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On the use of composite indices in economic history. Lessons from Italy, 1861-2017

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Abstract

We argue against the use of composite indices, such as the Human Development Index, in economic history. We show that composite indices can be interpreted as paternalistic social welfare functions (PSWF), and therefore are nothing more than a formal representation of the analyst's ethical system. This contrasts with the use economic historians typically make of composite indices, as tools to lend objectivity to the measurement of multidimensional phenomena. We support our claim by introducing a new constant-elasticity-of-substitution SWF family, which a) encompasses all composite indices put forth by the literature, and b) identifies the analyst's implicit preferences by means of standard tools, e.g. marginal rates of substitution and elasticity of substitution parameters. The theoretical framework is illustrated by an empirical investigation of the long-run evolution of Italians' living standards (1861-2017). We show how any history based on composite indices is one where both data and history play a minor role, if any.

Keywords: human development; composite indices; living standards; social welfare functions; Italy.
JEL classification: N01, N3, O15.

1 Introduction

Composite indices have found fertile ground in economic history. They emerged in the 1960s from a growing dissatisfaction with the one-dimensional monetary macroeconomic or welfare indicators, and seem to satisfy a need for an objective, synthetic measure of complex, typically multidimensional, phenomena (Land and Michalos 2018). Many composite indices have been proposed but, since its launch in 1990, the Human Development Index (HDI) has become the most popular. The HDI combined *a)* essentiality ('just one number, as vulgar as the GDP'; UNDP 1999: 23), *b)* authority deriving from its creators, the UNDP and some of the most renowned scholars of the time, most notably Amartya Sen, and *c)* the fascination of the capability approach to development it aimed to capture (Haq 2003: 127). Since the late 1990s, when several leading economic historians used the HDI to survey the course of development across a range of countries, it has become a standard item in the discipline's toolbox.[1]

In this paper, we argue that the use of composite indicators in economic history is fraught with conceptual difficulties. Ultimately, and this is the first point we make, the use of a composite index directly reflects the preferences of its creator, with no clear connection to the preferences of the individuals whose lives are being described. Following de Graaff (1957), we interpret the HDI as a *paternalistic* social welfare function. This amounts to say that the ethical system of the analyst is imposed on the reader and, more importantly, on the individuals of the society under scrutiny. Economic historians are well aware of the subjectivity of the weighting system embedded in any composite indicator (Decanq and Lugo 2013), but this has nothing to do, as we will show, with the paternalistic nature of the HDI. It is the absence of any analytical connection, in terms of the traditional value theory, between individual well-being and the HDI that leads us to challenge the increasing hegemony of composite indices as a way to carry out economic history analysis.

The second contribution of this paper is to take seriously the implicit preferences of economic historians. We bring them to light by analysing marginal rates of substitution (MRS) for most of the HDI formulas adopted in economic history (Ravallion 2011). MRSs reveal the implicit value judgments imposed by the researcher, and the

[1] See Costa and Steckel (1995), Floud and Harris (1996), Crafts (1997, 2002), Boyer (2007), Prados de la Escosura (2010, 2013, 2015, 2016, 2018).

conclusion is that those applied by economic historians so far differ greatly, and are sometimes difficult to accept. To generalize this point, we explore the use of a new specification of the HDI based on the constant elasticity of substitution (CES) utility (or production) function. Our CES-HDI turns out to be a convenient tool for revealing ethical judgments hidden in composite indices formulas. In a CES-based HDI, the elasticity of substitution parameter determines the degree of substitutability among the socio-economic indicators that enter the definition of the index: by varying this parameter, we can a) reproduce all the HDI versions adopted by economic historians, and b) identify their ethical systems. The CES-HDI reveals what HDI hides.

If we interpret the HDI as a *cardinal* measure – as most authors seem to have done in the past – then we find that the choice of the substitution parameter determines the results: however subjective is the choice of the former, equally subjective are the latter. If, instead, we interpret the HDI as an *ordinal* measure – as envisaged by its original proponents but embraced by few, if any, economic historians – then we find that the rank of the index is robustly identified only when its constituent elementary indicators are positively correlated (as is the case, typically, with income, education and health outcomes). In practice, economic historians have often been interested in using composite indices to resolve puzzling contradictions in the evidence, cases in which elementary indicators show diverging trends – think, for instance, to income and heights during industrialisation (Engerman 1997, Crafts 1997a). We find that in the presence of negatively correlated indicators, composite indices fail to deliver robust results, even when interpreted as ordinal indices.

After setting out the theoretical framework for composite indices, we illustrate our arguments using post-unification Italy (1861 to the present day) as a case study. Between 1922 and 1943, Italians lived "under the axe" of the first fascist regime: indices of civil and political rights are negatively correlated with the HDI's components: income, longevity, and schooling (Amendola et al. 2017). This circumstance, combined with the abundance of high-quality, long-run estimates of several socio-economic indicators (Toniolo 2013, Vecchi 2011, 2017), provides us with all the necessary ingredients to test the inter-temporal properties of composite indices. Our conclusion is clear: the history of Italians' living standards, as identified by any composite index, is *necessarily* and *entirely* subjective. Whether the HDI is interpreted

as an ordinal or cardinal index is irrelevant: results depend entirely on the choice of the substitution parameter, that is, on the analyst's preferences. In this sense, the HDI is an emblematic case where the judgment of historians replaces that of history.

The rest of the paper is organized as follows: Section 2 reviews the use of composite indices in economic history; Section 3 focuses on the HDI applied to Italian long-run economic development; Section 4 provides the conceptual framework to interpret the HDI as a paternalistic social welfare function. In Section 5 we shed light on the pros and cons of the many versions of the HDI proposed in the economic history literature, introducing a new generalized CES-HDI. Section 6 further discusses the CES-HDI, extending it along the lines of Dasgupta and Weale (1992). Section 7 concludes.

2 The HDI and economic history

Looking back at the literature in the 1960s and 1970s, one realizes that considerable effort has gone into replacing or supplementing GDP as an indicator of socio-economic development (Hicks and Streeten, 1979: 572). Some authors proposed to *adjust* the GDP, to account for the monetary value of aspects of human development it neglects, such as pollution or longevity. Usher (1973, 1980), for instance, proposed a method to adjust GDP per capita for longevity, while Williamson (1984: 162) proposed a revised version of this last index to correct for the endogeneity of secular improvements in mortality and income.

Other scholars chose an alternative route in devising composite indices that, instead of adjusting GDP, aggregated several indicators of development into a single number. Morris (1977) introduced the Physical Quality of Life Index (PQLI), an arithmetic mean of literacy, infant mortality and life expectancy at age one. He argued in favour of a 'historical PQLI', and estimated it back to the 19th century, for countries as diverse as Sri Lanka and the US (Morris 1979: 74). The PQLI attracted the interest of economic historians: to mention one case, Federico and Toniolo (1991) estimated decadal series from 1870 to 1910, comparing Italy to England, France and Belgium.

The PQLI was soon buried by the HDI, launched by the United Nations Development Program (UNDP) in 1990. In its initial formulation, the HDI was defined as a simple, arithmetic mean:

(1) $$HDI = \frac{1}{3}I_E + \frac{1}{3}I_S + \frac{1}{3}L_Y$$

where the terms on the right-hand side stand for life expectancy at birth (I_E), literacy (I_S), and income (L_Y). Contrary to the components of the PQLI, which can be easily expressed on a common 0 to 100 basis, the ingredients of the HDI must be made comparable. Each component x is normalized between 0 and 1 as follows: $I_x = (x_t - \underline{x})/(\overline{x} - \underline{x})$, where $\overline{x}$ and $\underline{x}$ stand for the maximum and minimum value of variable x, respectively. The notation L_Y signals that per capita GDP (y_t) is transformed by applying the natural logarithm to $y_t, \overline{y}$ and $\underline{y}$, to convey the idea of diminishing returns of income for wellbeing[2].

The HDI found simultaneous applications on both shores of the Atlantic, in parallel debates on living standards and industrialisation – the so-called 'antebellum puzzle' in the U.S. (Komlos 2012), and the 'quality of life' in Industrial Revolution Britain (Voth 2003). In 1997, in Chicago, Richard Steckel and Roderick Floud edited an NBER volume, *Health and Welfare during Industrialization*, where a wide array of contributors expressed confidence in the fact that composite indicators would strengthen our understanding and interpretation of history. Engerman (1997: 33) emphasized the advantages offered by these new (composite) indices of welfare, including the PQLI, the HDI, and the Dasgupta-Weale Index (DWI). Other authors, while joining the enterprise, expressed awareness of the analytical limitations of these tools. Costa and Steckel (1997: 71), for example, stressed that 'of particular concern in economic history is the choice of indicators and the selection of maximum and minimum values'; similarly, in the monograph's epilogue Steckel and Floud (1997: 437) shared their concern about the use of composite indices - a "debatable method" in their words.

In the same year, 1997, in London, Nicholas Crafts led the way to the use of the HDI, in his quest for a definitive resolution of the British 'quality of life' debate. Crafts (1997a) estimated both the HDI and 'its most ambitious cousin', the DWI, for six benchmark years between 1760 and 1850.[3] He showed how the steady increase in composite indices was at odds with the gloomy evidence based on heights. The comparison

[2] On the choice of the goalposts see UNDP (1990: 12-13), and UNDP (2016: 198). On the concave transformation see Kelley (1991: 317) and UNDP (1994: 108).
[3] Crafts used a slight variation of equation 1, a formula first proposed in UNDP (1994).

between Britain's HDI- and DWI-based achievements at 1860 with those of eleven other countries, called into question Britain's 'leadership' based on GDP: inter-country rankings differed markedly depending on the measure used. Crafts concluded that composite indices could 'be even more important for economic historians than for contemporary development economists' (p. 634). In a second paper, Crafts (1997b) produced estimates of the HDI for 16 industrialized countries, arguing that HDIs offered 'a new angle on comparisons of economic progress in different economic eras', new with respect to those based on real GDP per person (p. 301). [4]

Two decades later, one can probably claim that the HDI has become a standard welfare measure in economic history. It has earned a place in the historiography of every continent – Astorga et al. (2005) constructed a series for Latin America, Prados de la Escosura (2013a) for Africa – and in authoritative textbooks (Broadberry and O'Rourke 2010, Persson 2010).

Since its first appearance, the HDI has undergone several modifications, often in response to criticism from academia.[5] The main reason for dissatisfaction with the original formula in Equation (1) is that it implicitly assumes *perfect substitutability* between arguments. In Equation 1, one year less of life expectancy is perfectly compensated by an increase of equal magnitude in the schooling index (Desai, 1991)[6]. Paradoxically, the human development of a modern industrialized economy may be made equivalent to the degree of human development of a population with a zero life expectancy, as long as its citizens – who have not even had the time to go beyond the cradle – are sufficiently educated or wealthy. Perfect substitutability is incompatible with the idea that the components of the index are *essential* dimensions of wellbeing: by definition, that which is essential cannot be replaced (Sagar and Najam, 1998). The latest and most important revision of the HDI was carried out for its twentieth anniversary (UNDP 2010). On that occasion, it was decided to change Equation 1 by introducing a geometric mean instead of the simple arithmetic mean:

[4] The index was proposed in two alternatives: together with the one adopted in Crafts (1997a), a second HDI was computed normalising income, I_Y, along the same lines as the non-monetary components, with $\overline{y}$ set at the US per capita GDP in 1992.
[5] See, among others, Srinivasan (1994), Ravallion (1997, 2012a), and Klugman et al. (2011). Kovacevic (2010) reviews the first twenty years of the debate, instrumental to the 2010 revision.
[6] This is clearly not true, due to the log transformation, for the degree of substitutability between GDP and the other components of the HDI.

(2) $$HDI = I_E^{\frac{1}{3}} \cdot I_S^{\frac{1}{3}} \cdot L_Y^{\frac{1}{3}}$$

At the same time, GDP was replaced by the Gross National Income (GNI), and literacy by average years of schooling. The change in the functional form of the HDI was promptly accepted by economic historians, while the change in the indicators was not: the "old" indicators (literacy, GDP, and life expectancy) have been maintained in preference to the new. Following Gidwitz et al. (2010), Equation (2) has become known as the *hybrid* HDI, and is probably the most popular version currently in use among economic historians.

A notable exception is Leandro Prados de la Escosura. He took up an idea of the Indian development economist Nanak Kakwani, according to which development indicators should reflect the greater difficulty of improvement 'as the standard of living reaches progressively higher limits' (Kakwani 1993: 308). To implement this idea, Kakwani proposed a convex transformation of social indicators:$F_x = \left[ln\left(\overline{x} - \underline{x}\right) - ln(\overline{x} - x_t)\right] / ln\left(\overline{x} - \underline{x}\right)$[7]. Applying Kakwani's transformation F_x to the non-monetary components of HDI, Prados de la Escosura (2013) proposed a new HDI, the *Historical Index of Human Development* (HIHD):

(3) $$HIHD = F_E^{\frac{1}{3}} \cdot F_S^{\frac{1}{3}} \cdot L_Y^{\frac{1}{3}}$$

Equation (3) attributes increasing value to marginal increases of life expectancy and education, often costlier to achieve, but maintains the traditional decreasing marginal benefits of income, guaranteed by L_Y.

Concerned by the arbitrariness of both convex and concave transformations, Amendola et al. (2017) proposed a new version of the HDI that aggregates the three components using a geometric mean, but normalizes all of them symmetrically with the linear transformation I_x, as in Crafts (1997b):

(4) $$HDI_{AGV} = I_E^{\frac{1}{3}} \cdot I_S^{\frac{1}{3}} \cdot I_Y^{\frac{1}{3}}$$

[7] More precisely, Kakwani (1993) introduce the following parametric "achievement function": $\left[\left(\overline{x} - \underline{x}\right)^{\varepsilon} - (\overline{x} - x_t)^{\varepsilon}\right] / \left(\overline{x} - \underline{x}\right)^{\varepsilon}$. The limit of a linear transformation of this function, as ε approaches 0, coincides with the expression in the text and is fully consistent with the axiomatic structure proposed by the author.

The index HDI_{AGV} does not escape the interpretative limitations of all other HDIs, but does have the virtue of greater simplicity (due to absence of any non-linear transformation in the original variables), in addition to another hidden virtue that will be brought to light shortly, when discussing the marginal rates of substitution built into any HDI.

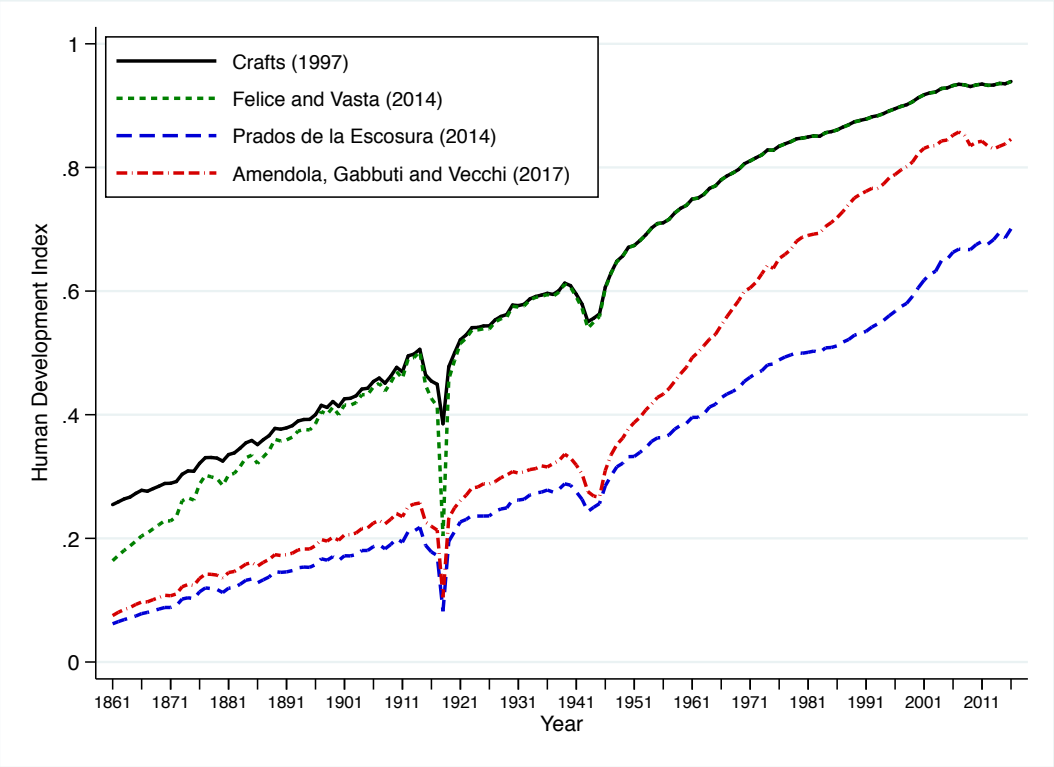
The different formulas of the HDI reviewed in this section are assessed in the next, in the context of the history of Italian living standards.

3 Italian living standards through the lenses of the HDIs

Italian economic historians did not miss the opportunity to use the HDI, with the aim of achieving a better understanding of the long-run dynamics of welfare in the country. Alternative estimates of the HDI – both at the national and the regional level – appeared in the 2000s: Conte, Della Torre, and Vasta (2001), Felice (2007), and then Brandolini and Vecchi (2013) produced new time series of the HDI from Italy's unification (1861) to the present day. More recently, Felice and Vasta (2015) constructed new regional estimates in support of their investigation of the roots of the *Questione Meridionale*, while Amendola et al. (2017) focused on the difficulties of adopting the HDI in interpreting Italian development. Different authors used different versions of the HDI, as discussed in Section 3, which suggests two questions. First, do different aggregation rules lead to different results? Second, did the HDI succeed in identifying the trend of welfare of the Italian population during the last 150 years? Our answer to the first question is positive, while the answer to the second question is, by and large, negative. We conclude arguing that economic historians need a unified conceptual framework before using the HDI and other composite measures – a task that we take on in Section 4.

Figure 1 shows the annual series of four HDIs for Italy: the 'old' HDI calculated by Crafts (1997) (Equation 1 in Section 3), the 'hybrid' HDI of Felice and Vasta (2014) (Equation 2), the HIHD of Prados de la Escosura (2014) (Equation 3), and the new-born HDI of Amendola et al. (2017) (Equation 4). Even a quick glance reveals that the series differ greatly not only in levels, but also in trends. How should we interpret these differences? Which index is the most 'correct'?

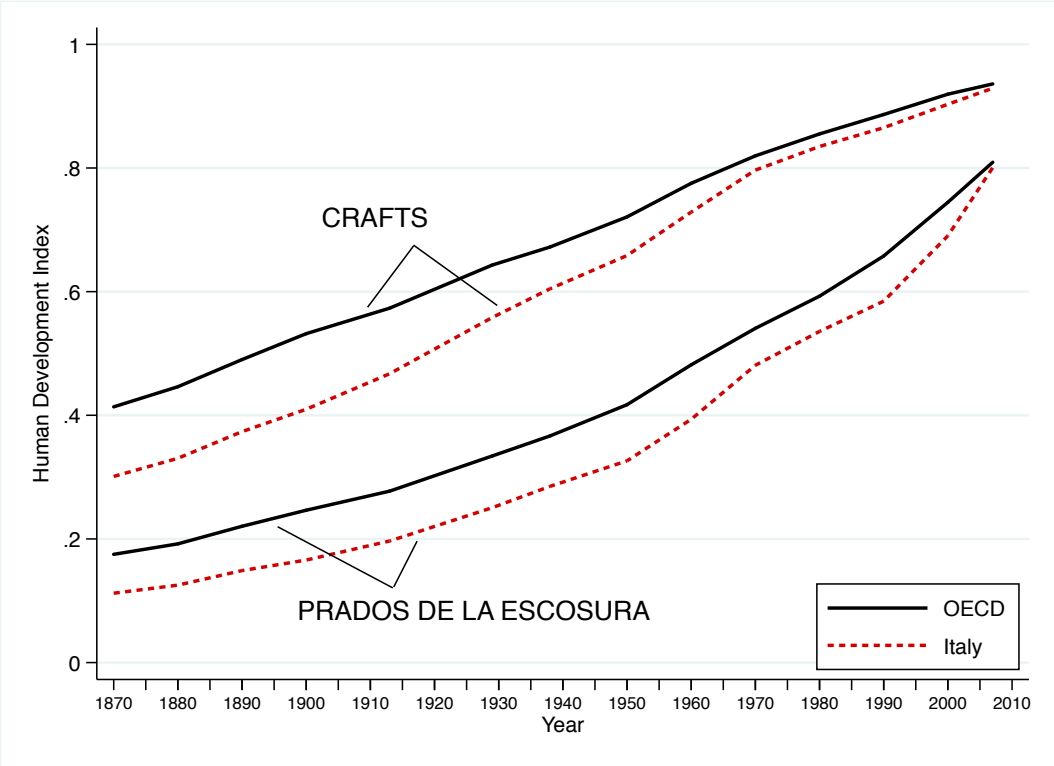
Figure 1 – Human Development Indices in Italy, 1861-2016



Source: authors' elaborations.

Consider the difference between the HIHD and Amendola et al.'s HDI. They proceed hand in hand until World War II, when they diverge in both trend and level. The reason is the different transformations of the components: all possible transformations are at work here, linear, concave, and convex transformations (I_x, L_Y and F_x, respectively). Within the Prados index, in fact, monetary and non-monetary dimensions are treated in opposite ways. While an increase of average income is "discounted" by the logarithm, as in the 'old' HDI, improvements in education and longevity are magnified by the convex transformation F_x. Both assumptions might be reasonable in historical terms, but they have to be recognized as *subjective* choices. The analyst's personal judgments are built into the formulas, but hidden from view, so that they cannot be assessed by the reader. No unambiguously best index exists; subjective judgment is the only criterion available in deciding which story one should send to the printer.

Figure 2 – Italy and the OECD compared, 1870 - 2010



Source: authors' elaborations on Amendola et al. (2017: 465).

Figure 2 elaborates on the consequences of this last argument, by comparing Italy's performance (dashed lines) to the OECD average (solid lines). The idea is to show the implications at the interpretative level that can result from using one formula rather than another. As we can see, the choice of formula changes not just the level of the index (the HHDI's geometric mean systematically shifts index values down compared to the arithmetic mean of the HDI), but also its dynamics. Regarding *levels*, Crafts (1997b) noted that 1870 values of the OECD countries were comparable with those of developing countries today (around 0.4). In contrast, using a geometric formula, the OECD countries of 1870 would fare worse than the Central African Republic (0.352), the country with the lowest HDI in UNDP (2016). Turning to the *dynamics*, according to the old HDI, Italy converged on the OECD throughout most of the last century, with an acceleration during the economic miracle of the 1950s, achieving near parity by the 1970s. If we use the HIHD, instead, the lesson to be drawn is the exact opposite: Italy failed to converge for almost 130 years, and managed to recover and align with OECD

standards only in the last twenty years.[8] Alternative HDI formulas do not reflect more or less innovative "technologies"; they correspond to different sets of subjective preferences. The choice between the old HDI and the HIHD hybrid is a chioce between different understandings of living standards – those of Crafts, Felice and Vasta, or Prados de la Escosura.

Figures 1 and 2 offer an opportunity to discuss a second issue of great importance. Graphs comparing HDI series for various countries over time have been created, typically, in order to study growth rates and convergence patterns between the various areas.[9] This interpretation is clearly based on the *numerical value* of the index. According to the creators of the HDI, however, this interpretation is inappropriate. The HDI was created explicitly to *rank* the *relative* performances of the various countries *at a given moment* in time (UNDP 1993: 110). Anand and Sen (1994: 8) did not overlook the possibility of constructing a historical series of the index but came to the conclusion that "no special significance is attached to the absolute value of the index, the entire analysis being conducted in terms of the ranking of countries relative to one another".

The HDI should thus be interpreted as a purely *ordinal* index, that can be used to create a ranking.[10] This poses serious limits to its use in economic history. When looking at the progress made by a country over time, as in Figures 1 and 2, the HDI – in any of its guises – tells us that the 1950s were better than the interwar years, which were mostly better than the 19th century; but we cannot tell by how much, nor compare the different speeds at which the HDI increased; the very definition of a growth rate is based on a cardinal interpretation of the HDI. For most of their history as a unified country, Italians have improved their standards of living. Although not completely mundane as a

[8] Similarly, with reference to of European living standards during the interwar period, Gallardo Albarrán (2018: 2-3) noted that HIHD overturns the optimistic interpretations of Millward and Baten (2010) based on the old HDI.

[9] Crafts (1997a: 310) used the HDI to measure "the speed of development in different eras"; Boyer (2007) in a discussion on 'convergence of living standards'; Prados de la Escosura (2010: 850) asked "whether the human development gap between the 'core' and the 'periphery' deepened over time" and, eventually, commented on the "absolute gap" and "rate of variations" (*Id*. 2014: 12); for Astorga et al. (2005: 775) the wellbeing of Latin Americans "almost doubled between 1900 and 1939, and more than doubled to 1980"; according to Millward and Baten (2010: 253) "HDI showed signs of convergence within Europe during the interwar period"; finally, for Baines et al. (2010: 399) "the average HDI score for Europe rose by almost 30 percent between 1950 and 2003".

[10] In the economic history literature, we found explicit acknowledgment of this fact only in Baines et al. (2010, 399), according to whom HDI is a 'relative', or 'comparative' measure of development. As mentioned in the previous note, however, they also consider its absolute variations.

historical insight, this is unfortunately all that we can say.[11] Turning to international comparisons, according to Figure 2, we can simply conclude that Italians have always experience a lower degree of wellbeing, on average, than their contemporaries in northern Europe or in North America. We cannot say by *how much*: when indices are ordinal ones, the vertical distance between the two curves in Figures 1 and 2 has no meaningful interpretation.

4 Historical HDI as a paternalistic social welfare function

In this section we put composite indices, and in particular the HDI, into a more general conceptual framework. We know, from Arrow's impossibility theorem (Arrow, 1951), that there are no democratic decision rules that can be used to aggregate individual preferences consistently. Only a dictatorship would avoid inconsistencies in social ordering systems (Sen, 1999). In this regard, the HDI is not an exception. Arrow rules out the possibility that economic historians could come up with an HDI-based ordering of two societies by aggregating individual preferences, unless they use subjective judgment, that is, unless they play dictators. A simple strategy to produce social rankings is via Bergson-Samuelson social welfare functions (BSWF), which allow the analyst to rank social alternatives, starting from individual orderings. They do so, of course, according to a dictatorial criterion. We suggest following this strategy, as BSFWs allow us to appreciate the details underlying a history of welfare based on the HDI.

Assume that individual preferences are defined over the three variables – longevity, schooling, and income – and that they can be described by a standard utility function:

$$u_i = u_i(e_i, s_i, y_i)$$

where the index *i* refers to individuals, and e_i, s_i and y_i denote life expectancy, educational attainment and income, respectively. A SWF can be defined as follows:

$$W = W\big(u_1(e_1, s_1, y_1), u_2(e_2, s_2, y_2), \dots\dots, u_n(e_n, s_n, y_n)\big) \quad (5)$$

[11] More interesting, from the interpretative side, is the exercise of decomposing the HDI into contributions made by each of the three components – life expectancy, education and income. See Amendola et al. (2017).

where $W(\cdot)$ is a real valued function that maps individual utilities into real numbers. The shape of the function $W(\cdot)$ reflects the ethical system of the dictator, and is defined *independently* of individual preferences.

One might be tempted to interpret the HDI as a SWF. In this perspective, the choice of a specific functional form of the HDI would reflect the ethical system of the economic historian. This is not the case. The degree of arbitrariness imposed by the HDI is stronger than that implied by a proper SWF. To see this, let us write the HDI as follows:

$$HDI = HDI(E, S, Y)$$

where E stands for life expectancy, S for schooling, and Y for income (GDP). This shows that the index does not depend on the wellbeing of individuals $u_i(e_i, s_i, y_i)$, but rather on aggregate indicators (*E, S, Y*), which in turn can be assumed to depend on individual-level variables: $E = E(e_1, e_2, \dots, e_n)$, $S = S(s_1, s_2, \dots, s_n)$, and $Y = Y(y_1, y_2, \dots, y_n)$. The HDI can therefore be written as:

$$HDI = HDI\big(E(e_1, e_2, \dots, e_n), S(s_1, s_2, \dots, s_n), Y(y_1, y_2, \dots, y_n)\big) \quad (6)$$

Equation (6) clarifies that the HDI does *not* qualify as a SWF, the former being defined on social indicators, the latter on individual preferences. Both equations (5) and (6) ultimately depend on individual levels of longevity, but the definition of a SWF requires that each and every individual in the society comes up with an ordering of possible outcomes based on *e*, *s* and *y*, and then individual orderings are aggregated by the SWF. [12] In contrast, equation (6) does not require any individual ordering. This difference explains why, following de Graaff (1957), we can interpret the HDI as a *paternalistic* social welfare function (PSWF).[13] The economic historian arbitrarily chooses not only the shape of the social welfare function, but also the implicit system of individual preferences[14].

The fact that the HDI can be interpreted as PSWF is crucial to our argument, as it formally establishes that the economic historian's HDI-based welfare ordering is entirely dictated by her preferences. Once we have proven that HDI is a PSWF, then to

12 The only way to make (5) and (6) equivalent is to assume linear individual preferences and an additive $W(\cdot)$. This is, basically, a special case of a Benthamite (or cardinal) social welfare function.

13 Technically, the HDI is a social welfare function that does not satisfy the nonpaternalism property, which prescribes that "(…) in the expression of social preferences only the individual preferences matter. The planner does not have direct preferences on the final alternatives" (Mas-Colell et al. 1995: 825).

14 In principle, we do not even know if such an implicit preference system exists.

say that the HDI is higher in A than in B is no more to say that the economic historian would choose A rather than B, if she were allowed to make the choice (de Graaff, 1957: 5). Irrespective of its specific formulation HDI is *not* an objective measure of human development.

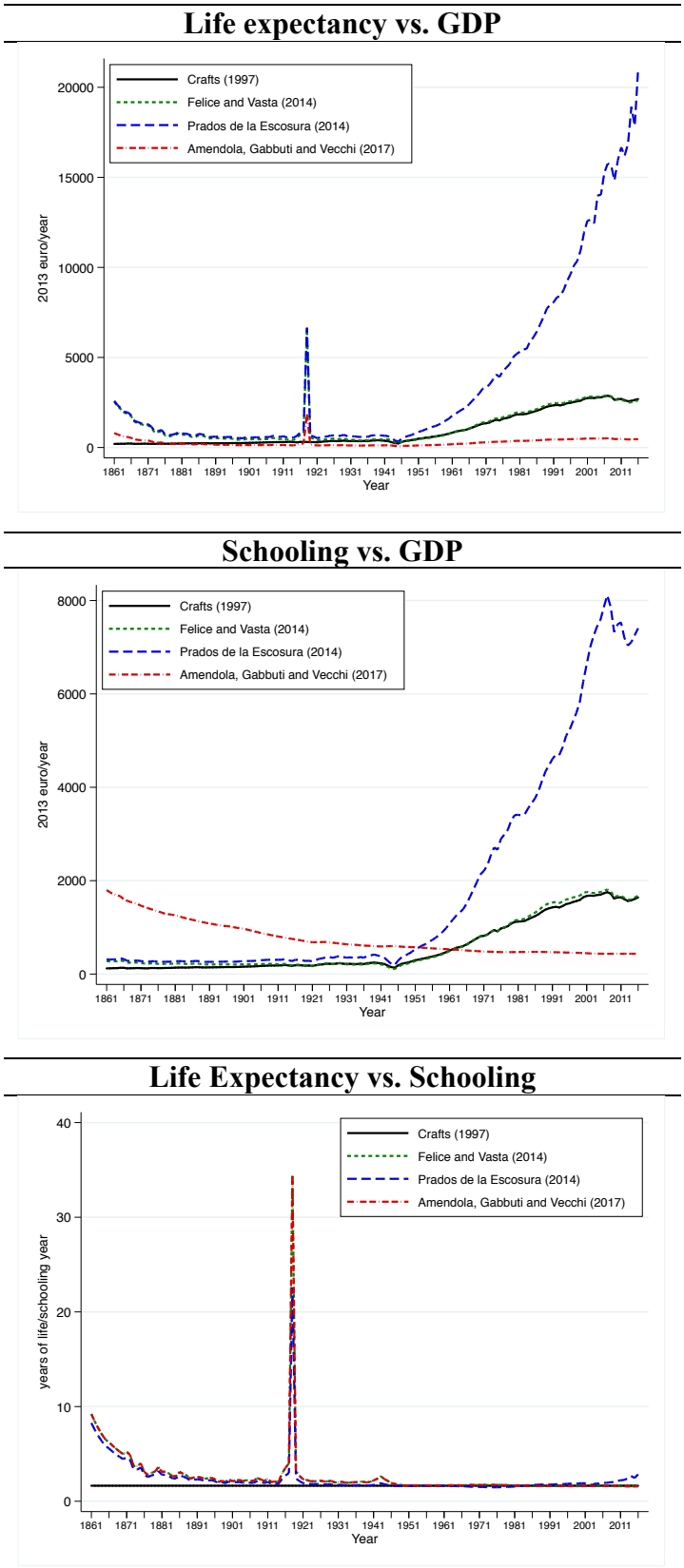
Even so, an interesting question remains to be answered: what are the defining characteristics of these ethical systems? In what ways does Prados de la Escosura's ethical system differ from Crafts', or from Felice and Vasta's? The marginal rates of substitution (MRS) provide a possible answer. In the HDI context, the MRS of life expectancy E_t with respect to per capita GDP Y_t is the amount of dollars that one (the dictator) has to give up when increasing life expectancy by one year, in order to keep the HDI unchanged. To all intents and purposes, the MRS is the "exchange rate" or the relative importance of the population's average life expectancy compared to average income. Table 1 shows the MRS implied in each of the formulas proposed for the HDI (Equations 1 - 4).

Table 1. Marginal rates of substitution (MRS) for different HDI specifications

	GDP vs. Life expectancy $\lvert MRS_{e_t/y_t} \rvert$	**GDP vs. Schooling** $\lvert MRS_{s_t/y_t} \rvert$	**Life expectancy vs. Schooling** $\lvert MRS_{e_t/l_t} \rvert$
Crafts HDI (eq. 1)	$\frac{y_t(lny - lny_0)}{e - e_0}$	$\frac{y_t(lny - lny_0)}{s - s_0}$	$\frac{s - s_0}{e - e_0}$
Felice and Vasta Hybrid HDI (eq. 2)	$\frac{y_t(lny_t - lny_0)}{e_t - e_0}$	$\frac{y_t(lny_t - lny_0)}{s_t - s_0}$	$\frac{(s - s_0)}{(e_t - e_0)}$
Prados de la Escosura HIHD (eq. 3)	$\frac{y_t(lny_t - lny_0)}{(e - e_t)(\ln(e - e_0) - \ln(e - e_t))}$	$\frac{y_t(lny_t - lny_0)}{(s - s_t)(\ln(s - s_0) - \ln(s - s_t))}$	$\frac{(s - s_t)[\ln(s - s_0) - \ln(s - s_0)]}{(e - e_t)[\ln(e - e_0) - \ln(e - e_t)]}$
Amendola et al. HDI (eq. 4)	$\frac{(y_t - y_0)}{(e_t - e_0)}$	$\frac{(y_t - y_0)}{(s_t - s_0)}$	$\frac{(s_t - s_0)}{(e_t - e_0)}$

Faced with different HDI formulations, the MRSs facilitate the understanding of which is more consistent with our preferences. Moreover, since the MRS is a relative magnitude, a sort of relative price, it means that it has a *cardinal* interpretation even if we do not share a cardinal interpretation of the HDI: it makes perfect sense to carry out comparisons of different MRS both in levels and in changes over time. Figure 3 shows the development over time of the MRS for life expectancy with respect to per capita GDP (top panel), for schooling and per capita GDP (panel in the middle), and for life expectancy versus schooling (bottom panel) in Italy (1861-2016).

Figure 3. HDI Marginal Rates of Substitution – Italy, 1861-2016



Source: authors' calculations.

To begin with, let us consider the new index proposed by Amendola et al. (2017) (red dashed line, equation 4 in section 3). According to this specific HDI, one extra year of life would be worth around $400 (in 2011 Geary-Khamis dollars) at the beginning of period. Not much, admittedly. The top panel in Figure 3 shows that for as much as a century and a half after unification, the MRS remains close to this value. The indices used by other authors show a very different trend. The index calculated by Crafts starts from a lower MRS (circa $200), while the indices put forward by Felice and Vasta and by Prados de la Escosura start from a much higher $1,800 and shoot up in the aftermath of World War II. Crafts' formulation assumes that in the 2010s a year of life is worth around $2,600 – a value not too far removed from the one assumed by Felice and Vasta (about $2,500). The index created by Prados de la Escosura exceeds all of these: from 1861 the value of one additional year of life rises from $1,894 to $17,641. These discrepancies stem from using a geometric mean. The point was well grasped by Ravallion (2012a), on the occasion of the introduction of the new HDI formulation: the HDI "puts a higher value to an extra year of life for people in rich countries than poor ones", with the "unacceptable implication that rich people, or residents of rich nations, are worth more than the poor" (p. 206). Ravallion's observation also naturally applies to inter-period comparisons or to economic history. As the above calculations show, different HDIs attribute very different weights to life expectancy in different periods of Italian history: this evaluation may be legitimate, but it is never transparent.

5 Conclusions

Comparison of the marginal rates of substitution between the components of the HDI illuminates differences in the ethical systems implicit in the various formulations of the HDI proposed in the literature. We can make a more systematic comparison by allowing for smooth variation in the degree of substitutability between the index components. We start by reformulating the HDI as a constant elasticity of substitution function[15] (CES). This allows us to vary the degree of substitutability between the HDI components

[15] Given our discussion in section 4, it is worth noting that Mas-Colell et al. (1995) introduce the CES function as an instance of a *generalized utilitarian social welfare function* (see example 22.c.4 p. 828-29). However, in our context, Eq. 7 generalizes a SWF that violates the *non-paternalism* property, i.e. a PSWF.

through a single parameter: the elasticity of substitution σ. Maintaining the same notation of the previous sections, the generalized HDI can be written as follows:

$$HDI_{CES} = \left[\alpha_1 (E_t)^{\frac{\sigma-1}{\sigma}} + \alpha_2 (S_t)^{\frac{\sigma-1}{\sigma}} + \alpha_3 (Y_t)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{7}$$

where the parameter α_i represents the weight attributed to component *i* of the HDI, $\alpha_i \geq 0$ for every i and $\sum \alpha_i = 1$. In what follows we assume that $\alpha_i = \alpha_j \; \forall \; i, j$, that is, we treat symmetrically all the arguments of the HDI.

In Equation (7), the parameter σ plays a crucial role. As σ approaches infinity, the components become perfect substitutes and we obtain the Crafts (1997) formulation of the HDI (Equation 1 in Section 2). As σ approaches 1, HDI_{CES} converges to the *hybrid* HDI proposed by Felice and Vasta (2014) (Equation 2 in Section 2) and, with slight modifications, to the HIHD if Prados de la Escosura (2013) (Equation 3 in Section 2). When σ approaches 0, then $HDI_{CES} = min\{E_t, S_t, Y_t\}$, that is, we obtain a new Leontief-like HDI specification, never considered in the literature, to the best of our knowledge. In this case the components of the HDI are perfect complements, a characteristic that fits well with the idea that they capture essential dimensions of wellbeing. A number of intermediate cases can be obtained by varying σ between 0 and infinity.

Unfortunately, Equation 7, even if simple and of immediate interpretation, is not sufficiently flexible to encompass *exactly* all the historical HDIs proposed in the literature. This is because these HDIs introduce specific "achievement functions", i.e. transformations of the original, elementary indicators. A general CES formulation of the HDI, able to encompass all the cases explored in the literature, must include additional parameters that model the achievement functions. The following general HDI_{CES} does the job:

$$HDI_{CES}(\sigma, \varepsilon, \eta) = \left[\sum_{i=1}^{K} \alpha_i \left[\frac{\left(\bar{x}^i - \underline{x}^i\right)^{\varepsilon} - \left(\bar{x}^i - x_t^i\right)^{\varepsilon}}{\left(\bar{x}^i - \underline{x}^i\right)^{\varepsilon} - 1} \cdot a_i\right]^{\frac{\sigma-1}{\sigma}} + \left(1 - \sum_{i=1}^{K} \alpha_i\right)\left[\frac{(y_t)^{\eta} - \left(\underline{y}\right)^{\eta}}{(\bar{y})^{\eta} - \left(\underline{y}\right)^{\eta}}\right]^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{8}$$

Notation in Equation 8 is as follows: x_t^i is the value of the *i*-th indicator (*e.g.*, life expectancy at birth) in year *t*; $\bar{x}^i$ and $\underline{x}^i$ are the theoretical, time-invariant maximum and minimum values, respectively, of the *i*-th indicator. Some authors refer to these boundaries as *goalposts*; y_t denotes real per capita GDP. The parameter $\varepsilon \in (0, 1]$ is an important one; it describes the degree of convexity of the achievement functions for the *K* components other than GDP. Finally, the parameter $\eta \in (0, 1]$ regulates the degree of concavity of the achievement function for GDP[16]. In short, Equation 8 identifies a class of HDIs characterized by the parameter vector $(\sigma, \varepsilon, \eta)$.

Table 2 below shows how the main historical HDIs proposed in the literature can be obtained from Equation 8 by choosing the parameter set $(\sigma, \varepsilon, \eta)$ appropriately. The first four rows refer to the indices described in the previous sections. Crafts assumes perfect substitutability among the HDI components and the achievement functions are linear with the exception of the GDP component. This implies $\sigma = \infty$, $\varepsilon = 1$ and $\eta = 0$. The hybrid HDI is based on the same assumptions about the achievement functions but allows for Cobb-Douglas type imperfect substitutability among the components, corresponding to $\sigma = 1$. The HIHD introduces a variation on the achievement functions for the non GDP components by assuming, other things being equal, $\varepsilon = 0$. The HDI_{AGV} index assumes linear achievement functions for all the components, which means $\varepsilon = \eta = 1$. The fifth row identifies a case that, to the best of our knowledge, has not been explored in the literature but deserves particular attention, in our opinion. This case assumes the complete absence of substitutability, which means $\sigma = 1$, with all the possible combination of the parameters ε and η. In this case, the HDI, as observed above, takes the shape of a Leontief type social welfare function that captures, in a utilitarian framework, the ethical system proposed by Rawls (1971). All the social indicators included in the HDI are supposed to be essential dimensions of well being for which a trade-off cannot be defined. As a consequence, the pattern of the HDI is entirely driven by the most deficient dimension of well-being. The last rows capture the residual possibilities characterized by imperfect substitutability and different degrees of concavity/convexity of the achievement functions.

[16] The adjustment coefficients $\alpha_i = \left(\bar{x}^i - \underline{x}^i - 1\right)/\left(\bar{x}^i - \underline{x}^i\right)$ are necessary to guarantee the exact convergence of the $HDI_{CES}(\sigma, \varepsilon, \eta)$ to the HDIs proposed in the literature.

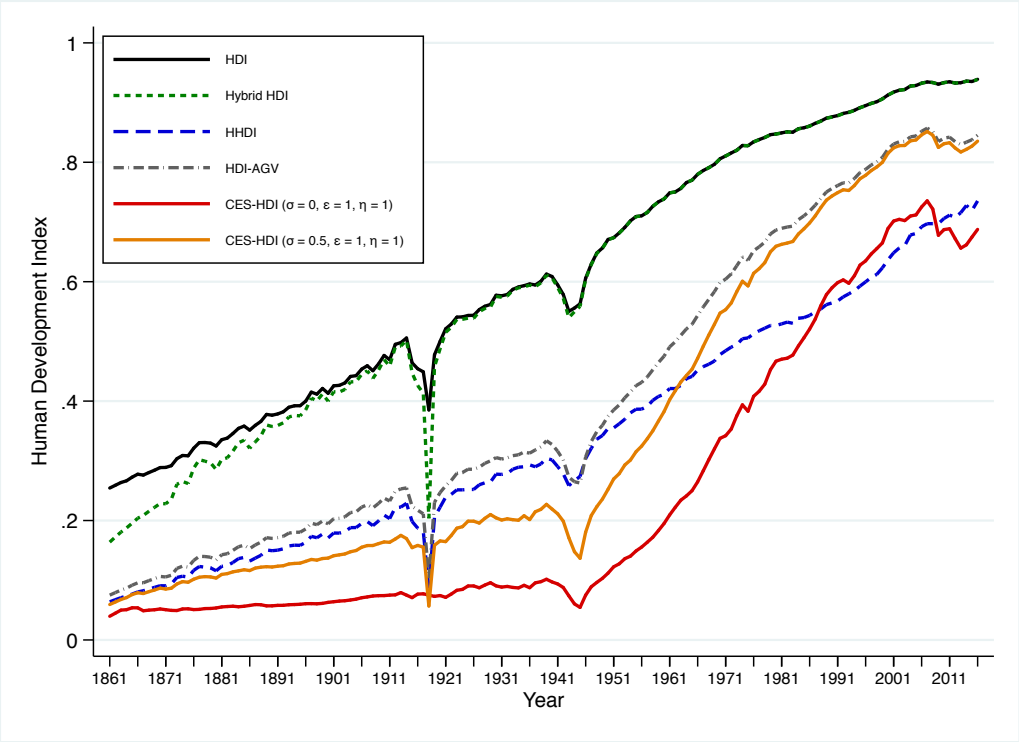
Table 2. A taxonomy of indices within the generalized historical HDI

Denomination	σ	ε	η	Pref.	Notes
HDI	∞	1	0	almost perfect substitutes	eq. 1 (a)
Hybrid HDI	1	1	0		eq. 2 (b)
HIHD	1	0	0		eq. 3 (c)
HDI_{AGV}	1	1	1	Cobb Douglas	eq. 4 (d)
Rawlsian HDI	0	[0,1]	[0,1]	perfect complements	
Imperfect substitute	$(0,\infty) \setminus 1$	[0,1]	[0,1]		
Perfect substitute	∞	1	1	linear preferences	

Notes: (a) United Nations (1990), (b) Felice and Vasta (2014), (c) Prados de la Escosura (various years), (d) Amendola et al (2017).

Figure 4 below plots the HDI_{CES} series that we obtain by varying the elasticity of substitution σ and the parameters η and ε. The figure contains all the HDIs previously illustrated in Figure 1, but also a subset of other indices based on the "Ralwsian" or "imperfect substitute" parameterization. It is evident that a fairly wide range of patterns results from this exercise.

Figure 4. The many facets of the CES-HDI in Italy, 1861-2017



The results in Figure 4 suggests an analogy with game theory's "folk theorem". Within the family of human development indices encompassed in Equation 8, it is not difficult to find an ethical system, summarized by the parameters $(\sigma, \varepsilon, \eta)$, which can generate any (arbitrary) trajectory for the HDI, for the same underlying elemental indicators. This is not true for *all* possible trajectories, but it is possible for a consistent subset of all the possible trajectories. We are not reasoning in a repeated game analytical setting, of course, but the message is similar: under fairly general conditions, "anything goes". That is, given a suitable choice of the parameters $(\sigma, \varepsilon, \eta)$ any HDI-based story can be told. Note that this result does *not* depend on the weights (α_i) used for the components of the HDI, but on their substitutability: the parameter σ regulates, symmetrically for all components, the degree of substitutability that, in turn, identifies the analyst's subjective *exchange ratios* among them.

Thus the parameter σ reveals the analyst's preferences. The fact that σ can take on, at least theoretically, any value greater than zero implies a fundamental "indeterminacy" in the HDI, a feature that deserves a comment. The negative side of HDI indeterminacy is that the HDI seems to be unable to deliver an "objective history" of human

development. There are many, virtually infinite, stories that can be told according to the ethical judgment of those who build the HDI index. The positive side is that all these stories can be supported on the basis of a vector in the $(\sigma, \varepsilon, \eta)$ parameter space.

We used the expression "*quasi* folk theorem" in the title of this section, where the qualifier "quasi" reminds us that the validity of the analogy is limited by the fact that the standard components of the HDI are, for most countries, highly positively correlated. This is a well-documented empirical regularity. Many authors have pointed out the redundant nature of the additional information incorporated in the human development index with respect to the single GDP component[17]. An immediate consequence of the fact that life expectancy at birth and education co-move with per capita GDP is that, irrespective of the elasticity of substitution, we are not able to reverse the trend of the historical HDI. If we interpret the HDI exclusively as an ordinal index, this amounts to saying that the "quasi-folk theorem" does not apply, as the ranking among years is unequivocally determined by the index and is independent of σ.

A possible rehabilitation of our quasi folk-theorem relies on the introduction of new indicators that are not so closely correlated with per capita GDP. This would not only enrich the concept of well-being inherent in the HDI but would also enlarge, as we will see, the conceivable trajectories of the HDI that can be sustained by an appropriate ethical system.

A strong candidate to extend the dimensions of well-being considered in the historical HDI is political and civil rights, a strategy already explored by Dasgupta and Weale (1992), Crafts (1997) and others. In the next section we explore this line of research, which seems particularly suitable for the case of Italy, a country where, over extended periods, political and civil rights followed an eccentric pattern with respect to the other dimensions of well-being included in the HDI.

[17] See Stewart (1985), McGillivray (1991) Srinivasan (1994), Felipe and Resende (1996: 187-190), and Diener and Suh (1997: 192-200). Ogwang (1994: 2011-2014), argued that indices such as the HDI "reveal nothing that per capita income and life expectancy alone would not have revealed, except perhaps in the case of a few unique countries where rankings differ substantially."

6 Beyond the HDI

It comes as no surprise that economic historians consider political and civil rights crucial in intertemporal assessment of living standards. The creators of the HDI argued that 'human development is incomplete without human freedom' (UNDP 1990: 15), but ended up limiting the aggregation to education. The choice was not an accident: it was put forward by Paul Streeten, a distinguished development economist, but also a refugee from Austria who had fought in Sicily against Nazi-Fascist forces (Haq 1995: 61). Streeten (1994: 236) argued in favour of measuring and including political rights: they are 'so important' – he wrote – 'that no trade-off should be possible'. On the other hand, the volatility of such indices (that 'can change overnight with a coup') and the inevitable subjectivity in quantifying such indicators represent a weakness the index. Crafts (1997a: 621-622) acknowledged the last argument, but also noted that Dasgupta and Weale's idea of including this dimension echoed radical stances in the standard of living debate, such as Thompson (1963).

The case of Italy makes clear how the inclusion or exclusion of political and civic liberties significantly alters the historical evolution of wellbeing. It is hard to reconcile the evolution of Figure 1 in the interwar years (1918-1939) with the definition of human development as 'enlarging people's choice' (UNDP 1997, p. 15). After a wave of violence against political opponents, in October 1922 Benito Mussolini was appointed Prime Minister following the so-called 'March on Rome'. Within a few years, his coalition government evolved into a dictatorship that restricted in many ways the scope of citizens' free will. Aside from the killings of opposition leaders, and the illiberal laws abolishing the freedom of the press, banning workers' strikes, and installing a one-party system by 1926, the Fascist regime restricted many civic liberties. The infamous Race Laws (1938), that expelled Jewish citizens from public education and employment and prohibited mixed marriages, were only a few of the most extreme examples; Fascist rule restricted many aspects of individual freedom, for instance by banning internal migration in the 1930s.[18] Still, all versions of the HDI increase in the period, driven by the slow but steady increases in education and life expectancy.[19]

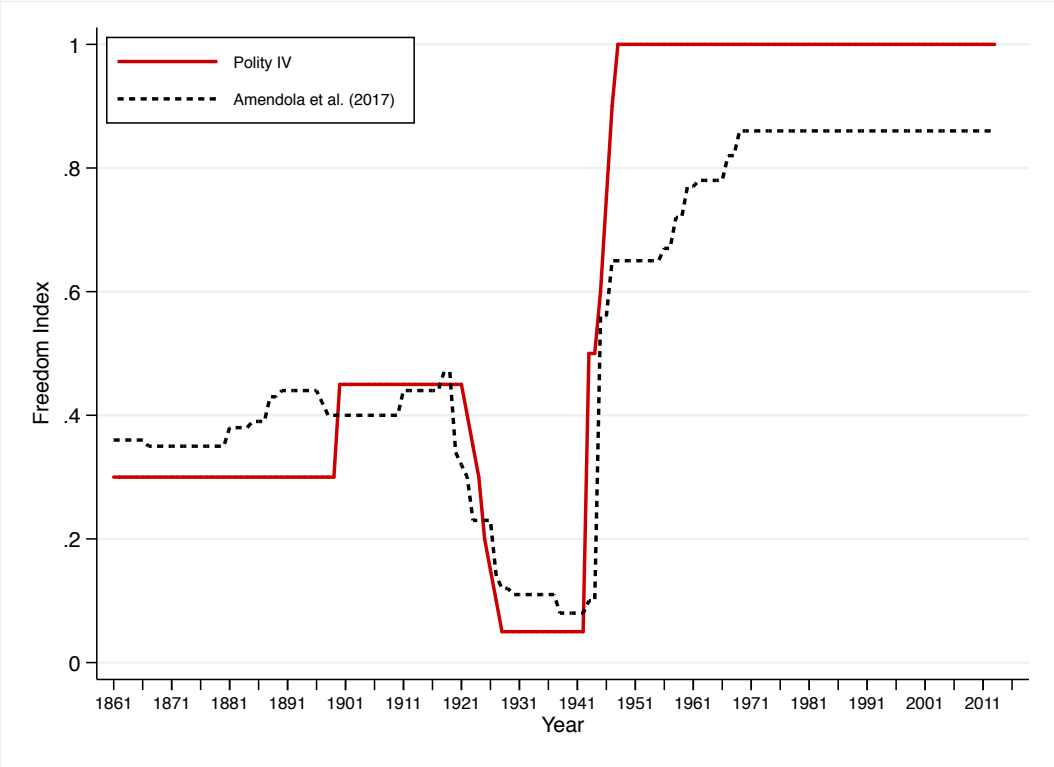
[18] For a brief review on the history of civil and political rights in Italy, see Amendola et al. (2017: 475-479) and the literature mentioned there.

[19] Ivanov and Peleah (2010) discuss the case of Soviet Union, whose last decades are covered by the UNDP data.

While no indicator of political rights can be considered 'objective', two sources have gained growing consensus in the literature (Hogstrom: 2013). The first is Freedom House, a US non-governmental organization that provides annual estimates on the level of political and civil rights enjoyed in almost all polities in the world. Their annual report, *Freedom in the World,* assesses the Political Rights and Civil Liberties indicators, proposed by Taylor and Jodice (1983: 58-68) and available from 1972. For each year, a score between 0 and 4 is assigned to 25 questions on various dimensions of political life and civil rights. The results can be expressed as a score between 0 and 100, or as two separate indices, ranging between 1 (most free) to 7 (least free). Amendola et al. (2017: 475-479) used these two indicators to estimate a *Dasgupta Weale Index* (DWI) of political and civil rights for Italy from unification to the present. A second alternative, the "Polity2 Indicator", is provided by the Polity IV Project (Marshall et al., 2017) and is arguably the most widely used in historical application. The index evaluates political institutions (such as the openness of elections and checks on the executive branch) and assigns a score between -10 to +10 (-6 and +6 being the thresholds for dictatorship and democracy, respectively). Figure 5 illustrates the evolution of political and civil rights in Italy, after rescaling the *Polity2* score between 0-1. The series show similar trends, and agree on the timing of the major reversal experienced by Italians in the interwar years.

By taking civil and political rights into consideration, the CES-HDI index better reflects Sen's idea of 'development as freedom', embodied in the concept of *capabilities*. Amendola et al. (2017) showed that including freedom among the components of a human development index alters the long-run evaluation of well-being in Italy. Figure 6 shows alternative versions of the CES-HDI augmented with our own freedom-index (the dashed line in Figure 5).

Figure 5 – Freedom indices for Italy, 1861-2016

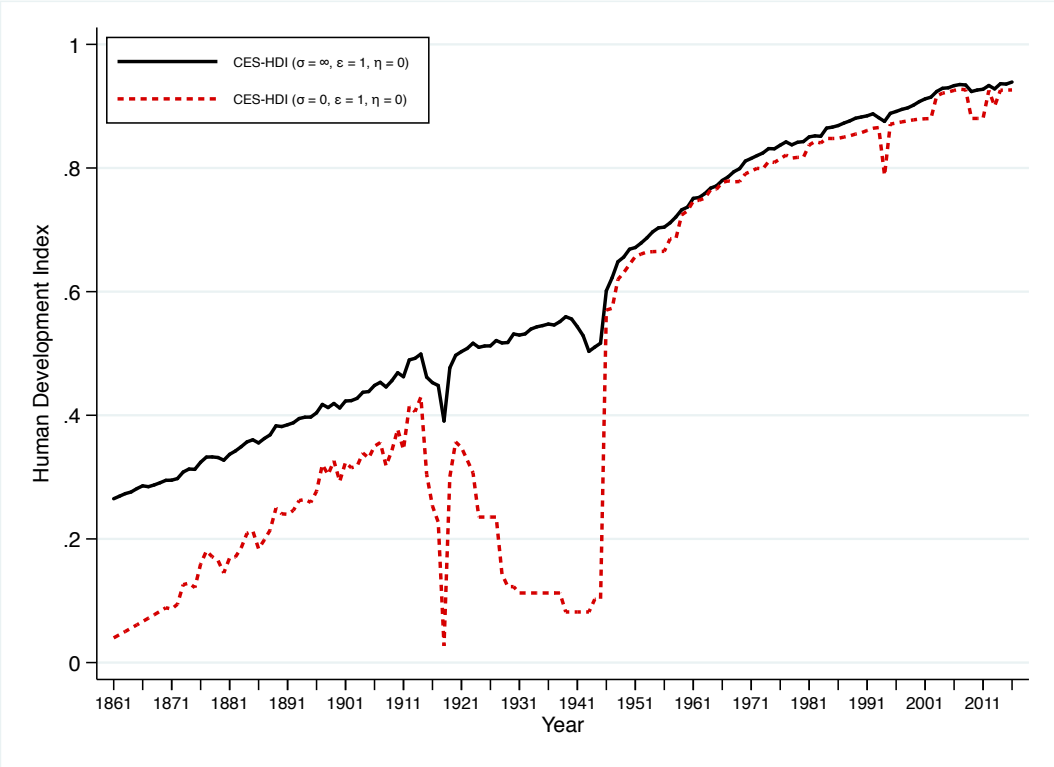


Source: authors' calculations.

Figure 6 shows the "folk theorem" at work, once again. Though the two curves *a)* are based on the same dataset, *b)* adopt the same dimensions in defining human development, and *c)* use the same weighting scheme[20], they tell opposite stories. The CES-HDI variant depicted by a solid line assumes a high elasticity of substitution, and delivers the message that the interwar years saw a steady improvement in aggregate welfare, despite the fascist dictatorship, the dashed line variant, which assumes a low elasticity of substitution, instead shows a dramatic deterioration – historically unparalleled outside of wartime – over the same period. Depending on the parameter σ – the ethical system of the analyst – "anything goes", any history can be narrated.

[20] The weights underlying Figure 6 are 0.3 for each of the three dimensions of the HDI, and 0.1 for the fourth dimension (freedom index); this scheme is the same for both curves. Furthermore, the result is robust to the choice of $\sigma = 0$ and $\sigma = \infty$; other, less extreme values for σ , would deliver the same result stylized in Figure 6.

Figure 6 –Human development index, preferences and trend reversal



Source: authors' elaborations.

7 Conclusion

It all began very promisingly. Faced with the challenge of going beyond the traditional, one-dimensional analysis based on GDP, development economists of the 1990s produced a composite index that was easy to calculate and communicate. Economic historians were not slow to take this idea on board, and began to use the HDI and other composite indices with growing enthusiasm. The original sin, we have argued in this paper, is that the creators of the HDI paid no attention to the "micro-foundations" of the index (Fleurbaey et al. 2009). True, they warned HDI-users about the many choices involved in moving from a single indicator to a composite index, but they focused their recommendations either on the selection of the relative weights for the different dimensions or on the choice of the dimensions themselves (Decanq and Lugo 2013). The fact that the HDI is not built up from individual preferences, but is instead defined directly on aggregate social indicators, is crucial. We have argued that this feature makes the HDI unsuitable for producing social rankings that are consistent with individual rankings. The general conclusion that we have offered is as simple as it is

apparently disappointing: composite indices are a false lead that does not solve the problem of defining well-being synthetically, in such as way as to capture all the aspects of this complex phenomenon.

We have made two arguments, one theoretical, and one empirical. The former hinges on standard tools that we find in economics textbooks. Following de Graaff (1957) and Mas-Colell et al. (1995), any HDI can be interpreted as a paternalistic social welfare function. No matter how trivial the proof of this result might look, the implication is powerful, as it rules out any interpretation of the HDI as an objective, value-free technique. It also rules out any HDI-based conclusion qualifying as evidence-based: historical data feeds the HDI machinery, but the product is a portrait of the owner of the machinery, not of the reality. If the person who uses the HDI is a historian, then the HDI will entirely reflect his/her own judgment of history. HDI does not tell us about the data, nor about history, but about the historian.

If the creators of the HDI aimed to vanquish complexity by constructing an objective aggregate measure of social wellbeing, then the battle can be considered lost. The HDI only gives a ranking of wellbeing consistent with the value system associated with the particular specification of the HDI. The plurality of value systems reviewed in this article implies that any specific HDI is just one among equals – as long as preferences and ethical systems cannot be ranked, so it is for HDIs.

A second argument against the use of composite indices in economic history comes from our extended empirical investigation of Italian living standards during the last 150 years. Our results have been summarized by borrowing the expression "quasi folk theorem" from game theory: we find that (almost) any ranking between two societies can be established by choosing an appropriate specification of the HDI. To demonstrate this result, we introduce a new CES-based HDI family of composite indices. This tool, despite its conceptual simplicity, is a powerful one. We have shown that the emperor has no clothes, that is, almost any conclusion can be reached by choosing the CES-HDI parameters appropriately. We can conclude, for instance, that welfare either increased or decreased during the interwar years, when the Fascists were in power, depending on our choice of the elasticity of the substitution parameter. This has nothing to do with the well-known (and very important) arbitrariness associated with the choice of the weighting scheme. Our analysis has also brought to the light the "troubling trade-offs" –

as Martin Ravallion put it – implicit in selected essays published in top economic history journals. We have argued, that while the marginal rates of substitution between, say, income and longevity, can be legitimately set at any value, many of those reviewed in this paper would be hard to defend. Development economists were puzzled, even embarrassed, when they were first shown that the value of one additional year of life in Zimbabwe was worth half a dollar, compared with more than 9,000 USD in rich countries (Ravallion, 2010). Similar, albeit not as spectacular, gradients have been shown to be built into – even if well hidden – the analysis of most economic historians.

Overall, the time is ripe to pause and rethink the use of composite indices in economic history.

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