (2007) focuses on mapping conflicting sub-goals within the overall goal of sustainable development. As such, our approach is more fundamental as we recognize the difficulty in any definition of the overall goal of (human or sustainable) development altogether (see also Kovacic, Z. & Giampietro, M. 2013. Beyond "beyond GDP indicators": The need for reflexivity in science for governance.: Mimeo, Autonomous University of Barcelona.).

perspective of freedom addresses human development beyond considerations of material living conditions alone. However, countering this critique, the protagonists of the basic needs perspective have argued that the "*concept of basic needs as we understood it, was not (as is sometimes thought) centred on the possession of commodities. Instead, it was concerned with providing all human beings, but particularly the poor and deprived, with the opportunities for a full life*" (Streeten et al., 1981, p.21; quoted in Clark, 2005, pp. 2-3). As such, the main elements constituting these perspectives are very much alike; both deal with both material and non-material aspects of human development. More generally, both the basic needs perspective and the perspective of freedom explicitly refer to various concrete dimensions of human life that give substance to their notion of human development. This is what distinguishes these two perspectives from the utilitarian perspectives. Indeed, from a utilitarian perspective, the information base of human development is limited to the abstract notion of happiness only.

Second, the utilitarian perspective finds common ground with the perspective of freedom in taking on board all people in the population. That is, from a utilitarian perspective and perspective of freedom, human development is targeted at all people. This stands in sharp contrast with the basic needs perspective which focusses primarily on the most deprived people in the population. Finally, what together distinguishes the utilitarian perspective and the basic needs perspective from the perspective of freedom is – what might be called – their claim on universality. For both the utilitarian perspective and the basic needs perspective, the very nature of human development is independent from any social context independent. That is to say, both perspectives treat human development irrespective from the situation in which particular human beings find themselves in. Again this is contrasted with the third perspective; that is, the perspective of freedom. From this latter perspective, the nature of human development is very much mediated by the context particular persons find themselves in. It is also in this sense that that the perspective of freedom can be said to be less absolutist that both the basic needs and utilitarian perspective.

In all, lacking one single best and agreed-upon conceptualization of human development does not mean that we cannot measure various aspects – taken from different perspectives – of human development. For one thing, the United Nations Human Development Index (UN-HDI), in an attempt to measure human development at the country level, has already proven to be highly successful in informing the human development debate (Sen, 1999). This is not to say that it provides a comprehensive picture of the state of affairs in human development across countries over time. As argued by those involved in constructing the UN-HDI, the index "*should be understood as the starting point of a conversation about what we mean by development, rather than as its endpoint*" (Klugman et al., 2011).

As such, we can at least first come up with a set of individual variables which may or may not be added up into one composite indicator on human development at the European regional level. Composite indicators allow us to summarize complex phenomena in a single indicator without reducing the underlying information base of the phenomenon under investigation. Consequently, composite indicators are easier to interpret than a set of many separate indicators and allow us to communicate the state of affairs of complex phenomena like human development effectively. However, the extent to

which various indicators can be aggregated into a composite indicator of human development is an empirical issue. Composite indicators are subject to strict statistical requirements (OECD/JRC, 2008), one of which is that the underlying pillars and (on a lower level) the underlying variables of each pillar should not anti-correlate. The extent to which pillars and variables actually (anti-)correlate is primarily an empirical issue. This issue will be taken up in the following sections of this report.

3. Measuring human development

3.1. From GDP to the United Nations Human Development Index

Gross domestic product (GDP) is the most widely used indicator to measure an economy's state of affairs (Stiglitz et al., 2009, Van den Bergh, 2009). GDP is the market value expressed in monetary terms of all final goods and services produced within a country or region in a certain time period (most often a year). The calculation of GDP has a long history and is bound to strict international standards. Given its historical track record and cross-country availability, GDP has become the single most important tool to measure economic performance across time and space. As such, however, GDP has often been treated and identified as a measure of welfare, well-being or human development more generally. Herein, the amount of goods and services brought about on the market is often conflated with people being better-off in general (Van den Bergh, 2009, Stiglitz et al., 2009).

With reference to the three perspectives on human development outlined in the previous section, the use of GDP as the sole indicator of human development can be criticized on at least three grounds.[5] First, from a basic needs perspective it has been argued that a higher GDP need not necessarily imply that people's basic needs are fulfilled (Streeten, 1984). In part a mismatch between GDP and the fulfillment of basic needs might be ascribed to distributional issues: as a measure of overall market production, GDP in itself does not take into consideration who benefit from it. That is to say, the benefits of an increase in GDP might well fall into the hands of a happy few; leaving the overall fulfillment of basic needs untouched. In addition, even if an increase in GDP in one way or another trickles down to all people in a country or region, this in itself does not imply that it also affects the fulfillment of basic needs. That is, people might make choices that do not contribute to meeting their basic needs.

Within the utilitarian tradition, ever since the seminal work of Easterlin (1974) the relation between higher levels of GDP and higher levels of happiness has been contested (see also Kahneman et al., 2006). For example, GDP increased between 1950 and 1970 in most OECD countries while well-being in the same period has stagnated in these countries (Branchflower and Oswald, 2004; cited in Van den Bergh, 2009). As such, there seems to be a threshold level after which further increases in GDP are not accompanied by further increases in well-being. Hence, also from a utilitarian perspective, GDP is not an adequate indicator of human development. Alternatively then, many utilitarians prefer to use self-reported measures of happiness as indicators of human development (Kahneman et al., 2004).

[5] For more comprehensive overviews of criticisms on the use and miss-use of GDP as an indicator of human development (or what is then often called welfare) see Van Den Bergh, J. C. J. M. 2009. The GDP paradox. *Journal of Economic Psychology,* 30**,** 117-135, Stiglitz, J. E., Sen, A. & Fitoussi, J.-P. 2009. Report by the commission on the measurement of economic performance and social progress. *Commission on the Measurement of Economic Performance and Social Progress*.

Finally, more on theoretical grounds, the use of GDP as the prime and only indicator of human development is also rejected by adherents of the functionings and capabilities approach to human development. With reference to Aristotle, Sen (1990, p. 40; quoted in Clark, 2005, p.3) argues that "*… wealth is evidently not the good we are seeking; for it is merely useful and for the sake of something else.*" In other words, to a large extent wealth is only a means to achieve some higher ends rather than being a prime end in itself. This is not to say that the perspective of freedom completely rejects any notion of wealth – and the use of GDP in measuring it therewith – as a constitutive feature of human development. On the contrary, given that a person's income has considerable impacts on what that person can achieve in other domains of life, it is often part of any account of human development from the perspective of freedom. Nevertheless, according to the proponents of a freedom perspective on human development, the main argument holds that measuring human development should never be based on GDP alone. At most then, GDP is only one among many other indicators of human development.

Going from these and other concerns with using GDP as a measure of human development, many alternative measures have been proposed such as the United Nations Human Development Index, the Genuine Progress Indicator, the Index of Sustainable Economic Welfare, Sustainable National Income, and Gross National Happiness (Van den Bergh, 2009). Among these indicators, the United Nations Human Development Index (UN-HDI) is perhaps the best-known alternative of GDP to measure human development. In what follows therefore, and notwithstanding the apparent attractiveness of some of the other alternatives, we will focus on the UN-HDI as our main reference point for measuring human development across European regions.

3.2. The United Nations Human Development Index (UN-HDI)

In defining human development as "*a process of enlarging people's choices*" (UNDP, 1990, p. 10), it has been a main aim of those proposing the United Nations Human Development Index to go beyond monetary aspects in measuring human development ever since its introduction in 1990. What is more, given its focus on enlarging people's choices, conceptually the construction of the UN-HDI is strongly related to the perspective of freedom on human development outlined above (Klugman et al., 2011). In arguing that "*human development (…) denotes both the process of widening people's choices and the level of their achieved well-being*" the first United Nations Development Report discussing the UN-HDI makes clear –albeit it to some extent implicit – reference to the dual notion of capabilities and functionings therein (UNDP, 1990, p. 10). All this should come as no surprise given that Amartya Sen – the main intellectual originator of the perspective of freedom – was closely involved in setting up the first United Nations Development Report and the index reported therein . Also here it is no wonder that in measuring human development focus has shifted beyond income measurements. Like the various United Nations Development Reports, Amartya Sen has often stressed that income is primarily a means to ultimately achieve human development as an end and should not be taken as single prime end in itself (Sen, 1999).

3.2.1. Changes in the UN-HDI throughout the years

From the start, the UN-HDI has been a composite indicator aggregating three dimensions into one single indicator: health, knowledge, and income.[6] Although it is recognized that the range of dimensions is potentially elusive, it is also argued that "*at all levels of development, the three essential ones are for people to lead a long and healthy life, to acquire knowledge and to have access to resources needed for e decent standard of living*" (UNDP, 1990, p. 10, box 1.1). In fact, its simplicity in focusing on three dimensions to human development only is considered one of the main strengths of the UN-HDI (Klugman et al., 2011). While the main conceptual building blocks of the UN-HDI have remained unaltered throughout the years, the underlying methodology has changed (Klugman et al., 2011). Table 3 summarizes the most important methodological changes made to the UN-HDI.

First, the set of variables included has changed over time. While the health dimension has always been captured by life expectancy at birth, the variables capturing the knowledge and income dimensions are different across the various reports. Initially the knowledge dimension was measured by a single variable only; that is, adult literacy rate. Then, the adult literacy rate variable was combined with mean years of schooling in 1991. This combination remained virtually unchanged until 1995 when the mean years of schooling variable was replaced by a combined gross enrollment ratio. Starting in 2010 both the adult literacy rate variable and the combined gross enrollment ratio variable were replaced and mean years of schooling and expected years of schooling took their place. As for the income dimension, lacking other variables capturing this dimension, it has been measured by real GDP per capita from 1990-2009. After 2009 this variable has been replaced by real GNI per capita.

Second, methodological changes have occurred as to the treatment of upper and lower bounds of variables. Initially (1990-1993), both upper (maximums) and lower (minimums) bounds were defined with reference to the observed data. Thereafter (1994-2009) fixed minimums and maximums were used. From 2010 onwards the maximums are set with reference to the observed data, while the minimums are fixed with reference to the literature dealing with these matters (Klugman et al., 2011). In addition, the variable included in the income dimension has been treated differently both as compared to the other variables as well as across the years. In the first year (1990) GDP per capita was log transformed whereby the upper bound was set according to the official poverty line in nine industrial countries. Between 1991 and 1993 GDP per capita was treated using the Atkinson formula and again threshold values were derived from the poverty line. Between 1994 and 1998 the Atkinson formula was still used but the threshold level was set according to the global average of GDP per

[6] In the course of time, though, different concepts have been used to name these three dimensions. Sometimes, the knowledge dimension is called the education dimension (especially in recent reports) and the income dimension is called the material living standards dimension. In this paper we name them health, knowledge, and income. In part because we deem these names to resemble most closely the interpretations given to them (esp. with respect to knowledge versus education) or because the name comes closest to our actual measurements (esp. with respect to income versus material living standards). Nevertheless, these name can be used (and are often even used by us) interchangeably.

capita. Between 1999 and 2009 GDP per capita was again log transformed, now with a threshold level of 40.000 USD. From 2010 onwards this threshold level was removed and the logarithmic transformation was replaced by the natural logarithm of GNI per capita.

Table 3: Changes to the UN-HDI 1990-2010

<table>
<tr><th>Year</th><th>Bounds</th><th>Health</th><th>Knowledge</th><th>Income</th><th>Pillar aggregation</th></tr>
<tr><td>1990</td><td rowspan="6">Observed</td><td rowspan="8">Life expectancy at birth</td><td>Adult literacy rate</td><td>Real GDP per capita (log transformed with a cap)</td><td rowspan="7">Arithmetic mean</td></tr>
<tr><td>1991-1993</td><td>(2/3) Adult literacy rate
(1/3) Mean years of schooling</td><td>Real GDP per capita (adjusted using Atkinson's formula with fixed threshold value)</td></tr>
<tr><td>1994</td><td>(2/3) Adult literacy rate
(1/3) Mean years of schooling index</td><td rowspan="3">Real GDP per capita (adjusted using Atkinson's formula with threshold value derived from global average)</td></tr>
<tr><td>1995-1998</td><td rowspan="3">Fixed</td><td>(2/3) Adult literacy rate
(1/3) Combined gross enrollment ratio with a cap</td></tr>
<tr><td>1999</td><td rowspan="2">Real GDP per capita (log transformed with a cap)</td></tr>
<tr><td>2000-2009</td></tr>
<tr><td>2010-onwards</td><td>Maximum observed; minimum fixed</td><td>(1/2) Mean years of schooling index
(1/2) Expected years of schooling index</td><td>Real GNI per capita (natural logarithm)</td><td>Geometric mean</td></tr>
</table>

Source: Based on Klugman et al. (2011), table 1.

Third, a final methodological change is reflected by the shift in aggregating the different dimensions from using the arithmetic mean between 1990 and 2009 to using the geometric mean from 2010 onwards. This shift has been legitimized as an in-between solution that favors neither perfect substitutability nor perfect complementarity of dimensions (Desai, 1991). That is, a geometric functional form to some extent allows for compensation in one dimension through improvements in others but not fully. An additional advantage of using the geometric mean is that the final rankings of the index are not sensitive to the measurement scale of the individual variables (Klugman et al., 2011).

Overall, the most recent UN-HDI builds on three dimensions and includes four variables: life expectancy capturing the health dimension, a combination of mean years of schooling and expected years of

schooling capturing the knowledge dimension, and GNI per capita capturing the income dimension. For life expectancy the minimum is set at 20 years under the assumption (informed by the literature) that it is hard for society to reproduce at levels below 20 years (Klugman et al., 2011) and the maximum is set by the maximum observed value. For both mean years of schooling and expected years of schooling the minimum is set at 0 years under the assumption that education is not an absolute necessity for a society to survive and again the maximums are set by the maximum observed values. GNI per capita is transformed into its natural logarithm. Here, the minimum was set according to the minimum observed in historical time series data and the maximum was likewise set to the observed maximum. As discussed, the dimensions are aggregated using the geometric functional form.

3.2.2. Critiques on the UN-HDI

Despite or perhaps due to its popularity, the UN-HDI has been criticized throughout the years on grounds of (i) the scope of the dimensions and variables included, (ii) the functional form used to aggregate the dimensions, and (iii) the overall added value of the index vis-à-vis other indicators of human development (Sagar and Najam, 1998, Ravallion, 2012). Though some of these issues have been left unaddressed, most of these critiques have been taken up in more recent constructions of the UN-HDI.

First, among the issues that have been taken up is the functional form used to define the UN-HDI. As argued, the UN-HDI has shifted from an arithmetic mean approach to a geometric mean approach. As such, the current UN-HDI meets some of the criticism in no longer allowing for perfect substitutability among dimensions. This does not mean that the issue is completely set. As argued, the geometric mean reflects a compromise that settles in-between perfect substitutability and perfect complementarity of dimensions. Yet, as a compromise, other solutions might – especially on moral grounds – in principle be favored as well (Ravallion, 2012).

Second, as the UN-HDI strongly correlates both with its underlying variables and with economic performance indicators like GDP or GNI per capita, the value added of this (additional) indicator of human development is contested. Addressing the added value of a (composite) indicator is a delicate issue. The existence of correlations between the index and its underlying variables is not bad per se; in fact, some correlation should be there for otherwise it would signal that the variable does not contribute to the overall index (OECD/JRC, 2008). That having said, Klugman et al. (2011) note that the rankings of countries from GNI per capita differ substantially from the rankings that are derived from the UN-HDI scores. This suggests that the UN-HDI is related to but also measures a phenomenon that is somewhat different from what is measured by GNI per capita alone.

A final set of criticism addresses the scope and the nature of variables and dimensions considered for the UN-HDI (Sagar and Najam, 1998). As to the validity of the variables, the extent to which the life expectancy variable and the GNI per capita variable adequately capture respectively the notion of a long and healthy life and material living standards is questioned. Obviously, longevity alone – as

implied by higher life expectancy – does not necessarily imply that this life is also healthier. More fundamentally, in singling out three dimensions to human development only (and in particular ways), the extent to which the UN-HDI adequately captures the complete phenomenon of human development can also be questioned.

3.2.3. The UN-HDI and the three theoretical perspectives on human development

As argued in the beginning of this sub-section, the UN-HDI project – with Amartya Sen being one of the contributors in the early years of its construction – is firmly grounded in the perspective of freedom. This is not to say that none of the other two perspectives is reflected by the UN-HDI.[7] On the one hand, it can be argued that the UN-HDI to a large extent reflects the basic needs perspective on human development even more than the perspective of freedom. As such, the discussion of the definition and measurement of human development in the first report clearly shows traces of a basic needs perspective on human development as well. For example, the choice for including literacy rates as a variable making up the knowledge dimension, it is argued that "literacy is a person's first step in learning and knowledge-building, so literacy figures are essential in any measurement of human development" (UNDP, 1990, p. 12). Likewise, throughout the years, the minimum and maximum values of indicators have sometimes been fixed from the outset. According to Klugman et al. (2011) this was done following a reasoning that "the lower bound was conceived as some sort of subsistence minimum and the upper bound as a "satiation" point, beyond which additional increments did not contribute to the expansion of capabilities." Again, though framed within the context of a freedom perspective on human development, elements of a basic needs perspective on human development clearly enter the UN-HDI in its construction. In fact, the choice for the three dimensions of health, knowledge, and income has been proposed on grounds that these constitute "the three essential ones" (UNDP, 1990, p. 10, box 1.1) for every understanding of human development. Therewith, in reducing human development to a highly limited set of core aspects, the UN-HDI seems to be very much in line with a basic needs perspective on human development.

On the other hand however, the utilitarian perspective on human development seems to be largely absent within the UN-HDI. In part this is not surprising given that the whole notion of utility is very much an abstract concept only, not particularly suited for being measured consistently across time and space (Sen, 2002). Nevertheless, advances have been made in measuring the related notions of

[7] In fact, it is even not to say that the UN-HDI also completely conforms to the perspective of freedom on human development. For example, in focusing on three dimensions only, the UN-HDI excludes at least two other dimensions deemed important by Sen (1999); for example, political freedoms and transparency guarantees. As such, even from a perspective of freedom on human development, the UN-HDI can be said not to meet the task of measuring human development comprehensively (SEN, A. 1999. *Development as Freedom*, OUP Oxford.).

happiness and subjective well-being (Kahneman et al., 2004).[8] As such, there might in principle be room for including the utilitarian perspective on human development in the construction of a composite indicator measuring human development like the UN-HDI. Beyond the three perspectives on human development discussed in this paper, this holds of course also for yet other perspectives on human development like those emphasizing aspects of equality and sustainability. It seems that those involved in constructing the UN-HDI are perfectly aware of this but also point at the virtual impossibility of coming up with a perfect measure of human development given the limitations of available data (UNDP, 1990). What holds then is that measuring human development involves and should involve an ongoing process going back and forth between theoretical insights, empirical observations, and the experiences of stakeholders on the ground.

3.3. From the UN-HDI to a European Regional Human Development Index

Starting from the United Nations Human Development Index (UN-HDI) we propose to construct a regional human development index for the European Union (EU-RHDI) that builds on but also extends the former index to include all three perspectives on human development discussed above. That is, we propose to reconfigure each pillar of the UN-HDI in terms of all three perspectives. This means that the education pillar will be addressed from the basic needs perspective, the utilitarian perspective, and the perspective on freedom; and likewise for the other two pillars.

First, addressing the three pillars from a basic needs perspective requires a discussion of the minimum requirements of people's health, education, and income. For health this means being able to life a long enough life; for education this means having the knowledge and skills to survive in society; and for income this means having just enough income to feed oneself (including having access to clean drinking water), have shelter, and wear clothes.

From a utilitarian perspective, though, addressing the three pillars of the UN-HDI is inherently problematic given that from its emphasis on overall happiness, a strict interpretation of the utilitarian perspective would altogether refrain from such value judgments about specific dimensions that might – but from this perspective need not necessarily (i.e. intrinsically) – build up people's happiness. Nevertheless, we believe that from the three different dimensions within the UN-HDI we can still

[8] The reason for not including self-reported measures of happiness and well-being on grounds of such measures being subjective is – from a utilitarian perspective at least – somewhat flawed. For utilitarians the whole point of diverting to subjective measures holds that happiness and well-being can impossibly be objectively set from the outset. That is, the idea of the utilitarian perspective on human development is to refrain from any (top-down) moral judgment of what ought to count as the "good life" and what not. Following this rationale, under strict utilitarianism, diverting to subjective measures is not just one among other options for measuring human development but in fact constitutes the only preferred option.

address these dimensions with an eye on utilitarian arguments; in a way taking happiness as the “sum” of subjective health, subjective skillfulness, and subjective income.

Finally, in addressing the three pillars from a freedom perspective on human development, we should on the one hand take into account these pillars in terms of both functionings (actual achievements) and capabilities (opportunities for achievements) in themselves and on the other hand take into account the linkages between these functionings and capabilities within and across pillars. For example, from the perspective of development as freedom it is not only important to realize the value of health functionings and capabilities in themselves but also in relation to the value of income and education functionings. The next sub-section will discuss these issues more into depth with respect to the data that we actually considered and used.

4. Selection of variables

Measuring means using data to say something meaningful about a particular phenomenon of interest; in our case human development. As such, it is important that the data to be used are of good quality. The better the data at hand, the more can be said about a particular phenomenon of interest. Following Griliches (1986; cited in Hall and Jaffe, 2012), we distinguish among three general types of quality issues: extent, reliability, and validity (OECD/JRC, 2008). Extent and reliability of data refer respectively to their coverage (in terms of years and regions) and consistency in their collection. The validity of data refers to their correspondence with the phenomena we intend to measure. In what follows we will discuss conceptual considerations revolving data validity first (section 4.1) and then turn to statistical considerations revolving the extent and reliability of the data (section 4.2).

4.1. Conceptual considerations: validity of the data

As a representation of real world phenomena, indicators unavoidably leave out some aspects of reality while paying explicit attention to others. Hence, every measurement (at least of social phenomena) is imperfect. Measurements represent the state of affairs of a phenomenon of interest, but do not involve the particular phenomenon interest itself. In other words, all measurements are proxies of the complex reality which we are trying to capture. Needless to say, aiming at informing public policy, our intention is not to affect the performance of regions in terms of the indicators that we propose. Rather, the intention is to affect the performance of regions in terms of the underlying phenomenon of interest. Hence, the issue is not whether particular variables are imperfect representations of the phenomena we are interested in but more to what extent this is so (Hall and Jaffe, 2012, Hardeman et al., 2013). In total we considered a set of 22 variables to be included in the composite indicator. In what follows fo rech dimension we will discuss why and to what extent we deem particular variables conceptually relevant for measuring human development.

4.1.1. Variables considered under the health dimension

For the health dimension we considered 7 variables. Following the UN-HDI we propose to include **life expectancy at birth** to measure a "long and health life." As argued, it is widely understood that instead of measuring a "long and healthy life", life expectancy at birth merely captures longevity (i.e. life itself) only. As an indicator of life itself, the life expectancy variable therefore perhaps best reflects a functionings understanding of the health dimension; that is, as an indicator measuring people's overall chances of staying alive. The higher the life expectancy in a region, the more developed it is said to be. Hence, life expectancy is expected to be positively associated with other variables capturing human development.

In addition or as a substitute we propose to include **healthy life expectancy** as a variable underlying the health dimension. This variable combines mortality data with data on self-perceived health[9] and as such can be considered as a variable that takes on board both the perspective of freedom on health in human development (i.e. as for the life expectancy at birth variable) and the utilitarian perspective as it is based on self-reported data. That is, although not capturing "a long and healthy life" in an objective way, more than life expectancy at birth, healthy life expectancy is able to measure the qualitative aspects of living a healthy life. As with life expectancy as such, healthy life expectancy is expected to correlate positively with human development at large. Hence, the higher a region's healthy life expectancy, the more developed it is said to be.

Also, we propose to include **infant mortality** as an additional variable underlying the health dimension. It can be argued that infant mortality does not measure a different perspective on human development than the one captured by life expectancy; that is, the basic needs perspective. However, it can be argued that infant mortality rate represents an indicator of health in a region that refers to an even more basic understanding of minimum health conditions required: to life a long life, you have to survive at least the first year of it. For now, we include it as a kind of yardstick to compare our other measure of basic health needs with. What we would for example expect than is that this variable relates more with other indicators capturing the basic needs perspective than the life expectancy variable. Overall, the higher infant mortality, the less developed a region is. As such, infant mortality is expected to be negatively associated with life expectancy and other variables that are positively associated with human development in general.

Access to health care, as measured by the number of doctors per 100,000 inhabitants in a region, is the final variable covering health capabilities. This variable is interpreted as signaling people's access to health care: the more doctors, the more opportunities for maintaining good or better health. Admittedly, the number of doctors per 100,000 inhabitants is a crude measure for health capabilities. Especially given that access to medical help need not be assured via physical contact with doctors (i.e. face-to-face encounters with health professionals) but might also occur via telephone or over the internet, the number of doctors per 100,000 need not say much about real opportunities for ensuring good health. Notwithstanding this concern, we include this variable as a potential measure capturing health capabilities. In all, we expect access to health care to be positively associated with life expectancy and healthy life expectancy and negatively associated with infant mortality.

[9] Note that data on self-perceived health are not available at the NUTS2 level for all regions. Therefore we decided to use data on self-perceived health at the national (NUTS0) level and life expectancy at birth at the regional (NUTS2) level to construct healthy life expectancy at the regional (NUTS2) level. Hence, healthy life expectancy will only show variation across regions of the same country to the extent that life expectancy at birth shows variation across regions of the same country. Variation in healthy life expectancy across regions of different countries might be due to both variation in self-perceived health and variation in life expectancy at birth.

We propose to measure health functionings by the age specific death rate at age 70 and the probability of dying at age 70. **Age specific death rate at age 70** and **the probability of dying before age 70** are strongly related variables in that the one is a prediction based on current values of the other.Like healthy life expectancy, both are included for consideration here in an attempt to come closer to the ideal of measuring "a long and healthy life." The general idea holds that (in Europe) low death rates and probabilities at the age of 70 might indicate a healthy life at least up until that age. As such, these variables are proposed as an attempt to move beyond the basic needs connotations that accompany life expectancy and infant mortality. Two cautionary remarks are in place here. One is that, although perhaps coming nearer to our main measurement objective, low rates or probabilities do not ensure a healthy life up until that age. In other words, we do not know whether the life lived up until the age of 70 has been healthy in qualitative terms. The second remark is that the specific age of 70 is arbitrarily set. One might wonder why the age is not set at for example 65. This is a valid critique. Alternatively, and to anticipate this critique, we also considered to include **probability of dying before age 65**. All three variables proposed to capture health functionings are expected to be associated negatively with life expectancy, healthy life expectancy, and access to health care and positively with infant mortality.

4.1.2. Variables considered under the knowledge dimension

For the knowledge dimension we considered 9 variables. **Early school leavers**, as measured by the percentage of people aged 18-24 having attained at most lower secondary education, is proposed to measure the extent to which people in a region do not have the basic skills and knowledge to participate in and contribute to society. As such, a relatively large amount of early school leavers would signal that a region's people are not equipped with the basic knowledge needs. Hence, this variable is expected to be associated negatively with variables capturing human development positively. Alternatively, "Not in Employment, Education or Training" (**NEET**) measures the extent to which people are insufficiently equipped to participate in the economy. Compared to measuring early school leavers, an advantage of this measure is that it takes into account the possibility of training-on-the-job. As education and training need not take place formally only, NEET is a broader measure of lacking basic knowledge needs than early school leavers. Like early school leavers, this variable is expected to be negatively associated with variables capturing human development (esp. in the knowledge dimension) positively.

All other 7 variables that we propose to include in the knowledge dimension are related to the perspective of freedom on human development.[10] On the side of capabilities, we propose to include 5

[10] Note then that we did not or in fact could not include variables capturing the utilitarian perspective on human development under the knowledge dimension. Ideally we would have included a self-reported knowledge variable measuring the extent to which people feel equipped with the knowledge and skills they have to live a happy life or, alternatively, measuring the extent to which people are happy with their knowledge and skills. However, as of now and to the best of our knowledge, such variables are not available.

variables: lifelong learning in a region, a region's knowledge intensity, the share of 30-34 year old persons having attained tertiary education, human resources in science & technology, and the share of personnel active in research & development. **Lifelong learning** is measured by the percentage of people aged 25-64 that are actively involved in education and training. This variable is meant to proxy the opportunities people in a region have to keep being involved in training and education even after their more formal studies have ended. Having the opportunity to be involved in life-long learning can be taken to increase one's skills and knowledge as an end in itself in the sense of a continuing process of self-actualization. In addition, life-long learning increases one's chances on assuring a steady income basis; that is, life-long learning enlarges the opportunities to achieve functionings in other dimensions most in particular the income dimension. As a positive measure of knowledge capabilities, lifelong learning is expected to be negatively associated with early school leavers and NEET.

As a more generic measure, a region's **knowledge intensity** – as measured by the share of higher education students in the total population – is proposed to be included in an attempt to measure people's access to knowledge in a region. Following the rationale of knowledge being geographically localized (Jaffe et al., 1993, Agrawal et al., 2006), the share of higher education students in the total population reflects the ability of a region's people to connect to the intangible aspects of the knowledge economy; that is, their capability to contribute to or benefit from the those intangible aspects of the economy deemed crucially important nowadays (i.e. knowledge). Taken as such, knowledge intensity is expected to be negatively associated with early school leavers and NEET but positively associated with lifelong learning. A downside of using knowledge intensity as a measure of knowledge capabilities is that this measure might provide a distorted picture due to commuting patterns. That is, those regions in which higher education institutes are located might score relatively high on this variable although the students attributed to that region do not actually life there and hence do not provide other inhabitant access to their knowledge. To overcome this issue we propose to include the **share of tertiary students within the age range 30-34** as a potential viable alternative. The main argument is the same; that is, the share of tertiary students within the age of 30-34 reflects the ability of a region's people to connect to the intangible aspects of the knowledge economy. Likewise, this variable is expected to be negatively associated with early school leavers and NEET but positively associated with lifelong learning.

Yet other alternatives of measuring people's capabilities to contribute to or benefit from knowledge available in a region are provided by **human resources in science & technology (S&T)** and **research and development (R&D) personnel** in a region. Instead of focusing on people with a particular educational background, these two variables focus on the knowledge intensity of people's occupation. Like the variable knowledge intensity, both human resources in science & technology and R&D personnel potentially suffer from being distorted by commuting patterns. In addition, it can be argued that human resources in science & technology is too much restricted to knowledge pertaining to science and technology and too little to knowledge in general (such as those important in services and the arts). The R&D personnel variable overcomes this issue as – following the OECD (OECD, 2002) and its definition of R&D – knowledge in this domain has wider applicability than science and technology alone. The extent to which either of these variables is appropriate for measuring knowledge capabilities

then crucially depends upon their statistical properties. In order of preference, in principle we would propose lifelong learning first, share of tertiary students within the age of 30-34 and/or R&D personnel second, and knowledge intensity and/or human resources in science & technology third. For all variables it holds that we expect them to be negatively associated with early school leavers and NEET.

On the side of knowledge functionings we propose to include another two variables**: lower secondary education** attainment and **general tertiary education** attainment. Both variables pertain to gross educational attainment data. Referring to attained levels of education, these variables are clearly about actual achievements and hence functionings in the knowledge dimension. However, expressed as a percentage of the population (or at least a large part of it), it also provides clues as to general access to education and hence knowledge capabilities in a region. As such, to our opinion, gross educational attainment data represent knowledge functionings with a strong capabilities "flavor." What this makes clear then is that it is sometimes difficult to distinguish capabilities from functionings. In addition, we note that, the more you go up in the particular levels of educational attainment (i.e. from focusing on primary education to tertiary education only), the more you depart from a basic needs perspective on human development towards focusing on a perspective of freedom on human development. While primary education can be said to reflect a more basic knowledge need, secondary education and even more so tertiary education can be said to open up choices for living the life that you want to life in general. Here, in not having access to gross attainment data for primary education, focus is more on the perspective of freedom in the knowledge dimension than it is on the basic needs perspective. What we expect then is that lower secondary education is negatively associated with associated with other variables in the knowledge dimension to human development while general tertiary education is expected to be positively associated with these variables.

4.1.3. Variables considered under the income dimension

For the income dimension, we propose to include 6 additional variables. As with the knowledge dimension, we do not include variables capturing the utilitarian perspective under the income dimension. For the perspective of freedom on human development, we propose to include three variables capturing capabilities and three capturing functionings of income. Concerning capabilities, a first variable we propose is **long term unemployment**. Long term unemployment, arguably, does not reflect income itself. Rather, this variable measures how many people of 15 years or older have structural difficulties in finding a job, hence generating their own income and as such having the opportunity to pursue the life they have reason to pursue in material terms. In other words, the long term unemployment variable is included to measure the extent to which people have difficulties in building up an income. The higher long term unemployment, the more difficult it is for people in a region to live up to the income standards they want. Hence, long term unemployment is expected to be negatively associated with other variables.

Also, while long term unemployment rate captures a region's people opportunities to provide their own income negatively, a region's **employment rate** reflects its positive equivalent. That is, the extnt to

which a region's people actually succeed in providing their own income. The employment rate is defined as the share of persons aged 15 or older that are employed in the total population of persons being 15 years or older. As such, it might be argued that employment rate is a measurement of income functionings. However, rather than measuring income itself, this variable only captures people's opportunities in providing their own income and as such can be positioned as covering capability aspects from the perspective of freedom. Also, it has the advantage of showing how many persons in the population of a region actually earn an income rather than focusing on the average amount of income earned. While the latter might provide a distorted picture of material living standards due to skewness in the income distribution, the former says less about the actual level of material living standards reached by a person. Taken together, income (measured by either GDP per capita or net adjusted household income; see below) and employment rate might thus provide a reasonably good picture of both elements of income. In all, what we expect is that a region's employment rate is negatively associated with long term unemployment.

A third proposed variable covering capabilities in the income dimension to human development is **ICT access** as measured by the percentage of households having access to internet. Along the lines of the European Union positioning itself as a knowledge economy (Lundvall and Rodrigues, 2002), we take this indicator as a proxy of people's access to it. In a way this indicator can be taken to measure the extent to which people in a region are connected to the knowledge economy or, alternatively, disconnected as in a digital divide (Norris, 2001, Archibugi and Coco, 2005). The underlying idea then holds that people who have access to the knowledge economy are better equipped to live the life they have reason to live. Whereas previously we suggested to take into account people's access to the intangible aspects of the knowledge economy (i.e. a region's knowledge intensity), the share of households having access to the internet can be taken as the material equivalent to people's ability to contribute to and benefit from the knowledge economy. What we expect is that ICT access is positively associated with a region's employment rate and negatively associated with long term unemployment.

On the side of functionings the 3 variables we propose here are GDP per capita, net adjusted disposable income, and economic activity rate. As discussed before, there are several issues with taking **GDP per capita** as a valid indicator of human development; even when complemented by other variables as in our composite indicator approach. Nevertheless, and in line with Klugman et al. (2011), from a perspective of freedom on human development including this variable still makes sense in that it represents an indirect measure of people having command over resources to ensure decent material living standards. Although GDP per capita does not cover the whole range of material living standards (e.g. it excludes those derived from non-market activities), it can be considered a valid proxy for the income dimension from the perspective of freedom on human development. To our opinion, and here we differ from Klugman et al. (2011), GDP per capita is more a reflection of the total achievements made in a particular region as to reaching a certain level of income (i.e. functionings) and does not tell much about the real opportunities of the people in that region to reach these achievements (i.e. capabilities). For one thing, since GDP per capita is an average, any level for this variable says little to nothing about people's actual abilities of reaching it. Beyond GDP per capita that measures functionings income, we thus need indicators measuring capabilities of income. What holds is that we

expect GDP per capita to be associated positively with other variables measuring the income dimension to human development.

Alternatively, **net adjusted disposable household income per capita** captures functionings in the income dimension better as it is not distorted by commuting patterns. Net adjusted disposable household income per capita is calculated as the net disposable income weighted by a national adjustment factor. The national adjustment factor is calculated as gross adjusted disposable income of a country divided by net disposable income of a country. As this variable is less distorted by commuting patterns, we consider this a viable alternative to GDP per capita; provided that data is available. What holds then is that we expect net adjusted disposable household income to be positively associated with ICT access, employment rate, and GDP per capita but negatively associated with long term unemployment.

Alternatively, we propose to include the **economic activity** rate which measures the extent to which people in a region are involved in economic activities more broadly. It includes both employed and unemployed people. As such, it does not measure economic activity in terms of employment but economic activity in terms of those people in a region that are potentially active in labor market activities. A downside of this measure is that it focusses on market activities only (therewith excluding non-market activities as a source of increasing income) and as an indicator measuring the degree of success of a region in engaging the population in some form of production activity it is sensitive to the demographic make-up of a region. Notwithstanding these caveats, the economic activity rate can be taken as a proxy of a region's performance in involving people in the economy. As such, it is expected that the higher the economic activity rate, the better a region performs on human development. Hence, we expect a positive association between the economic activity rate and other variables capturing the income dimension to human development. Nevertheless, given the disadvantages of using this variable, we propose to include this variable in our composite only when other variables (most notably long term unemployment and employment) do not meet our statistical requirements. It is to these requirements that we will now turn.

4.2. Statistical considerations: extent and reliability of the data

The objective of this report is to come up with a composite indicator measuring human development both at the level of European regions as well as across time. Hence, an important requirement for the extent of the data is that they span as many European regions and years possible. Reading the extensive literature in social and economic geography on the nature and scope of regions, a delineation of regions is far from straightforward (see e.g. Massey, 2005). For three reasons we choose to take administrative regions at the NUTS2 level as our main unit of analysis.[11] First, we choose to delineate

[11] The *Nomenclature of Territorial Units for Statistics* (NUTS) is a uniform breakdown of spatial units in the European Union which follows a four-level hierarchy that ranges from NUTS0 to NUTS3. The NUTS0 level corresponds to the territory of individual member states, whereas NUTS3 roughly corresponds to labor market

regions administratively as our main objective is to inform policymakers who – by virtue of the scope of their mandate – are usually attached to administrative regions. Second, though not necessarily a good reason in itself, current regional EU (cohesion) policy mainly targets the NUTS2 level. In addition then, and as a pragmatic note, we choose the NUTS2 level as our main unit of analysis as data is most often not available on lower levels of aggregation (i.e. the NUTS3 level). Focusing on European NUTS2 regions, in principle we might have 272 yearly observations. As to the year coverage, we targeted at covering at least five years with the most recent year being no later than 2012. Overall, we thus aim for including a minimum of 1360 region-year combinations (i.e. observations).

Turning to the actual data itself, Table 4 shows an overview of missing values percentages for all 22 variables considered for the years 2006-2012. It is readily apparent that some variables generally lack data across most (if not all) years. This is most notably so for health personnel, R&D labor, and ICT access; with missing values percentages larger than 40%. Given these high missing values percentages we decided not to consider these variables for inclusion in a composite indicator. Apart from these 3 variables, data are generally well covered across years. Nevertheless, given that some data are nevertheless missing, we still need to impute missing data. We will turn to this issue in section 5.1.

The 22 variables have all been retrieved from Eurostat. Unless stated otherwise we assume that these data have been collected systematically across both time and regions. Hence, in principle, we consider these variables reliable.[12] However, in order for the index to be reliable, an additional statistical requirement to construct composite indicators holds that all variables within each pillar should correlate substantially but not too much (i.e. $0.3 \leq corr. \leq 0.9$; OECD/JRC, 2008). For each pillar, Table 5 lists all pairwise correlations among the 22 variables. Note first that all correlations show the directions that we expected. That is, none of the variables correlate with other variables in ways that requires us to alter our conceptualization of human development drastically. Nevertheless, based on the magnitude of the correlations, we decided to exclude 16 variables from the proposed composite indicator.

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regions in most countries. For many countries, the NUTS2 level corresponds to relevant administrative regions, especially in the context of EU policy.

[12] Eurostat provides 10 qualifications about the reliability of their data. Data can be unreliable because of (i) a break in time series, (ii) the data is confidential, (iii) the definition differs, (iv) the data are estimated, (v) the data are forecasted, (vi) the data are not significant, (vii) the data are provisional, (iix) the data are provisional, (ix) the data are not applicable or (x) the data are generally of low reliability. We choose in principle to consider all data as trustworthy unless they provide a break in time series, the definition differs, or they are said to have low general reliability. The figures in Table 4 are provided with these cautionary notes in mind. Note then that this implies that our calculations are potentially subject to modification once provisional, estimated or forecasted data are updated in the future.

Table 4. Missing values percentages for all 26 variables considered

Variable/year	2006	2007	2008	2009	2010	2011	2012	Total
Life expectancy	4%	3%	3%	3%	3%	14%	18%	7%
Healthy life expectancy	10%	6%	4%	4%	3%	24%	30%	12%
Infant mortality	2%	2%	2%	2%	2%	0%	1%	2%
Health personnel	35%	34%	34%	43%	42%	100%	100%	55%
Age specific death rate (70)	4%	3%	3%	3%	3%	14%	18%	7%
Probability of dying (70)	4%	3%	3%	3%	3%	14%	18%	7%
Probability of dying (65)	4%	3%	3%	3%	3%	14%	18%	7%
Early school leavers	24%	34%	22%	18%	22%	18%	18%	22%
NEET	31%	35%	25%	11%	15%	13%	11%	20%
Lifelong learning	19%	25%	13%	7%	11%	12%	6%	13%
Knowledge intensity	33%	26%	25%	30%	30%	24%	24%	28%
Tertiary education (30-34)	27%	19%	18%	7%	11%	9%	6%	14%
HRST labor	96%	10%	8%	2%	2%	100%	2%	31%
R&D labor	61%	26%	62%	17%	54%	35%	97%	50%
Lower secondary education	10%	7%	6%	2%	7%	5%	2%	6%
General tertiary education	10%	7%	5%	2%	6%	5%	1%	5%
Long term unemployment	11%	8%	9%	4%	3%	2%	4%	6%
Internet access	59%	58%	39%	43%	35%	46%	45%	46%
GDP per capita	0%	0%	13%	0%	0%	0%	100%	16%
Net adjusted household income	3%	2%	2%	2%	2%	5%	5%	3%
Employment	8%	6%	6%	0%	0%	0%	0%	3%
Economic activity rate	9%	6%	6%	42%	0%	0%	0%	9%

First, we exclude age specific death rate at age 70, the probability of dying at age 70, and probability of dying at age 65 as all three variables correlate too much with life expectancy (corr. > 0.9). Although in the end we choose to include healthy life expectancy instead of life expectancy at birth and despite healthy life expectancy showing acceptable ranges of correlation with age specific death rate at age 70, the probability of dying at age 70, and probability of dying at age 65, we nevertheless choose to exclude these three alternative measures because healthy life expectancy is directly derived from life expectancy at birth.

Second, we exclude early school leavers whereas it is poorly correlated with other variables in the knowledge dimension (esp. lifelong learning and general tertiary education; corr. < 0.3) and because we deem NEET a more suitable alternative for reasons of also covering on-the-job learning opportunities. Third, we exclude knowledge intensity because it correlates poorly with both NEET and lifelong learning. Fourth, we exclude the share of tertiary students within the age of 30-34and human resources in science & technology whereas both variables correlate too much with general tertiary education and because the latter variable is preferred for conceptual reasons.

Fifth, we exclude R&D personnel because of all remaining variables it is poorly covered and, besides, the denominator of this variable is conceptually flawed as it only covers the active work population and not the total population. Sixth, we exclude lower secondary education whereas it correlates poorly with lifelong learning and general tertiary education and also because the underlying phenomenon is better captured by NEET. Seventh, internet access is excluded whereas it has poor coverage. Eighth, we excluded GDP per capita as the underlying phenomenon is better captured by net disposable household income.

Ninth, we decided to exclude long term unemployment in favor of employment rate as the two variables are related by virtue of how these data are constructed. Also, we deem it more important that people have a job (positive capability) than people structurally not being able to find one (negative capability). Finally, we decided to exclude the economic activity rate as we have variables that better capture the main phenomenon of interest. Summarizing, Table 6 provides an overview of all the variables and the reasons why eventually we did not include them in the proposed composite indicator.

Table 5. Pairwise correlations among selected variables

	1.	2.	3.	4.	5.	6.	7.
1. Life expectancy	1.00						
2. Healthy life expectancy	0.85	1.00					
3. Infant mortality	-0.67	-0.44	1.00				
4. Health personnel	0.36	0.31	-0.31	1.00			
5. Age specific death rate (70)	-0.94	-0.77	0.64	-0.34	1.00		
6. Probability of dying (70)	-0.94	-0.77	0.64	-0.34	1.00	1.00	
7. Probability of dying (65)	-0.93	-0.80	0.58	-0.35	0.89	0.89	1.00

	8.	9.	10.	11.	12.	13.	14.	15.	16.
8. Early school leavers	1.00								
9. NEET	0.46	1.00							
10. Lifelong learning	-0.11	-0.30	1.00						
11. Knowledge intensity	-0.19	-0.20	0.05	1.00					
12. Tertiary education (30-34)	-0.19	-0.27	0.46	0.31	1.00				
13. HRST labor	-0.41	-0.51	0.56	0.40	0.79	1.00			
14. R&D labor	-0.19	-0.41	0.45	0.62	0.55	0.70	1.00		
15. Lower secondary education	0.81	0.40	-0.09	-0.22	-0.16	-0.44	-0.15	1.00	
16. General tertiary education	-0.23	-0.31	0.55	0.38	0.91	0.89	0.61	-0.28	1.00

	17.	18.	19.	20.	21.	22.
17. Long term unemployment	1.00					
18. Internet access	-0.24	1.00				
19. GDP per capita	-0.35	0.47	1.00			
20. Net disp. household income	-0.34	0.56	0.77	1.00		
21. Employment	-0.73	0.56	0.52	0.58	1.00	
22. Economic activity rate	-0.38	0.50	0.45	0.48	0.84	1.00

Note: the number of observations ranges between 851-1805; all correlations above 0.07 are statistically significant at $\alpha \leq 0.01$

Table 6. Overview and description of variables considered for inclusion in the EU Regional Human Development Index

Variable	Source	Description	Dimension	Perspective	Direction	Included yes/no (reason)[13]
Life expectancy at birth	Eurostat	The mean number of years still to be lived at birth if subjected throughout the rest of his or her life to the current mortality conditions	Health	Functionings/ basic needs	Positive	No (validity)
Healthy life expectancy	Eurostat	The number of years a person is expected to live in good perceived health. Indicator combines mortality data with data on self-perceived health	Health	Functionings/utilitarian	Positive	Yes
Infant mortality	Eurostat	The ratio of the total number of deaths of children under one year of age during the year to the number of live births in that year. The value is expressed per 1000 live births.	Health	Basic needs	Negative	Yes
Access to health care	Eurostat	The number of physicians or doctors per 100,000 inhabitants.	Health	Capabilities	Positive	No (reliability and validity)
Age specific death rate at age 70	Eurostat	Age specific death rate at age 70	Health	Functionings	Negative	No (reliability and validity)
Probability of dying beforet age 70	Eurostat	Probability of dying between exact ages with age is 65 years: the probabilities that an individual of exact age x will die before exact age x + n.	Health	Functionings	Negative	No (reliability and validity)
Probability of dying before age 65	Eurostat	The probability that an individual of age 65 will die before that age	Health	Functionings	Negative	No (reliability and validity)
Early school leavers	Eurostat	The percentage of the population aged 18-24 having attained at most lower secondary education and not being involved in further education or training	Knowledge	Basic needs	Negative	No (reliability and validity)
NEET	Eurostat	The percentage of the population aged 18-24 that is not employed and not involved in further education or training.	Knowledge	Basic needs	Negative	Yes
Lifelong learning	Eurostat	Participation of adults aged 25-64 in education and training	Knowledge	Capabilities	Positive	No (reliability)

[13] As argued, we use three criteria to assess the quality of data: validity, extent, and reliability. Validity is about conceptual issues that revolve a particular variable. Here, we exclude a variable if, to our conceptual understanding of the phenomenon of interest, the variable does not appropriately capture a particular dimension and/or perspective on human development. Extent is about the coverage of the data on a particular variable. If the percentage of missing values is larger than 60% we choose to exclude that variable from the analysis. Reliability refers to consistency in the data. If the correlation of a variable with other variables in a pillar is smaller than 0.3, we choose to exclude that variable from the analysis conditional on the validity of that variable.

Variable	Source	Description	Dimension	Perspective	Direction	Included yes/no (reason)[13]
Knowledge intensity	Eurostat	Share of higher education students in total population	Knowledge	Capabilities	Positive	No (reliability and validity)
Share of 30-34 year olds with tertiary education	Eurostat	Persons aged 30-34 with tertiary education attainment as a share of total population in that age group	Knowledge	Capabilities	Positive	No (reliability and validity)
Human resources in science & technology	Eurostat	The number of people who either successfully completed education at the third level in a S&T field of study or are employed in a S&T occupation (as a share of the total population)	Knowledge	Capabilities	Positive	No (reliability and validity)
R&D personnel	Eurostat	R&D personnel (expressed as head count) as a percentage of the active population; whereby R&D is defined in accordance with the OECD Frascati/Oslo manual (2002).	Knowledge	Capabilities	Positive	No (extent and validity)
Lower secondary education	Eurostat	Persons aged 25-64 with lower secondary education attainment (as the percentage of people of the given age class)	Knowledge	Functionings	Positive	No (reliability and validity)
General tertiary education	Eurostat	Persons aged 25-64 with tertiary education attainment (as the percentage of people of the given age class)	Knowledge	Functionings	Positive	Yes
Long term unemployment	Eurostat/ DG-REGIO	The percentage of total unemployed persons seeking a job for longer than one year.	Income	Capabilities	Negative	No (validity)
Employment	Eurostat	The share of employed persons of 15 year or older as a share of the population of 15 year or older	Income	Capabilities	Positive	Yes
ICT access	Eurostat	Households with access to the Internet at home (as a percentage of all households)	Income	Capabilities	Positive	No (reliability and validity)
GDP per capita	Eurostat	Gross domestic product (GDP) at current market prices (PPS) per inhabitant	Income	Functionings	Positive	No (validity)
Net adjusted disposable household income	Eurostat/ DG-REGIO	A region's net disposable income weighted the region's country gross adjusted disposable income divided by the region's country net disposable income (per capita)	Income	Functionings	Positive	Yes
Economic activity rate	Eurostat	The number of employed and unemployed persons as a percentage of the population living in private households.	Income	Functionings	Positive	No (validity)

5. Methodology

A composite indicator measures multi-faceted phenomena which cannot be captured by a single indicator alone; in this case human development. The OECD/JRC (2008) "Handbook on constructing composite indicators: methodology and user guide" offers a number of guidelines for developing composite indicators. Methodologically, this involves three steps: the computation of missing values whenever data for a particular variable, region, or year is absent; the transformation of variables as to make them comparable; and the aggregation and weighting of the variables as to render one overall index. In what follows throughout this section, we will discuss these three steps in turn.

5.1. Imputation of missing data

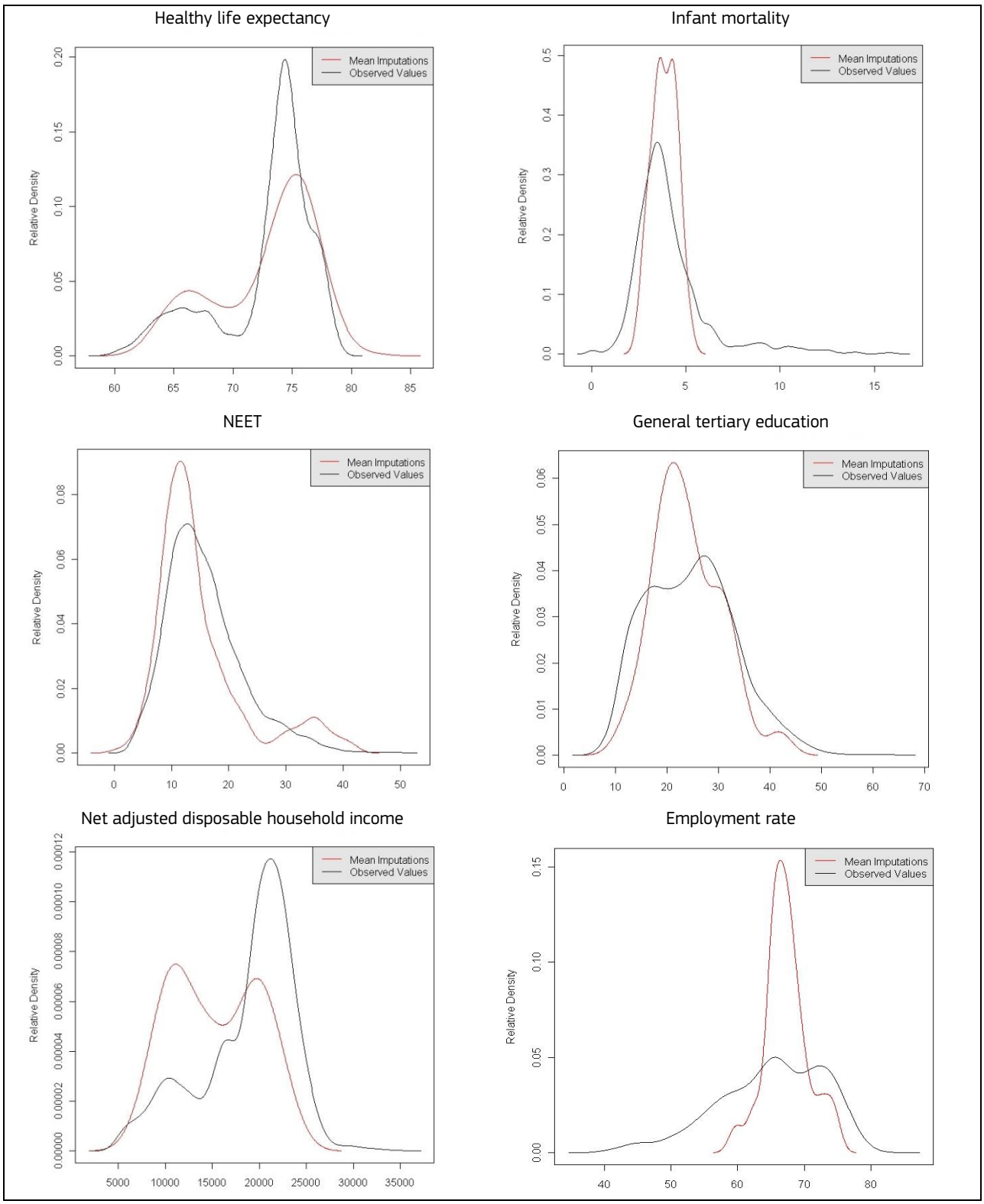
As mentioned, all variables include missing data for some region-year combinations. We use a multiple imputation method implemented in the Amelia software to estimate missing data and obtain a complete time-series cross section data set at the regional level (Honaker and King, 2010, Horton and Kleinman, 2007, Castellacci and Natera, 2011). Taking this approach, missing values are estimated by making use of all observed values whilst controlling for regional fixed effects, time-fixed effects, and region-specific time trends. The model is estimated through the expectation-maximization (EM) algorithm (Castellacci and Natera, 2011, Honaker and King, 2010). EM imputation consists of two steps, the expectation and the maximization. Assuming Gaussian data, the EM algorithm initially guesses the mean and the covariance matrix on the basis of non-missing values and then iteratively updates these through alternating steps of imputing missing values and re-estimating the mean and the covariance matrix from the completed dataset until it reaches convergence (i.e. when the estimates and the covariance matrix no longer change). This estimation is repeated multiple times so that eventually multiple complete data sets are generated (Honaker and King, 2010, Castellacci and Natera, 2011).

The advantages of using this multiple imputation method are twofold (Castellacci and Natera, 2011, Honaker and King, 2010). First is that in this way we obtain a complete data set out of one with missing values. This means that we do not have to exclude observations (years and/or regions) from the analysis. Second, this method is specifically designed to deal with cross-section time-series data as in our case where we have multiple regions across multiple years. That is, including regional fixed effects, time-fixed effects, and region-specific time trends renders the estimates more efficient (Castellacci and Natera, 2011, Honaker and King, 2010).

Table 7. Comparison of descriptive statistics between incomplete raw data and complete imputed data

	Obs.		Average		S.D.		Min.		Max.		Skew.		Kurtosis	
	Raw	Imp.	Raw	Imp.	Raw	Imp.	Raw	Imp.	Raw	Imp.	Raw	Imp.	Raw	Imp.
Life expectancy at birth	1773	1904	79.60	79.63	2.65	2.60	70.90	70.90	84.20	84.20	-1.12	-1.16	0.50	0.64
Healthy life expectancy	1683	1904	72.79	72.78	4.20	4.21	59.41	59.41	79.28	81.81	-1.15	-1.09	0.37	0.24
Infant mortality	1872	1904	4.15	4.15	2.04	2.02	0.00	0.00	16.10	16.10	2.19	2.20	6.51	6.66
Health personnel	851	1904	332.32	347.31	114.61	93.79	120.60	120.60	940.80	940.80	1.27	1.01	2.88	3.30
Age specific death rate (70)	1773	1904	0.02	0.02	0.01	0.01	0.00	0.00	0.04	0.04	1.07	1.10	0.58	0.72
Probability of dying (70)	1773	1904	0.02	0.02	0.01	0.01	0.00	0.00	0.04	0.04	1.07	1.10	0.58	0.72
Probability of dying (65)	1773	1904	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.03	1.14	1.18	0.43	0.58
Early school leavers	1481	1904	14.69	14.41	7.65	7.50	2.00	0.31	56.50	56.50	1.57	1.46	3.43	3.06
NEET	1520	1904	15.75	15.59	6.68	6.98	2.80	0.36	49.10	49.10	1.05	1.19	1.55	1.70
Lifelong learning	1651	1904	9.87	9.73	6.77	6.62	0.90	-3.21	36.10	36.10	1.21	1.16	1.03	1.05
Knowledge intensity	1380	1904	0.92	0.91	0.46	0.43	0.10	0.10	4.10	4.10	2.32	2.33	10.10	10.74
Tertiary education (30-34)	1639	1904	31.97	31.22	10.77	10.77	8.00	6.87	73.10	73.10	0.28	0.30	-0.45	-0.44
HRST labor	1308	1904	27.47	27.12	7.97	7.84	9.20	8.64	59.40	59.40	0.20	0.22	-0.12	-0.07
R&D labor	948	1904	1.30	1.40	0.96	0.84	0.11	-0.80	5.74	5.74	1.50	1.17	2.56	2.71
Lower secondary education	1799	1904	27.68	27.90	14.83	14.75	3.30	3.30	82.00	82.00	0.99	0.95	0.79	0.70
General tertiary education	1805	1904	24.68	24.64	8.62	8.53	6.80	6.80	63.00	63.00	0.41	0.42	-0.06	-0.03
Long term unemployment	1794	1904	3.76	3.64	3.13	3.10	0.00	-1.43	19.76	19.76	2.05	2.06	5.23	5.44
ICT access	1020	1904	63.98	62.69	17.01	16.38	17.00	17.00	98.00	102.38	-0.20	-0.16	-0.63	-0.57
GDP per capita	1598	1904	23540.86	23617.44	9046.17	8899.10	5700.00	1155.53	85900.00	85900.00	1.57	1.35	7.29	6.45
Net ad. disp. house. income	1846	1904	18721.84	18616.99	5035.05	5055.99	4795.29	4795.29	34452.03	34452.03	-0.78	-0.74	0.08	-0.02
Employment rate	1849	1904	65.02	65.08	7.98	7.89	39.40	39.40	82.50	82.50	-0.58	-0.60	-0.09	-0.02
Economic activity rate	1735	1904	76.94	77.05	5.52	5.45	52.47	52.47	90.66	90.66	-0.97	-0.98	1.70	1.76

Figure 3. Comparison of statistical distributions between incomplete observed data and complete imputed data



The way we proceeded is as follows. In a first step we included all 22 variables for which we have missing values percentages not exceeding 40% in one data set of 7 years and 272 regions (i.e. 1904 observations). That is to say, although we eventually did not use all variables to construct the composite indicator, we did use the complete set of variables to estimate missing values in our data set. In a second step we ran the Amelia algorithm on this data set to estimate the missing values in the data. In order to render the estimates efficient we repeated the estimation procedure 10 times, leaving us with 10 different complete data sets. Third, we then combined these 10 data sets into one by taking the average for each observation, leaving us with a single complete data set. Finally, we scrutinized the reliability of the estimated complete data set by (i) comparing the descriptive statistics of the incomplete observed data set with the descriptive statistics of the complete imputed data set (see Table 7) and (ii) comparing the statistical distributions of the variables in the incomplete observed data set with the statistical distributions of the variables in the complete imputed data set (see Figure 3).

Both the descriptive statistics and the distributions of the estimated complete data are fairly in line with those of the incomplete raw data. From this we conclude that the estimated complete data set can be used to construct the composite indicator. Note however that for the estimated complete data set, some variables report values that are practically infeasible. That is, some variables report on minimums that cannot be obtained in reality. For these and other variables we need to perform some data transformations. It is to these data transformations that we will turn in the next section.

5.2. Data transformations

Before transforming variables as to make them comparable, we performed an additional reliability check and checked whether some of the variables show considerable fluctuations across the years. As this is the case for infant mortality and NEET we decided to take moving averages across 3 years for these two variables. Then, in order to render all variables comparable we transformed them in three steps. First, as argued, the estimated values of some variables might in principle be infeasible. However, it turns out that none of the included variables show infeasible values. Hence, no such corrections were made.

Second, in order for outliers in the data not to drive the results of the composite indicator, we Winsorized or log-normalized those variables that show extremely skewed distributions (absolute skewness > 2 and kurtosis >3.5). Winsorization means that we set the highest values to the next highest ones up until the point that skewness and kurtosis drop within acceptable ranges. Following this strategy we Winsorized infant mortality (moving average).

Third, we choose to normalize all variables using a min-max approach (OECD/JRC, 2008). As such, the observations of all variables are to range between 0-1. Both the minimums and maximums are set to observed and forecasted values. For all variables, values are forecasted for 2013-2017 using linear trends. This way the index scores of 2006-2012 are less prone to changes due to new data becoming available in the near future. In addition, we take the global minimums and maximums; that is, across

all years and regions as to make the index comparable both across time and space. More formally, for variables that measure a positive contribution to human development (healthy life expectancy, general tertiary education, net adjusted disposable household income, and employment rate) the following formula is used:

$$x_t = \frac{x_i - Min(x_n)}{Max(x_n) - Min(x_n)}.$$

For variables that measure a negative contribution to human development (infant mortality and NEET) the following formula is used:

$$x_t = \frac{x_i - Max(x_n)}{Min(x_n) - Max(x_n)},$$

where x_t is the transformed value of a variable for a particular region in a particular year; x_i the value of that variable after imputation for that region and year; $Min(x_n)$ is the minimum of that variable across all regions and (forecasted) years; and $Max(X_n)$ is the maximum of that variable across all regions and (forecasted) years. Table 8 provides an overview of minimums and maximums across all regions and (forecasted) years.

Table 8. Overview of minimums and maximums per variable

Variable	Min/max	Value	Region	Year
Healthy life expectancy	Minimum	59.41	Észak-Magyarország (HU)	2007
	Maximum	85.32	Inner London (UK)	2017
Infant mortality	Minimum	0.00	3 regions (Marche, IT; Provincia Autonoma di Bolzano/Bozen, IT; Åland, FI)	4 years (2006, 2012, 2016, 2017)
	Maximum	9.87	13 regions (Vest, RO; Yuzhen tsentralen, BG; Yugoiztochen, BG; Sud – Muntenia, RO; Nord-Vest, RO; Severoiztochen, BG; Severozapaden, BG; Centru, RO; Sud-Est, RO; Guyane, FR; Sud-Vest Oltenia, RO; Nord-Est, RO; Ciudad Autónoma de Ceuta, ES)	All years (2006-2017)
NEET	Minimum	1.28	Praha (CZ)	2006
	Maximum	53.46	Peloponnisos (EL)	2017
General tertiary education	Minimum	3.22	Emilia-Romagna (IT)	2017
	Maximum	75.79	Inner London (UK)	2017
Net disposable income	Minimum	4795.29	Severozapaden (BG)	2006
	Maximum	37318.31	Luxembourg (LU)	2017
Employment rate	Minimum	34.77	Campania (IT)	2017
	Maximum	83.31	Thüringen (DE)	2017

5.3. Aggregation and weighting

We choose to aggregate variables within the dimensions using the arithmetic average. That is within a single dimension we allow for complete compensation of different aspects of that dimension. Instead, different dimensions are aggregated using the geometric average. That is, different dimensions are only partially compensatory vis-à-vis each other as we do not want to allow good performance in say income to fully compensate for bad performance in health. Note that in using the geometric average to aggregate different dimensions in the overall index we follow the most recent methodological change applied in the construction of the UN-HDI (Klugman et al., 2011).

More formally, each dimension aggregates two transformed variables using the arithmetic mean, following the formula:

$$D = \frac{\sum x_{t1}\,,\ x_{t2}}{2},$$

where D is the dimension index of either health, knowledge or income; and x_{t1} and x_{t2} are respectively the first and second transformed variable of each dimension (i.e. healthy life expectancy and infant mortality for the health dimension; NEET and general tertiary education for the knowledge dimension; and net adjusted household income and employment rate for the income dimension).

The EU-RHDI is the geometric mean of the three dimensions using the following formula:

$$EU - RHDI = \sqrt[3]{D_{health} \cdot D_{knowledge} \cdot D_{income}}$$

Although weights can be assigned to each dimensions such that all dimensions are roughly equally important within the overall index (Paruolo et al., 2013), for practical reasons we choose not to use weights that are assigned on the basis of equal importance. Assigning weights on the basis of equal importance requires approximating the weights on a case-by-case basis; that is, whenever the index is updated with a new year the weighting scheme has to be updated as well and determined anew. Also, weights assigned on the basis of equal importance might turn out to be negative. In our case it turns out that, using an approximation of weights based on equal importance (see section 7.2), the income dimension indeed receives a negative weight in the overall index which is counterintuitive as it does not conform to the definition of human development adhered to here. Hence we choose to build the index based on equal weights instead of weights assigned on the basis of equal importance.

Table 9 and Table 10 provide respectively an example of how to calculate the EU-RHDI for each region and an overview of the structure and methodology used to construct the EU-RHDI. First, as with the UN-HDI, we structured the EU-RHDI along three dimensions: health, knowledge, and income. Second, as much as we could from the data that is available, we included variables that cover different perspectives on human development. As such we cover all perspectives in the overall index to a greater or lesser extent. For each dimension we included two variables; rendering the overall index to comprise six variables. Third, given that after imputation of missing data some variables were highly skewed in their distribution or use a different scale of measurement, we transformed the variables as to make them comparable. Finally, weights were assigned equally and subsequently variables were aggregated

using the arithmetic average within dimensions and dimensions were aggregated using the geometric average within the overall index.

Table 9. Steps to calculate the EU-RHDI: the case of Åland (FI) in 2012

1. The values of the 6 variables underlying the EU-RHDI are as follows for Åland in 2012.

Healthy life expectancy	Infant mortality	NEET	General tertiary education	Net adj. disp. household income	Employment rate
75.16	0.00	5.64	32.70	26292.99	80.70

2. Minimum and maximum values are set in order to transform the variables into indices between 0 and 1. The minimum and maximum values are respectively the highest and lowest observed and forecasted values across all regions (272) and years (2066-2017) after Winsorization.

Variable	Minimum	Maximum
Healthy life expectancy	59.41	85.32
Infant mortality	0.00	9.87
NEET	1.28	53.46
General tertiary education	3.22	75.79
Net disp. household income	4795.29	37318.31
Employment rate	34.77	83.31

3. Variables are transformed using the min-max approach. Note that, depending on the sign of the contribution to human development (positive or negative) a different formula is used to transform variables using a min-max approach. To illustrate, the transformed healthy life expectancy value for Åland, is calculated as:

$$0.61 = \frac{75.16 - 59.41}{85.32 - 59.41}$$

Alternatively, the transformed NEET value for Åland is calculated as:

$$0.92 = \frac{5.64 - 53.46}{1.28 - 53.46}$$

4. The transformed values for all variables for Åland in 2012 are as follows.

Healthy life expectancy	Infant mortality	NEET	General tertiary educ.	Net adj. disp. household income	Employment rate
0.61	1.00	0.92	0.41	0.66	0.95

5. Dimension indices are calculated using the arithmetic mean. To illustrate, the health dimension index is calculated as follows for Åland in 2012:

$$0.80 = \frac{0.61 + 1.00}{2}$$

Likewise, the knowledge and income dimension render scores of respectively 0.66 and 0.80 for Åland in 2012.

6. Finally, using the geometric mean with weights assigned to each based equally renders the following overall index score for Åland in 2012:

$$0.75 = \sqrt[3]{0.80 \cdot 0.66 \cdot 0.80}$$

Table 10. Structure and methodology of EU Regional Human Development Index

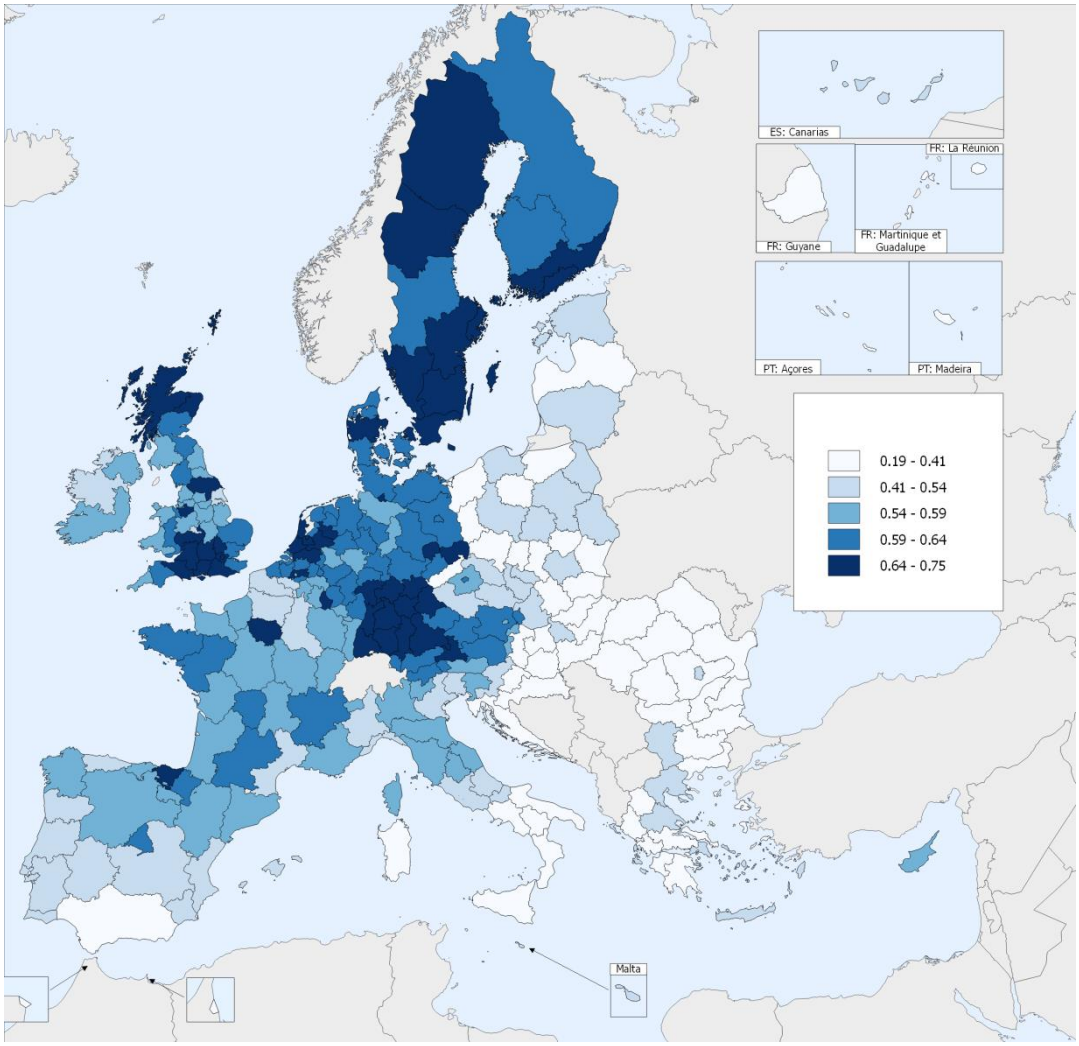
Variable	Transformation	Normalization	Weighting	Aggregation	
				Variables	Index
Healthy life expectancy	-	Min-max (based on forecasted values)	Equal weights	Arithmetic	Geometric
Infant mortality	Moving average; Winsorization				
NEET	Moving average				
General tertiary education	-				
Net adj. disp. household income	-				
Employment rate	-				

6. Results

6.1. Geographical distribution of scores

Figure 4 shows a regional map of the EU-RHDI for the year 2012. Although we present results for 2012 only here, the results of the index are available for all years (2006-2012) and regions (272). The scores are presented based on quintile categories going from the 55 regions with the lowest scores in lightest blue to the 55 regions with the highest scores in darkest blue.

Figure 4. Map of the 2012 EU Regional Human Development Index scores (quintiles)



A number of patterns stand out. First, the map shows a clear north-west/south-east divide in Europe with regions in countries like Luxembourg, Denmark, the United Kingdom, Sweden, Finland, Germany, and the Netherlands generally outperforming regions in countries like Poland, Romania, Greece, and (esp. southern) Italy. Second, also within countries differences exist as to regional performance in human development. Sometimes even neighboring regions differ markedly in their performance on human development. Again, Italy can be mentioned as a case where southern regions are clearly outperformed by northern regions. Also there seems to be an overall tendency of capital city regions (London, Paris, Madrid, and Prague) and larger city regions (Hamburg, Bremen, and Munich) to outperform more rural areas. Note however, that the differences across regions within countries might be exaggerated by virtue of fixing the categories on the basis of quintiles.

Alternatively, Figure 5 shows a regional map with the same scores but then presented based on categories fixed on the basis of predefined scores. Though, some exceptions aside, within country differences are less marked. Nevertheless, again most capital city regions and larger city regions seem to outperform more rural areas. Also, the north-west/south-east divide in Europe is still apparent. Furthermore, what stands out from Figure 4 and Figure 5 is that no region scores higher than 0.75; that is, within the range of the highest category (0.8-1.0). Given that some regions do score above 0.8 in some dimensions, this might be due to their relative underperformance in others. Also, recall here that our method of aggregating dimensions using the geometric mean does not allow for full compensation of disproportionate underperformance in one dimension by disproportionate over-performance in another dimension. Following up on these points, we observe in Figure 5 that a vast majority of regions scores within the range of 0.4 and 0.6. Apart from some eastern and southern European regions, overall human development thus seems to be rather evenly spread across EU regions.

Figure 5. Map of the 2012 EU Regional Human Development Index scores (fixed categories)

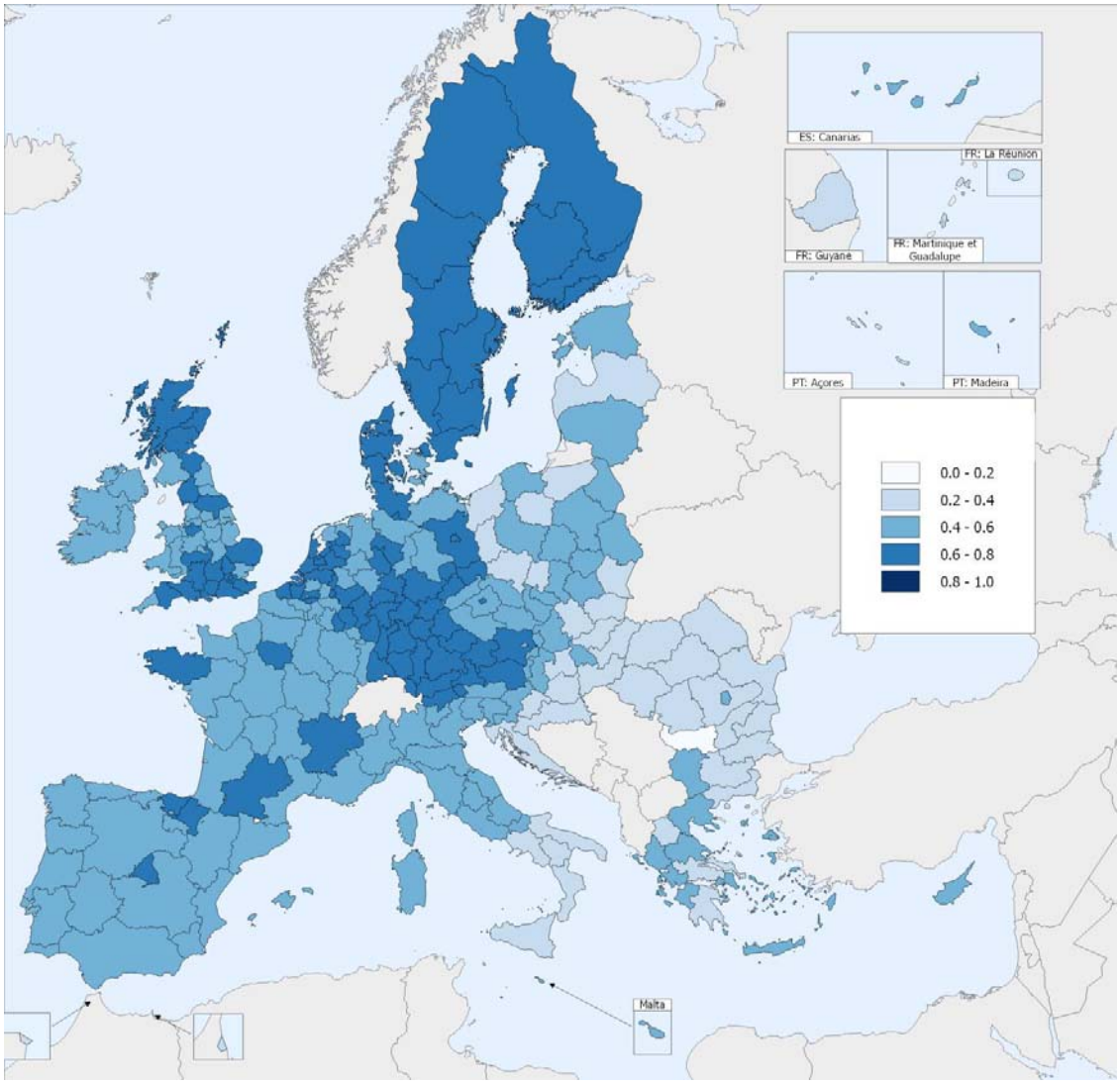
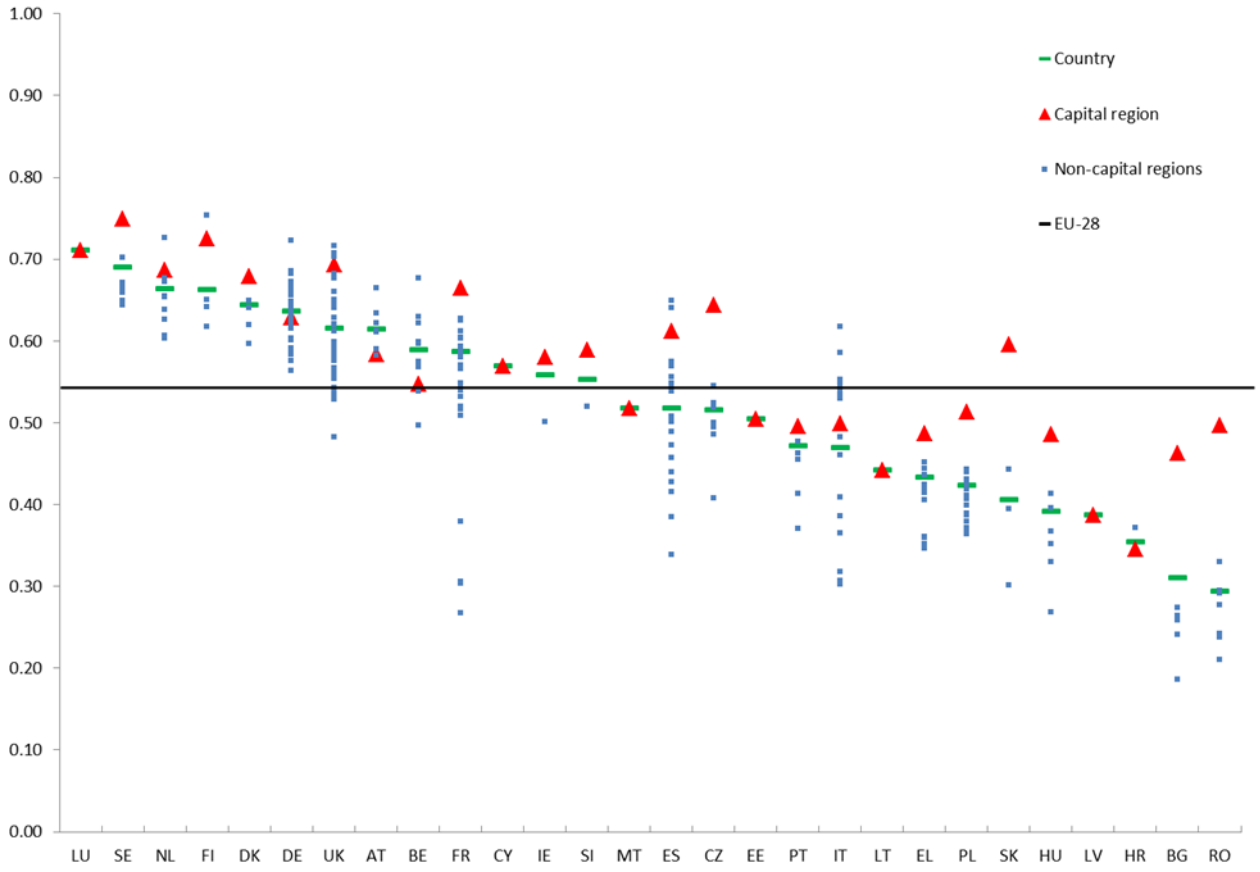


Figure 6. Comparison of EU-RHDI scores among EU regions (year 2012; 272 regions)



Note: the country regional average and the EU regional average have been calculated as the population weighted average of the scores of all regions in respectively that country and the EU.

In a different way, Figure 6 presents an overview of all regions' scores for the EU-RHDI in comparison to their national and the EU regional average. Regions' countries are ordered such that the country with the highest average regional score is found on the left hand side of the graph and the country with the lowest average regional score is found on the right hand side of the graph. National regional averages and the EU regional average have been calculated as the population weighted average of the scores of all regions in respectively that country and the European Union. Figure 6 shows even more clearly the position of capital cities in the human development landscape. Except for The Netherlands, Finland, Germany, the United Kingdom, Austria, Belgium, Spain, Italy, and Croatia it holds for all other countries that all regions of a country are outperformed by the capital city region of that country. This pattern is most staggering for Eastern European countries where the national regional average is among the lowest in Europe.

It is also clear that within countries there is quite some variation in regional scores on the EU-RHDI. Noteworthy here are the United Kingdom, Belgium, France, Ireland, Slovenia, Spain, Czech Republic, and

Italy where we find both regions that are among the top performers on human development as well as regions that perform below the EU regional average. For France this mostly stems from the 4 overseas areas. For Italy this is again a clear expression of the north/south divide in that country. Less obvious from the maps presented earlier, for Germany and Belgium this pattern points at respectively the west/east (former BRD and former DDR) and north/south (Flanders and Wallonia) divides in these countries.

Figure 7. Map of the 2012 health dimension scores (fixed categories)

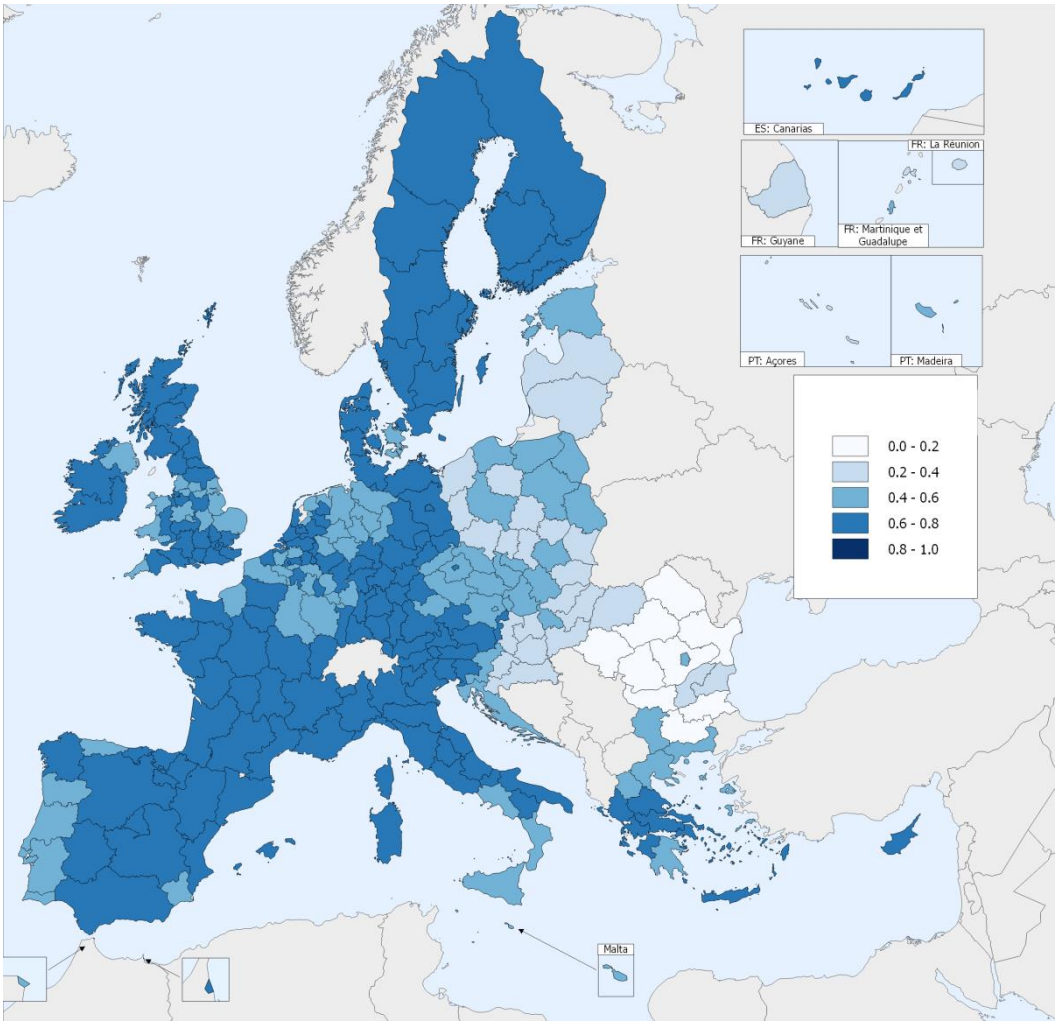
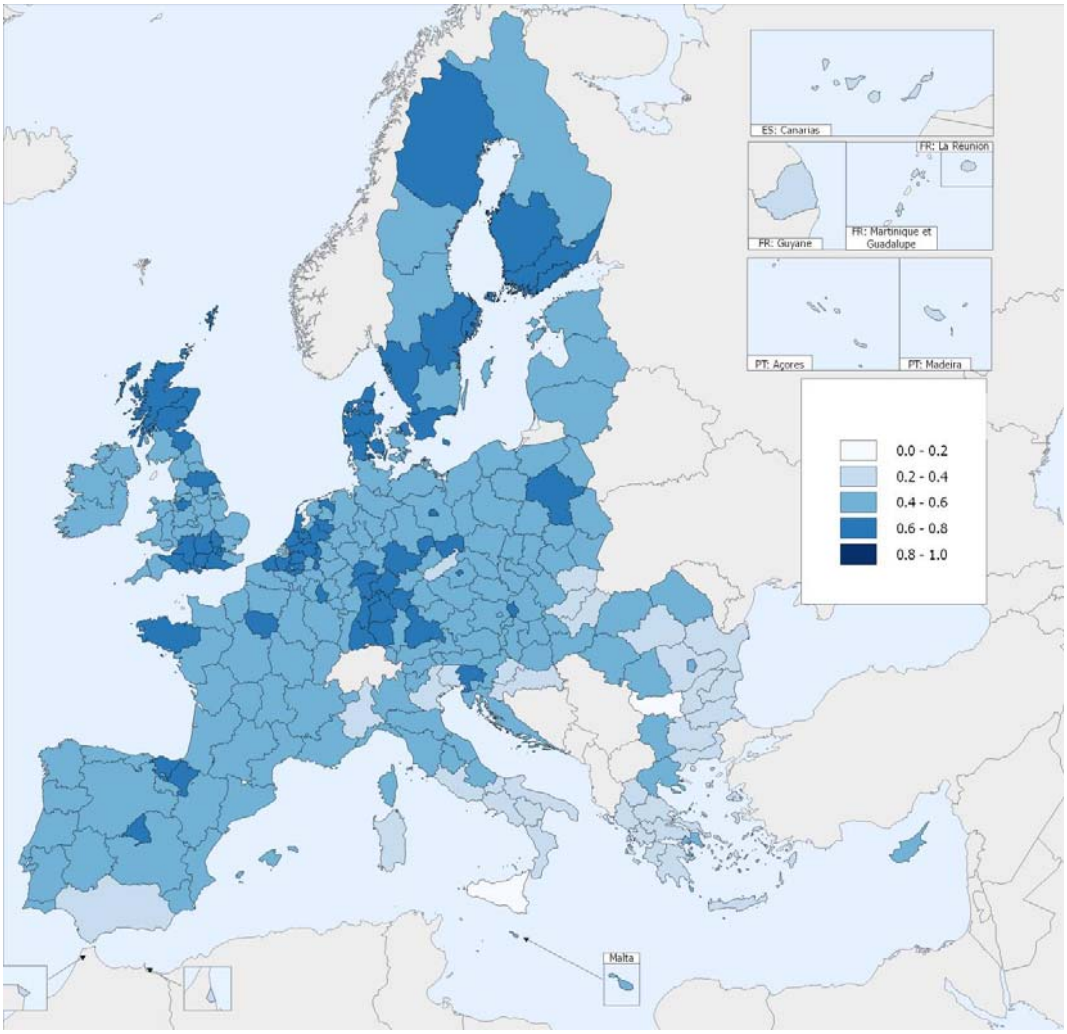


Figure 7, Figure 8, and Figure 9 show regional maps of scores in respectively the health, knowledge, and income dimension. All three maps present scores based on predefined categories. In comparison to Figure 4 and Figure 5, two patterns stand out. On the one hand, as in the map presenting the overall index scores, eastern European regions are generally outperformed by north-western European regions when it comes to human development. This can be observed from the overall index scores presented in

Figure 4 but also from the health dimension scores, knowledge dimension scores, and income dimension scores presented respectively in Figure 7, Figure 8, and Figure 9. It is safe to conclude that many eastern European regions are outperformed by their north-western European counterparts on all dimensions of human development and, hence, human development in general.

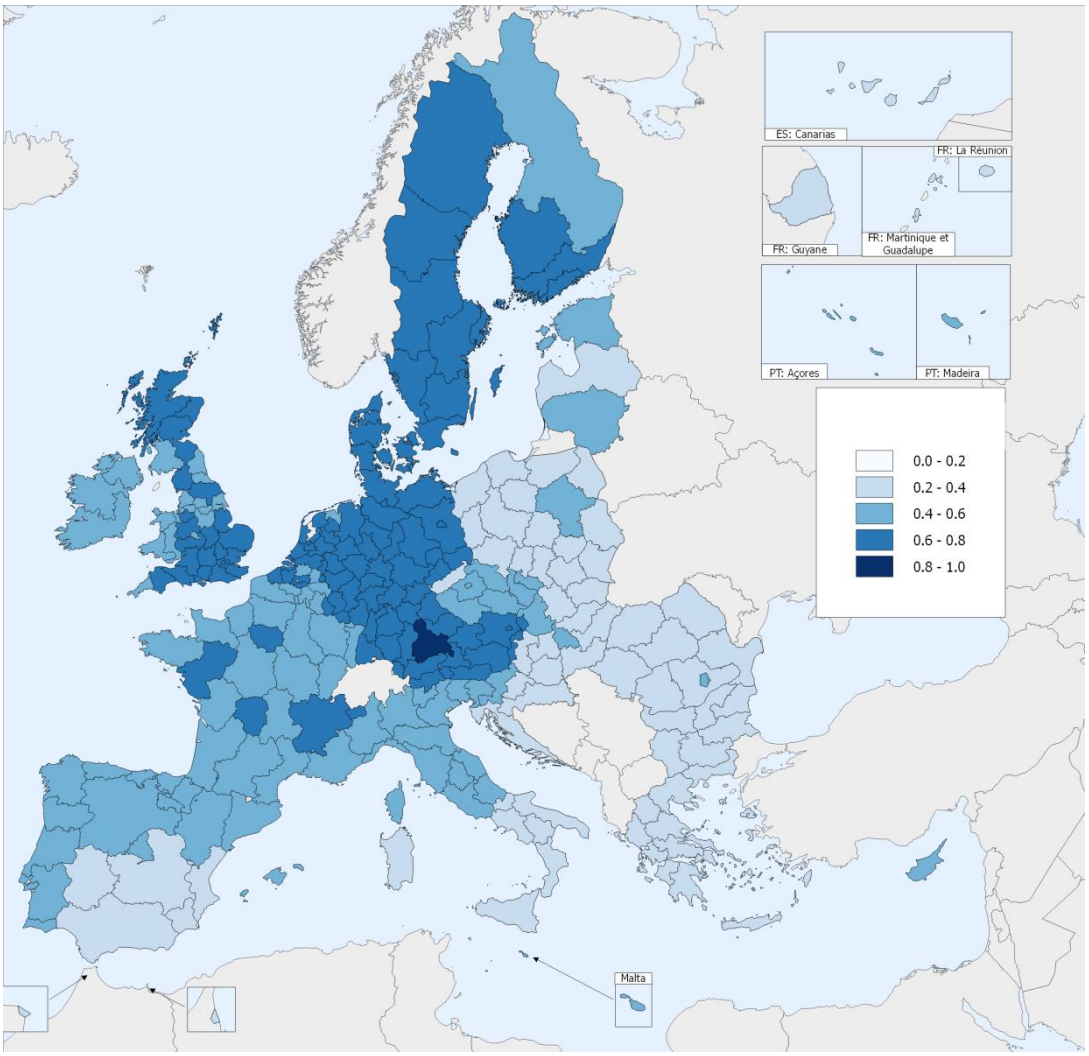
Figure 8. Map of the 2012 knowledge dimension scores (fixed categories)



On the other hand, though, this pattern does not hold when comparing north-western European regions with southern European regions. Southern European regions outperform many north-western European regions when it comes to the health dimension. As such, many north-western European regions might increase their human development by focusing on the health dimension in particular. The main bottleneck for southern European regions seems to be the knowledge dimension (esp. southern Italy and large parts of Greece) and the income dimension (esp. south-east Spain and southern Italy) to human development. More in general it holds that there is more spread in the scores of the dimensions

(esp. the knowledge dimension) than in the scores of the overall index. Whilst for the overall index few regions are assigned to both the lowest and highest categories, for the three dimensions more regions are assigned to these categories.

Figure 9. Map of the 2012 income dimension scores (fixed categories)



6.2. Leaders and followers

Table 11 presents the top-20 EU regions on human development as measured by the 2012 EU-RHDI. All 20 top-regions are from north-western European countries (Finland, United Kingdom, Sweden, Germany, the Netherlands, Denmark, Luxembourg, and Belgium). Also, the scores of these regions are well above the EU regional average. Apart from the ranking in 2012, what Table 11 also shows is that differences are apparent both across time and across dimensions for the individual regions. Across time there are quite some fluctuations in regions' ranks in human development. For example, Inner

London is ranked 3rd in 2012 while it was ranking 14th in 2006. Also, with the exception of Stockholm (SE), hardly any region ranks roughly equally well in all dimensions. Some regions rank equally in two out of the three dimensions (e.g. North Eastern Scotland, UK) but not in all three dimensions.

Table 11.The top-20 EU regions in human development in 2012

Region	EU-RHDI score 2012	EU-RHDI rank 2012 (2006)	Health dimension rank 2012 (2006)	Knowledge dimension rank 2012 (2006)	Income dimension rank 2012 (2006)
Åland (FI)	0.75	1 (1)	1 (1)	21 (27)	2 (23)
Stockholm (SE)	0.75	2 (2)	2 (5)	9 (8)	9 (17)
Inner London (UK)	0.74	3 (14)	13 (135)	1 (2)	22 (11)
Utrecht (NL)	0.73	4 (4)	25 (58)	2 (1)	21 (9)
Helsinki-Uusimaa (FI)	0.73	5 (38)	16 (36)	3 (25)	26 (82)
Oberbayern (DE)	0.72	6 (13)	46 (57)	13 (43)	1 (4)
North Eastern Scotland (UK)	0.72	7 (16)	49 (175)	5 (7)	12 (2)
Luxembourg (LU)	0.71	8 (17)	57 (22)	10 (65)	3 (13)
Berkshire, Buckinghamshire and Oxfordshire (UK)	0.71	9 (3)	31 (64)	12 (10)	11 (1)
Surrey, East and West Sussex (UK)	0.70	10 (5)	19 (44)	15 (12)	18 (3)
Västsverige (SE)	0.70	11 (9)	3 (3)	27 (33)	39 (55)
Noord-Holland (NL)	0.69	12 (8)	83 (51)	7 (4)	40 (24)
Tübingen (DE)	0.69	13 (24)	99 (24)	24 (63)	8 (19)
Freiburg (DE)	0.68	14 (34)	62 (46)	43 (70)	7 (18)
Mittelfranken (DE)	0.68	15 (78)	48 (164)	51 (93)	5 (27)
Stuttgart (DE)	0.68	16 (30)	85 (68)	36 (66)	4 (12)
Bedfordshire and Hertfordshire (UK)	0.68	17 (7)	72 (37)	18 (22)	29 (5)
North Yorkshire (UK)	0.68	18 (15)	65 (52)	17 (40)	36 (7)
Hovedstaden (DK)	0.68	19 (64)	132 (131)	4 (20)	43 (102)
Prov. Vlaams-Brabant (BE)	0.68	20 (26)	100 (78)	8 (6)	49 (63)
EU Regional Average	0.54	156 (175)	182 (194)	149 (139)	154 (169)

Note: the EU regional average has been calculated as the population weighted average of the scores of all regions.

Table 12 presents the bottom 20 EU regions on human development. As measured by the 2012 EU-RHDI. It is clear that generally these regions are underperformers in all dimensions of human development included in the EU-RHDI. Also, and again contrary to the top-performers in human development, there seem to be little major changes in their ranking across the years; that is, their rank in 2012 seems to be fairly in line with their rank in 2006. Finally, the difference in score between the bottom regions and the top performers is staggering. In fact, the scores of the bottom-20 regions are well below the EU regional average as well.

Table 12. The bottom-20 EU regions in human development in 2012

Region	EU-RHDI score (2010)	EU-RHDI rank (2010 (2006, 2012))	Health dimension rank (2010)	Knowledge dimension rank (2010)	Income dimension rank (2010)
Åland (FI)	0.75	1 (1)	1 (1)	21 (27)	2 (23)
EU regional average	0.54	156 (175)	182 (194)	149 (139)	154 (169)
Nord-Vest (RO)	0.33	253 (262)	262 (265)	207 (228)	212 (258)
Calabria (IT)	0.32	254 (230)	206 (188)	268 (267)	267 (241)
Campania (IT)	0.31	255 (236)	196 (161)	269 (270)	271 (251)
Guadeloupe (FR)	0.31	256 (239)	258 (221)	258 (260)	233 (238)
Réunion (FR)	0.30	257 (248)	243 (220)	267 (265)	244 (265)
Sicilia (IT)	0.30	258 (235)	195 (150)	271 (271)	268 (246)
Východné Slovensko (SK)	0.30	259 (266)	260 (269)	238 (259)	242 (252)
Vest (RO)	0.29	260 (267)	265 (270)	208 (230)	229 (239)
Sud-Vest Oltenia (RO)	0.29	261 (259)	267 (259)	217 (248)	224 (240)
Nord-Est (RO)	0.28	262 (258)	270 (258)	215 (239)	203 (245)
Severoiztochen (BG)	0.27	263 (263)	261 (264)	241 (250)	266 (255)
Észak-Magyarország (HU)	0.27	264 (270)	259 (271)	246 (252)	269 (267)
Guyane (FR)	0.27	265 (271)	256 (260)	264 (264)	270 (271)
Severen tsentralen (BG)	0.26	266 (260)	263 (257)	248 (266)	264 (270)
Yuzhen tsentralen (BG)	0.26	267 (269)	264 (268)	249 (263)	261 (263)
Centru (RO)	0.24	268 (261)	266 (263)	259 (247)	249 (262)
Yugoiztochen (BG)	0.24	269 (268)	268 (267)	256 (269)	245 (250)
Sud - Muntenia (RO)	0.24	270 (265)	269 (266)	255 (254)	251 (244)
Sud-Est (RO)	0.21	271 (264)	271 (262)	250 (256)	265 (260)
Severozapaden (BG)	0.19	272 (270)	268 (262)	272 (272)	272 (271)

Note: the EU regional average has been calculated as the population weighted average of the scores of all regions.

6.3. EU-RHDI versus GDP per capita

Turning back to the GDP debate, what is important to discuss for the legitimacy of a EU-RHDI is the relation between GDP per capita and the EU-RHDI. Figure 10 shows a map of GDP per capita for the year 2011. Comparing Figure 10 with the figures of the EU-RHDI (both the overall index and the underlying dimensions), it is clear that GDP per capita shows similar patterns as human development as measured by the EU-RHDI. Again we see a north-west/south-east divide across European regions. Also, as with the EU-RHDI, we observe that capital and large city regions outperform rural areas when it comes to GDP per capita. Overall it might be argued that the picture presented by GDP per capita

figures is very similar to the one presented by the EU-RHDI, especially when considering the overall index.

Figure 10. Map of the 2011 GDP per capita scores (fixed categories)

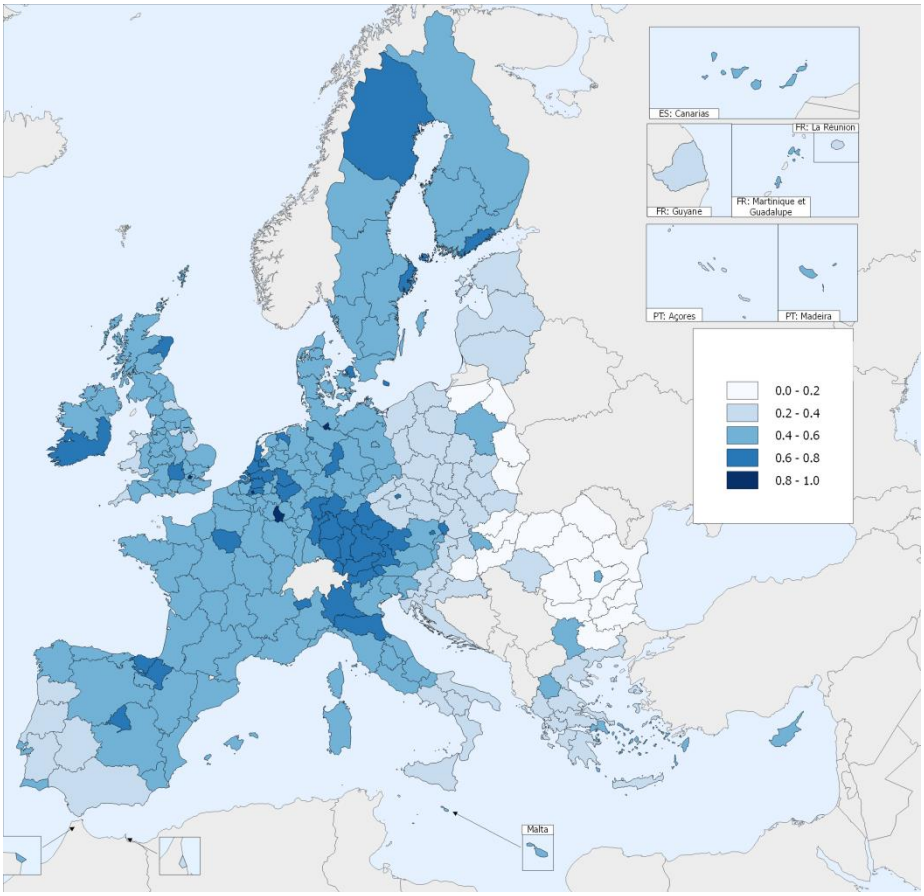


Table 13 and Table 14 go deeper into the relation between GDP per capita and the EU-RHDI (both 2011).[14] Table 13 presents correlations between GDP per capita and the overall EU-RHDI on the one hand and GDP per capita and the dimensions scores on the other. The overall index correlates stronger with GDP per capita than the separate dimensions. From these correlations one might argue that, on top of measuring GDP per capita, the EU-RHDI is redundant as an indicator of human development. We do not agree with this claim. First, though showing high correlations, a large part of the EU-RHDI still remains unaddressed in focusing on GDP per capita alone. Second, as shown by the rank correlations in the third column of Table 13, regions still differ substantially when comparing their rank performance

[14] Note that we use 2011 values here and not 2012 values because for GDP per capita data were not available for 2012 at the time of writing this report.

based on GDP per capita with their rank performance based on the EU-RHDI. In fact, the lower (rank) correlations of the underlying dimensions with GDP per capita directs us at an added value of a composite indicator for human development in that such an index can be decomposed into dimensions while GDP per capita figures are not. Overall, the average absolute rank differences between GDP per capita and the EU-RHDI (36), the health dimension (53), the knowledge dimension (48), and the income dimension (36) are all substantial (>10% of the total number of regions).

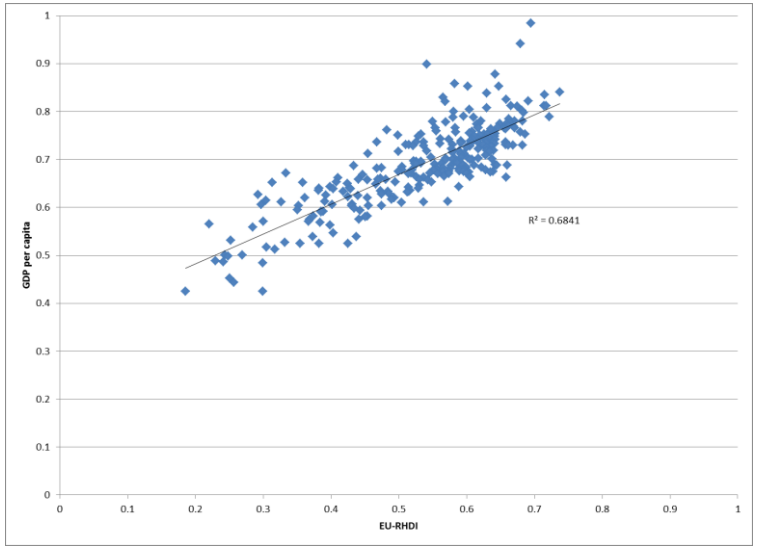
Table 13. Correlations of the EU-RHDI and underlying dimensions with GDP per capita (year 2011; 272 regions)

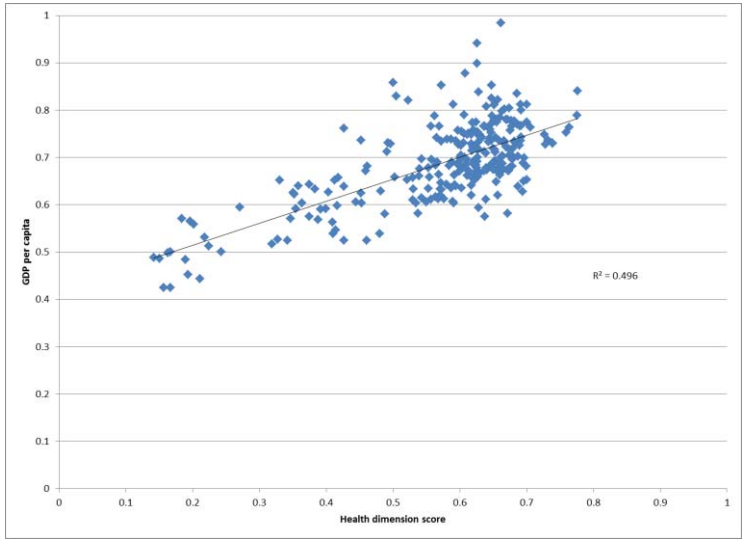
	Score correlation with GDP per capita	Rank correlation with GDP per capita
EU-RHDI	0.83	0.81
Health	0.70	0.59
Knowledge	0.67	0.68
Income	0.80	0.81

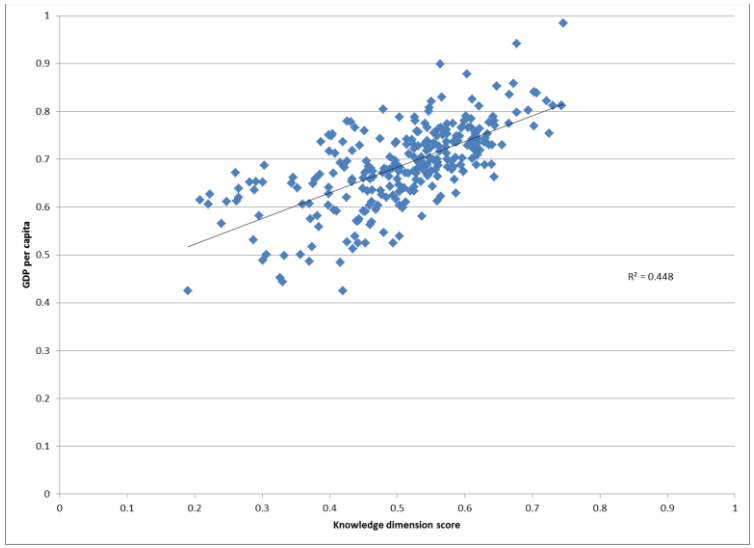
Note: GDP per capita data are log-transformed by taking the natural logarithm and subsequently normalized using the min-max approach; all correlations are statistically significant at $\alpha \leq 0.01$

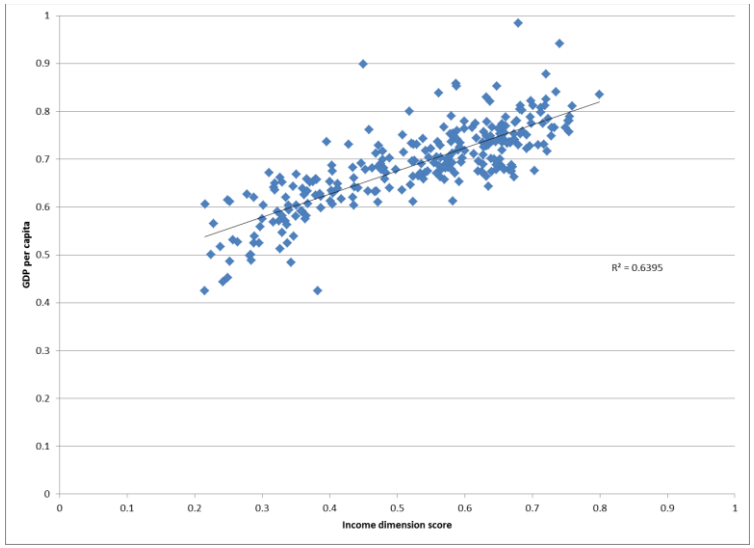
Third, it follows that, in relating GDP per capita with the EU-RHDI and its underlying dimensions, we still find a scattered picture. More precisely, the coefficient of determination (R^2) not exceeding 0.70 shows that a large part of the variation in the EU-RHDI (either focusing on the overall index or each of its underlying dimensions) remains unaddressed by the variation in GDP per capita. Figure 11 shows the scatter plots and the coefficients of determination between GDP per capita on the one hand and the EU-RHDI 2011 scores and its underlying dimensions scores on the other.

Figure 11 Scatterplots mapping GDP per capita versus the EU-RHDI, the health dimension, knowledge dimension, and income dimension (all 2011; N = 272)









Fourth, changes in GDP per capita do not readily translate into changes in the EU-RHDI or its underlying dimensions. Table 14 shows correlations between on the one hand growth in GDP per capita and on the other hand growth in the EU-RHDI and the underlying dimensions. It is clear that growth in GDP per capita is not completely on par with growth in the EU-RHDI. In other words, the EU-RHDI captures something different than GDP per capita; a broader definition of human development makes a difference to our objectives and measurement of progress and, as such, has important policy implications.

Table 14. Correlations among growth in GDP per capita, EU-RHDI, and underlying dimensions (2006-2010; N=272)

	Correlation with GDP per capita growth (2006-2011)	Rank correlation with GDP per capita growth (2006-2011)
Growth in EU-RHDI (2006-2011)	0.76	0.78
Growth in health (2006-2011)	0.44	0.37
Growth in knowledge (2006-2011)	0.46	0.56
Growth in income (2006-2011)	0.69	0.78

Note: all correlations are statistically significant at $\alpha \leq 0$.

7. Statistical coherence and robustness assessment

Monitoring human development at the regional level across time within the European Union raises practical challenges related to choice of variables and the combination of these into a single composite indicator. Notwithstanding recent proposals to establish best practice in the construction of composite indicators (OECD/JRC, 2008), there exists no single best way to construct one (Cherchye et al., 2007). This may in part be due to the ambivalent role of composite indicators in balancing between analysis and advocacy (Saltelli, 2007). As the boundaries between analysis and advocacy, science and policy are often blurred, controversy may arise when assessing the outcomes of composite indicators.

Anticipating on such controversies, in the construction of a composite indicator on human development it is important to take into account existing methodologies in order to avoid biases in the outcomes of the analysis and, consequently decisions made thereupon. Acknowledging the variety of assumptions involved in the construction of an index, it is possible to determine to what extent the outcomes change when the underlying assumptions change (Saisana et al., 2011, Saltelli et al., 2008). In doing so, we are able to gauge the robustness of the proposed index and increase transparency about its construction.

This section discusses the robustness of the EU-RHDI along two main axes: the statistical coherence of the adopted framework and the impact of key modelling assumptions on the regions' rankings. These are necessary steps to ensure the transparency and reliability of the index, to enable policymakers to derive informed and meaningful conclusions, and to potentially guide choices on priority setting and policy formulation (Saisana et al., 2011, Saltelli et al., 2008). The statistical coherence is carried out using correlation and principal component analysis (section 7.1). The key modelling assumptions tested are (i) weighting based on equal importance of dimensions versus weighting based on equal weights of dimensions and (ii) the inclusion and exclusion of alternative variables in the composition of the index (section 7.2).

7.1. Statistical coherence: correlation and principal component analysis

Correlation analysis was performed in order to reconfirm that the transformed underlying variables of the EU-RHDI correlate positively and substantially with both the overall index and their respective dimensions. Table 15 reports on the results of this analysis. All variables correlate positively and substantially with their respective dimensions. In fact, all variables also correlate positively and significantly with the dimensions they have not been assigned to. Note then that the dimension scores correlate more with variables assigned to them than with the variables not assigned to them. The correlation structure of the variables with the dimensions and the overall index thus provides a first indication that these variables in fact measure different dimensions to the same underlying phenomenon; that is human development.

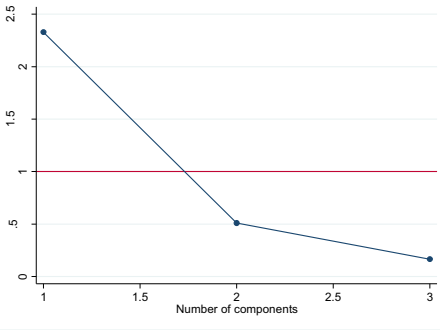
Table 15. Correlations between variables and the EU-RHDI and its different dimensions (N=1904; 7 years; 272 regions)

	EU-RHDI	Health	Knowledge	Income
Healthy life expectancy	0.78	0.85	0.44	0.71
Infant mortality	0.72	0.88	0.41	0.56
NEET	0.68	0.35	0.83	0.69
General teriary education	0.65	0.45	0.79	0.54
Net disposable household income	0.88	0.81	0.57	0.88
Employment rate	0.81	0.49	0.78	0.89

Note: all correlations are statistically significant at $\alpha \leq 0.01$

Table 16. Results principal component analysis of the overall index (N=1904; 7 years; 272 regions)

Component	Eigenvalue	Difference	Proportion	Cumulative
1	2.33	1.81	0.78	78%
2	0.51	0.35	0.17	95%
3	0.16		0.05	100%



Dimension	Coefficient 1st component	Correlation with 1st component
Health	0.55	0.84
Knowledge	0.56	0.85
Income	0.62	0.95

In addition, we performed principal component analysis (PCA) at the overall index level as to assure that the three underlying dimensions indeed capture a similar latent phenomena; that is, human development at the EU regional level. Ideally, a latent factor shows a unique, most relevant principal component which accounts for a large amount of variability. Such a result would provide further justification for summarizing the dimensions by a single combined index. In the ideal case where all dimensions are placed on equal footing with respect to the overall index, they should contribute roughly in the same extent to the variation of the overall scores and with the same orientation to the first principal component. This type of information can be derived from the strength of the correlation between the variables and the first principal component. Note that the higher the correlation, the less influence any adjustment of weights may have on their aggregation (Hagerty and Land, 2007, Michalos, 2011, OECD/JRC, 2008). Table 16 presents the results of the PCA we carried out in order to test whether the three dimensions taken together are associated with a single latent dimension. The results show that there is indeed a single latent dimension within the 3 dimensions; hence these

dimensions express different aspects of the same phenomenon. Only the first component shows an eigenvalue which is greater than 1 rendering it to account for an amount of variability that exceeds 60% of total variability.

7.2. Robustness assessment

This section discusses the difference in scores and ranks when (i) weighting the underlying dimension of the index based on equal importance or based on equal weights (as in the EU-RHDI) and (ii) including alternative (sets) of variables in the construction of the index. In order to test the simultaneous and joint impact of these (alternative) choices, we constructed a number of alternative indexes. Table 17 lists the different scenarios considered for performing the uncertainty analysis. Given that we considered two alternatives for the setting of weights, four alternatives for the set of variables included in the health dimensions, three alternatives for the set of variables included in the knowledge dimension, and four alternatives for the set of variables included in the income dimension, we considered 71 alternative indexes in total. However, from this set of indexes we excluded those indexes for which the approximation of weights based on equal importance rendered negative weights for one of the three dimensions. Appendix A lists the details of all individual indexes considered. After calculating the scores of the alternative indexes, we compared the median scores and ranks of the alternative indexes in 2012 with the scores and ranks of the proposed index in 2012. The results of this comparison are reported in Table 18 and appendix B presents ranking properties of 2012 for individual regions.

Both correlation of scores ad rank correlation are statistical significant ($\alpha \leq 0.01$) and greater than 0.95. Hence, overall the proposed index and the alternatives are fairly similar both in scores and ranks. Nevertheless, shifts in ranking still occur. On average, regions shift close to 18 ranks when comparing the EU-RHDI with the alternatives; this amounts to less than 10% of the number of observations. The maximum amount of rank shifts is 94. In general, rank shifts occur less frequent in the 1st, 2nd (taken together the bottom 40%) and 5th quintile (top 20%) of the distribution of scores and more frequent in the intermediate quintiles (40%-80% of the distribution of scores). Still, 57 regions shift 27 ranks or more. Arguably then, given that a considerable amount of regions shift 27 positions (i.e. roughly 10% of all observations in one year), it can be argued that the composite indicator is volatile as to the methodological choices made. Although the EU-RHDI correlates extremely high with all alternatives considered, the ranking of individual regions might change when considering alternative sets of variables and weights. Overall, though, we believe that the proposed EU-RHDI is justified based on both conceptual and statistical considerations.

Table 17 Scenarios for uncertainty analysis: alternative weights and variables

I. Uncertainty in the treatment of weights
Reference: Weights assigned based on equal shares Alternative: Weights assigned based on an approximation of equal importance
II. Uncertainty in the choice of variables
Reference: Health: Healthy life expectancy and infant mortality Knowledge: NEET and general tertiary education Income: net adjusted disposable household income and employment Alternatives: Health: life expectancy and infant mortality or healthy life expectancy or life expectancy Knowledge: secondary education and general tertiary education or general tertiary education Income: net adjusted disposable household income and long term unemployment or net adjusted disposable household income

Table 18 Comparison of scores and ranks between EU-RHDI 2012 and the median scores and ranks of alternatives in 2012

Correlation of scores	0.96
Rank correlation	0.96
Average rank shift	18
Minimum rank shift	0
Maximum rank shift	94
Average rank difference 1st quintile	8
Average rank difference 2nd quintile	14
Average rank difference 3rd quintile	23
Average rank difference 4th quintile	28
Average rank difference 5th quintile	15

In order to address the sources of the differences in ranks (i) we compared indexes based on weights using equal shares with indexes based on weights using equal importance whilst keeping the variables included constant[15] and (ii) we compared the EU-RHDI 2012 with alternative indexes using different

[15] Unfortunately, due to the negative weight assigned to the income dimension for the same index based on equal importance weighting, we cannot meaningfully compare the index based on equal share weights with the alternative based on equal importance weights. Instead, therefore, we compare each alternative index based on equal share weighting with its equivalent based on equal importance weighting.

combinations of variables whilst keeping the weighting scheme fixed and assigned equally. The results of these comparisons are reported in Table 19. Although the maximum number of shifts in rank is higher for changing the weights than for changing the variables, overall changing the variables seems to have a larger impact on shifts in rank than changing the weighting procedure. The average of average and median rank differences is substantially larger for changing the variables than for changing the weights. Also, the standard deviations of average and median rank differences are substantially larger for changing the variables than for changing the weights. This suggests that volatility in ranking is largely attributable to the choice of variables rather than the choice of weighting procedure. In other words, and as a concluding remark, the choice of (sets of) variables is particularly important as it is the most important source of volatility in the overall index.

Table 19 Comparison of sources of uncertainty: changing weights versus changing variables

	Change in weights	Change in variables
Average of average rank differences	12	20
Average of median rank differences	10	18
Minimum rank difference	0	0
Maximum rank difference	136	125
Standard deviation of average rank differences	8.73	63.29
Standard deviation of median rank differences	8.07	55.44

8. Conclusion

8.1. Summary

The measurement of human development goes well beyond measuring Gross Domestic Product (GDP). This has been recognized not only by the European Commission (2009) with its communication on "GDP and beyond" but also by such organizations like the OECD with its "Global Project on Measuring the Progress of Societies". However one defines human development; this is a call for going beyond monetary and market aspects alone in measuring human development. In order to come to terms with the general call for a measure of human development that goes beyond GDP, the objective of this report was to develop a composite indicator on human development that (i) is applicable to the European context, (ii) takes the region instead of the country as the basic unit of analysis, and (iii) enables one to compare regions both cross-sectional as well as over time.

The report follows from a project entitled "Regional Human Development" on request of the Directorate-General Regional and Urban Policy (DG REGIO) of the European Commission. The main objective of the overall project is to develop indicators that are capable of measuring and monitoring patterns and trends in human development across the regions of the EU member states. The main contribution of this report lays in a proposal for conceptualizing and measuring human development at the EU regional level using a composite indicator approach.

First, we developed a conceptual framework that provides the basis for the selection of variables to include in a composite indicator on human development. Drawing upon the notion of human development as an essentially contested concept, we discussed three different perspectives on human development and propose seeking to include all three in our measurement of human development. These three perspectives involve the basic needs perspective, the utilitarian perspective, and the perspective of freedom on human development. It is argued that, by including multiple perspectives on human development in our measurement of this complex phenomenon, we can arrive at a better appreciation of the state and nature of human development across EU regions. Second, therefore, we collected variables which cover these three different perspectives as much as possible. Herein, we took the existing human development index proposed by the United Nations (UN-HDI) as our framework to collect variables covering different dimensions to human development. These dimensions are health, knowledge, and income. In total we collected 22 variables covering all perspectives for the health dimension and two out of three dimensions for the knowledge and income dimension. For conceptual and statistical reasons we decided to included only a sub set of these in our final composite. In all, we propose to include 2 variables in each dimension: healthy life expectancy and infant mortality in the health dimension; not in employment, education or training (NEET) and general tertiary education in the knowledge dimension; and net adjusted disposable household income and the employment rate in the income dimension. Third, after imputing missing data using an expectation maximization (EM) approach and transforming variables as to make them comparable, we assigned weights equally to the three dimensions and subsequently we aggregated variables using the arithmetic average within dimensions and dimensions were aggregated using the geometric average within the overall index.

The results of the EU-RHDI show a clear north-west/south-east divide across EU regions when it comes to the overall index. Within countries differences exist as to regional performance in human development. This is especially so for the United Kingdom, Belgium, France, Ireland, Slovenia, Spain, Czech Republic, and Italy. In general, capital city regions seem to outperform non-capital city regions within countries. This is especially so for regions in eastern EU member states where the large intra-country differences in scores are largely driven by the capital city outperforming all other regions by a length. As to the ranking of the EU-RHDI, we again find northern and western regions of the EU topping the rank while southern and especially eastern EU regions are found at the bottom. While the bottom-20 regions rank generally low on all dimensions and in all years, for the top-20 regions we find volatility in both the underlying dimensions and across years. As a final remark on the results, zooming in on the individual dimensions, we find in general that the EU is especially characterized by a west/east divide. In health, southern regions are often outperforming northern regions. However, southern regions' relative good performance in health contrasts sharply with their underperformance in income and especially knowledge.

Finally, we performed robustness analysis to assess the volatility of the proposed composite indicator to the particular methodological choices made throughout its construction. As indicated by correlation analysis and principal component analysis there is one latent component indicating that they potentially describe one latent phenomenon; that is human development. Arguably, the composite indicator is volatile as to the choice of variables included. Although the EU-RHDI correlates extremely high with all alternatives considered, the ranking of individual regions might change when considering alternative sets of variables. Nevertheless, we believe that, overall, the proposed index is justified based on both conceptual and statistical considerations.

8.2. Discussion and recommendations

Before turning to the implications of our work, one issue requires further attention; that is the issue of volatility of the index that goes beyond technical issues (for similar remarks see also Hardeman et al., 2013). From the robustness assessment we concluded that the proposed index on human development is both conceptually and statistically sound. However, it needs to be stressed that the robustness assessment of the index was restricted to the perspectives and variables included in the analysis only.

For one thing, in defining human development with reference to three perspectives only, other perspectives (most prominently one on sustainability) are excluded from the assessment. Also, some data that are not available might shed a different light on the phenomenon of human development altogether. On top of performing robustness analysis, what is needed in addition is performing what has been called sensitivity auditing that goes beyond an assessment of technical (i.e. mathematical and statistical) uncertainties to include an exploration of the broader space of assumptions underlying the particular conceptual models and data used (Saltelli et al., 2012). Hence, we take the proposed composite indicator on human development as a necessary step to inform research policymakers, but also as a first and preliminary step in the ongoing debate on measuring human development in the

context of EU regions and informing policymakers therewith. In all, the validity of the proposed composite indicator on human development does not just depend on its statistical soundness rather than on the indicator being accepted by the community of people it seeks to address.

From the analysis and results presented in this report we make two recommendations. One recommendation revolves the use of the proposed composite indicator on human development as an input to the broader debate on measuring and monitoring human development at the regional level. As argued, we take the proposed composite indicator on human development as a necessary but also preliminary step to inform development policymakers. Human development is an important issue, an issue that concerns each and every citizen of the EU. As it concerns everyone but as the same time is essentially contested, we deem it necessary if not inevitable to include different voices in the construction of a valid indicator on human development. This is and needs to be an ongoing project. As argued, the validity of an indicator does not just depend on its statistical soundness rather than on the indicator being accepted by the community of people it seeks to address.

Another recommendation concerns the necessity of collecting and using alternative data and methods for the analysis. Some data might be nearby; others further away, not to say out of range altogether. Recall here that the currently proposed index covers some perspectives on human development better than others mainly because of a lack of data. Most in particular, we had to exclude data covering the utilitarian dimension, rendering that perspective eventually completely absent in our measurement of human development. However, and notwithstanding the difficulties in collecting alternative data that capture human development at the EU regional level, measuring and monitoring human development appropriately would greatly benefit from alternative data becoming available. As to using alternative methods, given that the results of the robustness analysis show that the proposed composite indicator is sensitive to particular methodological choices, these choices need to be discussed more thoroughly and might need to be revised in the future.

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Appendix A[16]

Index	Variables health dimension	Variables knowledge dimension	Variables income dimension	Weight health dimension	Weight knowledge dimension	weight income dimension
Reference	Healthy life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 1	Life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 2	Healthy life expectancy	NEET + General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 3	Life expectancy	NEET + General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 4	Healthy life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 5	Life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 6	Healthy life expectancy	Secondary education + General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 7	Life expectancy	Secondary education + General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 8	Healthy life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 9	Life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 10	Healthy life expectancy	General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 11	Life expectancy	General tertiary education	Net adj. disp. household income + Employment	0.33	0.33	0.33
Alternative 12	Healthy life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 13	Life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 14	Healthy life expectancy	NEET + General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33

[16] The alternative indexes not considered in the uncertainty analysis due to negative weights being assigned to one dimension are shaded in grey. These are alternatives 36, 38, 39, and 51.

Index	Variables health dimension	Variables knowledge dimension	Variables income dimension	Weight health dimension	Weight knowledge dimension	weight income dimension
Alternative 15	Life expectancy	NEET + General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 16	Healthy life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 17	Life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 18	Healthy life expectancy	Secondary education + General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 19	Life expectancy	Secondary education + General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 20	Healthy life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 21	Life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 22	Healthy life expectancy	General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 23	Life expectancy	General tertiary education	Net adj. disp. household income + Long term unemployment	0.33	0.33	0.33
Alternative 24	Healthy life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 25	Life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 26	Healthy life expectancy	NEET + General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 27	Life expectancy	NEET + General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 28	Healthy life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 29	Life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 30	Healthy life expectancy	Secondary education + General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 31	Life expectancy	Secondary education + General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 32	Healthy life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 33	Life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 34	Healthy life expectancy	General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 35	Life expectancy	General tertiary education	Net adj. disp. household income	0.33	0.33	0.33
Alternative 36	Healthy life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income + Employment	0.37	0.66	-0.03

Index	Variables health dimension	Variables knowledge dimension	Variables income dimension	Weight health dimension	Weight knowledge dimension	weight income dimension
Alternative 37	Life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income + Employment	0.31	0.68	0.01
Alternative 38	Healthy life expectancy	NEET + General tertiary education	Net adj. disp. household income + Employment	0.33	0.78	-0.12
Alternative 39	Life expectancy	NEET + General tertiary education	Net adj. disp. household income + Employment	0.34	0.79	-0.13
Alternative 40	Healthy life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income + Employment	0.40	0.51	0.09
Alternative 41	Life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income + Employment	0.36	0.55	0.09
Alternative 42	Healthy life expectancy	Secondary education + General tertiary education	Net adj. disp. household income + Employment	0.29	0.49	0.22
Alternative 43	Life expectancy	Secondary education + General tertiary education	Net adj. disp. household income + Employment	0.37	0.56	0.07
Alternative 44	Healthy life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income + Employment	0.36	0.38	0.26
Alternative 45	Life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income + Employment	0.34	0.40	0.26
Alternative 46	Healthy life expectancy	General tertiary education	Net adj. disp. household income + Employment	0.29	0.37	0.33
Alternative 47	Life expectancy	General tertiary education	Net adj. disp. household income + Employment	0.35	0.40	0.25
Alternative 48	Healthy life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income + Long term unemployment	0.31	0.56	0.13
Alternative 49	Life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income + Long term unemployment	0.27	0.56	0.17
Alternative 50	Healthy life expectancy	NEET + General tertiary education	Net adj. disp. household income + Long term unemployment	0.30	0.67	0.03
Alternative 51	Life expectancy	NEET + General tertiary education	Net adj. disp. household income + Long term unemployment	0.31	0.70	-0.02
Alternative 52	Healthy life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income + Long term unemployment	0.29	0.42	0.30
Alternative 53	Life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income + Long term unemployment	0.28	0.45	0.27
Alternative 54	Healthy life expectancy	Secondary education + General tertiary education	Net adj. disp. household income + Long term unemployment	0.20	0.39	0.40
Alternative 55	Life expectancy	Secondary education + General tertiary education	Net adj. disp. household income + Long term unemployment	0.29	0.47	0.24

Index	Variables health dimension	Variables knowledge dimension	Variables income dimension	Weight health dimension	Weight knowledge dimension	weight income dimension
Alternative 56	Healthy life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income + Long term unemployment	0.23	0.30	0.47
Alternative 57	Life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income + Long term unemployment	0.24	0.31	0.45
Alternative 58	Healthy life expectancy	General tertiary education	Net adj. disp. household income + Long term unemployment	0.20	0.29	0.52
Alternative 59	Life expectancy	General tertiary education	Net adj. disp. household income + Long term unemployment	0.25	0.31	0.44
Alternative 60	Healthy life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income	0.24	0.64	0.11
Alternative 61	Life expectancy + Infant mortality	NEET + General tertiary education	Net adj. disp. household income	0.25	0.67	0.07
Alternative 62	Healthy life expectancy	NEET + General tertiary education	Net adj. disp. household income	0.26	0.65	0.10
Alternative 63	Life expectancy	NEET + General tertiary education	Net adj. disp. household income	0.30	0.68	0.02
Alternative 64	Healthy life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income	0.26	0.57	0.17
Alternative 65	Life expectancy + Infant mortality	Secondary education + General tertiary education	Net adj. disp. household income	0.32	0.59	0.09
Alternative 66	Healthy life expectancy	Secondary education + General tertiary education	Net adj. disp. household income	0.22	0.57	0.21
Alternative 67	Life expectancy	Secondary education + General tertiary education	Net adj. disp. household income	0.33	0.59	0.08
Alternative 68	Healthy life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income	0.31	0.49	0.21
Alternative 69	Life expectancy + Infant mortality	General tertiary education	Net adj. disp. household income	0.36	0.51	0.13
Alternative 70	Healthy life expectancy	General tertiary education	Net adj. disp. household income	0.29	0.47	0.24
Alternative 71	Life expectancy	General tertiary education	Net adj. disp. household income	0.37	0.50	0.13

Appendix B

Region	EU-RHDI 2012	Median rank	Absolute difference	Highest rank	Lowest rank
Burgenland (AT) (AT)	124	166	42	117	225
Niederösterreich (AT)	91	144	53	83	197
Wien (AT)	122	110.5	11.5	85	134
Kärnten (AT)	113	143	30	101	196
Steiermark (AT)	79	126.5	47.5	63	185
Oberösterreich (AT)	61	137.5	76.5	50	192
Salzburg (AT)	30	85.5	55.5	19	160
Tirol (AT)	62	118.5	56.5	45	170
Vorarlberg (AT)	87	135	48	59	181
Région de Bruxelles-Capitale (BE)	151	83	68	22	169
Prov. Antwerpen (BE)	103	63	40	34	103
Prov. Limburg (BE) (BE)	105	79	26	48	119
Prov. Oost-Vlaanderen (BE)	66	49.5	16.5	31	84
Prov. Vlaams-Brabant (BE)	20	10	10	5	27
Prov. West-Vlaanderen (BE)	65	59	6	24	96
Prov. Brabant Wallon (BE)	78	13.5	64.5	3	78
Prov. Hainaut (BE)	186	171.5	14.5	132	202
Prov. Liège (BE)	161	141	20	88	174
Prov. Luxembourg (BE) (BE)	132	108	24	65	160
Prov. Namur (BE)	137	106	31	58	170
Severozapaden (BG)	272	271	1	255	272
Severen tsentralen (BG)	266	265.5	0.5	243	271
Severoiztochen (BG)	263	263	0	241	270
Yugoiztochen (BG)	269	266	3	236	271
Yugozapaden (BG)	198	196	2	158	256
Yuzhen tsentralen (BG)	267	265	2	239	269
Kýpros (CY)	136	69	67	36	152
Praha (CZ)	51	61	10	6	165
Střední Čechy (CZ)	154	184	30	135	231
Jihozápad (CZ)	171	189.5	18.5	151	236
Severozápad (CZ)	225	241	16	214	264
Severovýchod (CZ)	188	199	11	176	245
Jihovýchod (CZ)	174	183.5	9.5	134	218
Střední Morava (CZ)	183	198.5	15.5	169	244
Moravskoslezsko (CZ)	192	212.5	20.5	174	249
Stuttgart (DE)	16	27	11	8	51
Karlsruhe (DE)	27	38	11	15	61
Freiburg (DE)	14	39.5	25.5	10	75
Tübingen (DE)	13	27.5	14.5	9	52
Oberbayern (DE)	6	10	4	2	25
Niederbayern (DE)	64	96.5	32.5	46	163
Oberpfalz (DE)	34	69.5	35.5	30	128

Region	EU-RHDI 2012	Median rank	Absolute difference	Highest rank	Lowest rank
Oberfranken (DE)	48	81.5	33.5	40	133
Mittelfranken (DE)	15	44	29	13	81
Unterfranken (DE)	38	55	17	20	105
Schwaben (DE)	23	63	40	18	123
Berlin (DE)	68	51.5	16.5	30	93
Brandenburg (DE)	76	87.5	11.5	51	125
Bremen (DE)	140	122.5	17.5	83	165
Hamburg (DE)	49	50	1	25	69
Darmstadt (DE)	28	34	6	16	53
Gießen (DE)	56	62.5	6.5	40	91
Kassel (DE)	73	88	15	69	141
Mecklenburg-Vorpommern (DE)	97	121.5	24.5	66	159
Braunschweig (DE)	123	122	1	85	154
Hannover (DE)	83	89	6	65	121
Lüneburg (DE)	114	131.5	17.5	84	173
Weser-Ems (DE)	100	124	24	94	172
Düsseldorf (DE)	111	120.5	9.5	86	148
Köln (DE)	77	75	2	42	100
Münster (DE)	101	117	16	89	162
Detmold (DE)	86	109.5	23.5	55	159
Arnsberg (DE)	130	148.5	18.5	103	177
Koblenz (DE)	67	103	36	50	155
Trier (DE)	63	71	8	33	110
Rheinhessen-Pfalz (DE)	75	78	3	39	111
Saarland (DE)	118	130.5	12.5	108	167
Dresden (DE)	33	42	9	13	79
Chemnitz (DE)	60	78	18	38	122
Leipzig (DE)	39	48	9	18	96
Sachsen-Anhalt (DE)	99	125.5	26.5	69	161
Schleswig-Holstein (DE)	69	87.5	18.5	61	137
Thüringen (DE)	53	73.5	20.5	35	113
Hovedstaden (DK)	19	19	0	10	37
Sjælland (DK)	104	126.5	22.5	87	154
Syddanmark (DK)	82	102.5	20.5	63	125
Midtjylland (DK)	46	70	24	43	103
Nordjylland (DK)	58	87.5	29.5	52	127
Eesti (EE)	180	176.5	3.5	77	230
Anatoliki Makedonia, Thraki (EL)	246	241	5	209	261
Kentriki Makedonia (EL)	216	198	18	163	227
Dytiki Makedonia (EL)	247	235.5	11.5	202	253
Thessalia (EL)	214	199.5	14.5	168	230
Ipeiros (EL)	220	199	21	164	233
Ionia Nisia (EL)	203	221.5	18.5	190	246
Dytiki Ellada (EL)	227	220.5	6.5	197	252

Region	EU-RHDI 2012	Median rank	Absolute difference	Highest rank	Lowest rank
Sterea Ellada (EL)	245	231	14	206	259
Peloponnisos (EL)	249	232	17	205	269
Attiki (EL)	190	161	29	83	200
Voreio Aigaio (EL)	219	214.5	4.5	191	240
Notio Aigaio (EL)	210	207	3	193	239
Kriti (EL)	204	205.5	1.5	186	222
Galicia (ES)	155	152.5	2.5	69	176
Principado de Asturias (ES)	179	140	39	43	179
Cantabria (ES)	135	96.5	38.5	33	149
País Vasco (ES)	47	16	31	2	51
Comunidad Foral de Navarra (ES)	57	29	28	11	76
La Rioja (ES)	160	124.5	35.5	39	163
Aragón (ES)	133	100	33	31	147
Comunidad de Madrid (ES)	89	30.5	58.5	5	93
Castilla y León (ES)	142	114	28	37	154
Castilla-La Mancha (ES)	196	186	10	135	217
Extremadura (ES)	212	203	9	165	243
Cataluña (ES)	149	139.5	9.5	50	170
Comunidad Valenciana (ES)	189	173.5	15.5	99	195
Illes Balears (ES)	182	178	4	141	204
Andalucía (ES)	218	203	15	152	234
Región de Murcia (ES)	201	192.5	8.5	143	221
Ciudad Autónoma de Ceuta (ES)	251	232	19	176	252
Ciudad Autónoma de Melilla (ES)	235	223.5	11.5	175	247
Canarias (ES)	208	196.5	11.5	144	225
Länsi-Suomi (FI)	54	39	15	24	81
Helsinki-Uusimaa (FI)	5	5	0	2	13
Etelä-Suomi (FI)	42	38.5	3.5	25	85
Pohjois- ja Itä-Suomi (FI)	85	60	25	36	128
Åland (FI)	1	19.5	18.5	1	77
Île de France (FR)	31	13	18	3	31
Champagne-Ardenne (FR)	166	160	6	146	179
Picardie (FR)	176	179	3	162	215
Haute-Normandie (FR)	152	147.5	4.5	117	167
Centre (FR)	110	100.5	9.5	63	125
Basse-Normandie (FR)	125	126.5	1.5	98	151
Bourgogne (FR)	126	125	1	92	142
Nord - Pas-de-Calais (FR)	178	167.5	10.5	142	188
Lorraine (FR)	158	150	8	126	165
Alsace (FR)	117	93	24	59	117
Franche-Comté (FR)	139	139	0	106	158
Pays de la Loire (FR)	98	92.5	5.5	62	115
Bretagne (FR)	88	65.5	22.5	54	90
Poitou-Charentes (FR)	112	127.5	15.5	93	147

Region	EU-RHDI 2012	Median rank	Absolute difference	Highest rank	Lowest rank
Aquitaine (FR)	108	94.5	13.5	70	115
Midi-Pyrénées (FR)	71	37.5	33.5	19	71
Limousin (FR)	95	82	13	63	97
Rhône-Alpes (FR)	74	50	24	26	74
Auvergne (FR)	134	124	10	97	144
Languedoc-Roussillon (FR)	173	150	23	101	174
Provence-Alpes-Côte d'Azur (FR)	127	88.5	38.5	45	131
Corse (FR)	150	151	1	119	171
Guadeloupe (FR)	256	242	14	182	262
Martinique (FR)	237	199.5	37.5	124	248
Guyane (FR)	265	254	11	198	266
Réunion (FR)	257	237.5	19.5	173	263
Jadranska Hrvatska (HR)	239	228	11	189	261
Kontinentalna Hrvatska (HR)	250	250	0	228	271
Közép-Magyarország (HU)	191	185	6	119	217
Közép-Dunántúl (HU)	229	243.5	14.5	224	255
Nyugat-Dunántúl (HU)	221	237	16	209	253
Dél-Dunántúl (HU)	248	252	4	229	262
Észak-Magyarország (HU)	264	264	0	255	271
Észak-Alföld (HU)	252	257	5	235	267
Dél-Alföld (HU)	241	249.5	8.5	227	260
Border, Midland and Western (IE)	181	141.5	39.5	63	192
Southern and Eastern (IE)	128	52	76	18	131
Piemonte (IT)	169	189.5	20.5	149	216
Valle d'Aosta/Vallée d'Aoste (IT)	119	179	60	70	220
Liguria (IT)	165	170.5	5.5	131	190
Lombardia (IT)	146	174	28	111	201
Abruzzo (IT)	193	192	1	171	205
Molise (IT)	200	199.5	0.5	175	227
Campania (IT)	255	251	4	219	267
Puglia (IT)	243	243	0	203	262
Basilicata (IT)	234	230.5	3.5	194	249
Calabria (IT)	254	244	10	205	261
Sicilia (IT)	258	253	5	220	271
Sardegna (IT)	224	225	1	198	254
Provincia Autonoma di Bolzano/Bozen (IT)	84	178	94	40	213
Provincia Autonoma di Trento (IT)	147	166.5	19.5	79	195
Veneto (IT)	167	191	24	141	224
Friuli-Venezia Giulia (IT)	168	176	8	139	199
Emilia-Romagna (IT)	148	172.5	24.5	135	193
Toscana (IT)	156	178	22	137	210
Umbria (IT)	163	169	6	140	185
Marche (IT)	153	179	26	126	196
Lazio (IT)	184	172.5	11.5	149	214

Region	EU-RHDI 2012	Median rank	Absolute difference	Highest rank	Lowest rank
Lietuva (LT)	207	214.5	7.5	157	266
Luxembourg (LU)	8	7.5	0.5	1	26
Latvija (LV)	232	234	2	204	262
Malta (MT)	175	195.5	20.5	100	255
Groningen (NL)	94	106.5	12.5	26	174
Friesland (NL) (NL)	96	132.5	36.5	55	173
Drenthe (NL)	92	130.5	38.5	85	165
Overijssel (NL)	41	88.5	47.5	20	138
Gelderland (NL)	40	71.5	31.5	22	127
Flevoland (NL)	93	110	17	48	155
Utrecht (NL)	4	10.5	6.5	2	23
Noord-Holland (NL)	12	28	16	7	66
Zuid-Holland (NL)	24	49.5	25.5	13	93
Zeeland (NL)	59	130	71	47	167
Noord-Brabant (NL)	22	59.5	37.5	17	107
Limburg (NL) (NL)	72	121	49	36	167
Łódzkie (PL)	215	225	10	196	247
Mazowieckie (PL)	177	164	13	101	202
Ma?opolskie (PL)	205	197	8	161	231
Śląskie (PL)	223	216	7	190	232
Lubelskie (PL)	217	215	2	183	250
Podkarpackie (PL)	236	225	11	183	256
Świętokrzyskie (PL)	226	220.5	5.5	190	246
Podlaskie (PL)	213	207	6	177	241
Wielkopolskie (PL)	209	208.5	0.5	178	230
Zachodniopomorskie (PL)	238	230.5	7.5	204	245
Lubuskie (PL)	244	240	4	206	255
Dolno?l?skie (PL)	231	222.5	8.5	196	238
Opolskie (PL)	228	225.5	2.5	200	248
Kujawsko-Pomorskie (PL)	233	233.5	0.5	212	249
Warmińsko-Mazurskie (PL)	242	243	1	214	258
Pomorskie (PL)	211	203	8	173	232
Norte (PT)	199	223.5	24.5	182	269
Algarve (PT)	202	218.5	16.5	189	263
Centro (PT) (PT)	195	219.5	24.5	179	267
Lisboa (PT)	187	184	3	150	226
Alentejo (PT)	197	235	38	193	270
Região Autónoma dos Açores (PT)	240	258	18	227	272
Região Autónoma da Madeira (PT)	222	245	23	206	271
Nord-Vest (RO)	253	256	3	223	263
Centru (RO)	268	263	5	241	270
Nord-Est (RO)	262	264	2	241	271
Sud-Est (RO)	271	271	0	266	272
Sud - Muntenia (RO)	270	269.5	0.5	258	271

Region	EU-RHDI 2012	Median rank	Absolute difference	Highest rank	Lowest rank
Bucureşti - Ilfov (RO)	185	162	23	137	194
Sud-Vest Oltenia (RO)	261	263	2	232	268
Vest (RO)	260	259	1	233	266
Stockholm (SE)	2	3	1	1	9
Östra Mellansverige (SE)	26	37	11	16	55
Småland med öarna (SE)	29	56.5	27.5	25	92
Sydsverige (SE)	25	27.5	2.5	15	45
Västsverige (SE)	11	22	11	9	34
Norra Mellansverige (SE)	52	77.5	25.5	46	117
Mellersta Norrland (SE)	44	64	20	40	101
Övre Norrland (SE)	37	39	2	22	74
Vzhodna Slovenija (SI)	172	179	7	132	201
Zahodna Slovenija (SI)	115	108	7	24	175
Bratislavský kraj (SK)	107	105.5	1.5	38	181
Západné Slovensko (SK)	206	223	17	197	255
Stredné Slovensko (SK)	230	239.5	9.5	205	264
Východné Slovensko (SK)	259	257	2	235	271
Tees Valley and Durham (UK)	164	140	24	119	183
Northumberland and Tyne and Wear (UK)	121	105	16	81	157
Cumbria (UK)	90	85	5	66	118
Greater Manchester (UK)	143	108.5	34.5	70	165
Lancashire (UK)	141	105.5	35.5	60	171
Cheshire (UK)	45	24.5	20.5	10	82
Merseyside (UK)	144	132.5	11.5	107	166
East Yorkshire and Northern Lincolnshire (UK)	170	150.5	19.5	130	207
North Yorkshire (UK)	18	19	1	11	44
South Yorkshire (UK)	157	142.5	14.5	111	174
West Yorkshire (UK)	159	131.5	27.5	89	176
Derbyshire and Nottinghamshire (UK)	109	91	18	64	146
Leicestershire, Rutland and Northamptonshire (UK)	116	98.5	17.5	61	153
Lincolnshire (UK)	129	124.5	4.5	100	157
Herefordshire, Worcestershire and Warwickshire (UK)	43	34.5	8.5	20	87
Shropshire and Staffordshire (UK)	138	121.5	16.5	77	167
West Midlands (UK)	194	168.5	25.5	125	218
East Anglia (UK)	80	59.5	20.5	30	124
Bedfordshire and Hertfordshire (UK)	17	13	4	8	24
Essex (UK)	102	83.5	18.5	62	153
Inner London (UK)	3	1	2	1	4
Outer London (UK)	32	10.5	21.5	5	42
Berkshire, Buckinghamshire and Oxfordshire (UK)	9	4	5	2	15
Surrey, East and West Sussex (UK)	10	5	5	2	16
Hampshire and Isle of Wight (UK)	21	18	3	10	34
Kent (UK)	81	53	28	41	110

Region	EU-RHDI 2012	Median rank	Absolute difference	Highest rank	Lowest rank
Gloucestershire, Wiltshire and Bristol/Bath area (UK)	36	25	11	18	58
Dorset and Somerset (UK)	35	35	0	24	53
Cornwall and Isles of Scilly (UK)	131	94	37	44	156
Devon (UK)	70	35.5	34.5	17	105
West Wales and The Valleys (UK)	162	120	42	95	189
East Wales (UK)	106	56	50	36	134
Eastern Scotland (UK)	55	20.5	34.5	10	81
South Western Scotland (UK)	120	55.5	64.5	28	129
North Eastern Scotland (UK)	7	9	2	4	18
Highlands and Islands (UK)	50	38	12	26	86
Northern Ireland (UK)	145	129	16	88	166

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