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An empirical support of Schopenhauer's ethics: A dynamic panel data analysis on developed and developing countries

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ABSTRACT

This paper covers *all* main theoretical features of Schopenhauer's ethics (i.e., life satisfaction arising from art, compassion based on virtue of justice or virtue of loving, and compassion leading to asceticism) in an analytical model, it translates this analytical model into a statistical model by referring to empirical variables (i.e., household expenditures in recreation and culture for art, the Gini index for compassion based on virtue of justice; percentages of people nationally defined as poor for compassion based on virtue of loving; percentages of believers in Buddhism, Christianity, Hinduism, Islam, Judaism; governmental enrolments and expenditures in primary, secondary and tertiary education; and inter-generational equal access to Earth resources for compassion leading to asceticism), and it estimates this statistical model by using panel data at a country level for 99% of the world's population (i.e., 18% in 34 OECD developed countries and 81% in 128 non-OECD developing countries) from 2000 to 2020. Statistical results about reliability show that Schopenhauer's ethics is supported by observations (i.e., *all* predictions are confirmed within an each individual perspective with reliable variables depicting compassion based on virtue of justice, Christianity, and primary education) and it can explain the observed decreasing life satisfaction within an average individual perspective (i.e., believers in developed countries are showed to be decreased from 86% to 73% and compassion based on virtue of justice, art, and tertiary education turn out to be reliable). Mathematical results about feasibility show that some reliable principles of Schopenhauer's ethics can compensate for the decreasing life satisfaction at a cultural individual level (i.e., compassion based on virtue of justice, Christianity) and some of its reliable principles can compensate the decreasing life satisfaction at a representative individual level (i.e., compassion based on virtue of justice, art). Therefore, the methodological contribution of this paper is twofold. First, it provides an example of interdisciplinary science (i.e., contextual rather than topical, abductive rather than inductive, observational rather than experimental). Second, it highlights (theoretical and empirical) synergies between social (behavioural) sciences and (moral) philosophy: Schopenhauer's ethics turn out to be not only a normative philosophy (i.e., it suggests individual behaviours) but also a positive philosophy (i.e., it explains individual behaviours), within its virtue approach; Schopenhauer's ethics can explain the observed dynamics of life satisfaction at global level, if an utilitarian rather than a virtue approach is adopted.

1. Introduction

Schopenhauer stated that there are three fundamental incentives of human actions (i.e., egoism, malice, and compassion as based on the virtue of justice and the virtue of loving kindness), whereas there are three main steps towards the Will denial (i.e., art contemplation, compassion, and religious or secular asceticism) (Hassan, 2022; Shapshay, 2017; Wicks, 2020). See Table 1 in Section 2.1 for a conceptual summary. Next, life satisfaction has decreased over the last 20 years at global level, both in developed countries (i.e., from 7.5 in 2000 to 6.0 to

2020 in OECD countries) and in less-developed countries (i.e., from 5.7 in 2000 to 4.7 in 2020 non-OECD countries), with a marginal change in relative populations (i.e., from 19% to 80% in OECD and non-OECD countries in 2000, respectively, to 17% and 82% in OECD and non-OECD countries in 2020, respectively) (World Happiness Reports; Hovi & Laamanen, 2021; World Value Survey). See Fig. 1 in Section 3.1 for a graphical dynamics.

The purpose of the present paper is twofold. First, in Section 4.1 about reliability, the goal of this paper is to statistically evaluate whether Schopenhauer's ethics is supported by observations (i.e., the

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expected important and unimportant variables to describe life satisfaction are statistically significant and non-significant, respectively, by referring to *cultural* individuals at global level as well as for developed or developing countries) and whether Schopenhauer’s ethics can explain the decreasing life satisfaction (i.e., the significant variables combined with the variable dynamics account for the reduction of life satisfaction, by referring to *representative* individuals at global level as well as for developed and developing countries). Second, in Section 4.2 about feasibility, the goal of this paper is to mathematically estimate whether some reliable principles of Schopenhauer’s ethics can compensate the decreasing life satisfaction at an each individual level (i.e., by referring to *cultural* individuals at global level as well as for developed and developing countries) and whether some of its principles can compensate for the decreasing life satisfaction at an average individual level (i.e., by referring to *representative* individuals at global level as well as for developed and developing countries).

To do so, I will characterise the main concepts of Schopenhauer’s ethics in Section 2.1, by providing the analytical model in Section 2.2. Next, I will discuss the dynamics of the relevant variables to depict these concepts in Section 3.1, by providing the statistical model in Section 3.2.

Note that I will also obtain insights on intra-generational issues (i.e., impacts of a larger intra-generational economic equality on life satisfaction) and insights on inter-generational issues (i.e., impacts of a larger inter-generational ecological equality on life satisfaction).

In other words, by referring to Zagonari (2019) where (moral) philosophy and theology are showed to function as (behavioural) sciences, I will address the following four research questions:

1. Is Schopenhauer’s ethics supported by empirical evidence within an each individual or cultural individual perspective?
2. Does Schopenhauer’s ethics provide insights to cope with the decreasing life satisfaction within an each individual or cultural individual perspective?
3. Can Schopenhauer’s ethics explain the decreasing life satisfaction within an average individual or representative individual perspective?
4. Does Schopenhauer’s ethics provide insights to cope with the decreasing life satisfaction within an average individual or representative individual perspective?

Note that question 4 adopts a utilitarian approach for intra-generational issues (i.e., a moral action decreases average suffering, regardless of its intentions): indeed, approximating welfare with life satisfaction and adopting an average or representative individual perspective by weighing individuals’ welfare across populations implies that “maximising total welfare” amounts to “maximising average welfare”. In contrast, question 2 adopts an egalitarian approach for inter-generational issues (i.e., all human beings should have access to the same amount of Earth resources, as provided by natural dynamics): indeed, linking the use of Earth’s resources to a given level of life satisfaction and adopting an each or cultural individual perspective by focusing on individuals in both current and future generations, under a tight constraint on Earth resources, implies that “maximising inter-

generational life satisfaction” amounts to “maximising inter-generational equality in access to Earth’s resources”.

The main empirical contribution of the present paper is to provide contextual answers to the previous research questions. In particular, the answer is YES to question 1; the answer is YES to question 2, by relying on compassion based on virtue of justice and virtue of loving; the answer is YES to question 3; the answer is YES to question 4, by relying on compassion based on virtue of justice.

The main methodological contribution of the present paper is twofold. First, this paper provides an example of interdisciplinary science (i.e., contextual rather than topical, abductive rather than inductive, observational rather than experimental). In particular, like Zagonari (2022, 2023), this paper represents an example of interdisciplinary science (i.e., getting hypotheses about ethics from the analyses of texts by Schopenhauer, depicting these hypotheses within a theoretical model, applying statistics to check for reliability of the relationships between ethics and life satisfaction within an each and average individual perspectives, applying mathematics to check for feasibility of the reliable ethics to achieve life satisfaction within an each and average individual perspectives). Note that interdisciplinary science is here characterized as an abductive rather inductive science (Andersen & Hepburn, 2016) (i.e., its hypotheses are not based on observations, but on axioms such as “art provides a temporary alleviation of suffering, whereas compassion provides a permanent alleviation of suffering”), an observational rather than experimental science (Morgan, 2013) (i.e., casual relationships are not identified by implementing experiments, but by applying statistical tests to data on estimated ethical behaviours and observed life satisfaction in 162 countries from 2000 to 2020), and a contextual rather than topical science (Goertz, 2017) (i.e., the tested relationships are presumed to depend on time periods and sampled countries). Second, this paper highlights (theoretical and empirical) synergies between social sciences and philosophy. In particular, social (behavioural) sciences can rely on an additional ethics to explain individual behaviours: Schopenhauer’s ethics turn out to be not only a normative philosophy (i.e., it suggests individual behaviours) but also a positive philosophy (i.e., it explains individual behaviours), within its virtue approach. In addition, (moral) philosophy can refer to an additional approach to interpreting Schopenhauer’s ethics: it can explain the observed dynamics of life satisfaction at global level, if an utilitarian rather than a virtue approach is adopted.

In summary, within a cultural individual perspective, ethics of pessimistic religions (as in Christianity) helps the short-run dissemination of compassion based on virtue of justice and virtue of loving, together with secular shared values (as from primary education) (Pargera and Paralipomena §2, 303). Moreover, within a representative individual perspective, both religious and secular ethics *socially* contrast (in the world as Representation with time, space and casual dimensions) the *natural* suffering of human beings (due to the world as Will without time, space and casual dimensions) (The World as Will and Representation, Volume Two §628, 528). Finally, within both perspectives, religious or secular asceticism helps the achievement of a long-run ecological equilibrium (The World as Will and Representation, Volume One §68, 410).

Table 1

A conceptual summary. Abbreviations: TWD = temporary Will denial, PWD = permanent Will denial, TJ = temporal justice (i.e., immersed in the time-space-casual dimensions), EJ = eternal justice (i.e., distracted from the time-space-casual dimensions).

	Based on	Actions	Outcomes	Observations	Sources
Art (TWD)				Higher household expenditures in recreation and culture (% GDP)	EDU
Compassion (low PWD)	Virtue of justice (TJ)	Harm no one	Intra-generational Relative equality	Lower within (GINI) and between (DC vs. LDC countries) inequality	EDU and REL
	Virtue of loving (TJ)	Help others	Intra-generational Absolute equality	Lower poverty (% people below the nationally defined poverty level)	REL
Ascetism (high PWD)	EJ	Ecological equilibrium	Inter-generational Absolute equality	Lower inter-generational inequality (equal access to Earth resources)	EDU or REL

2. The theoretical framework

In this Section, I will characterise the main concepts of Schopenhauer's ethics (Section 2.1) and provide the analytical model (Section 2.2).

Two methodological remarks are worthy here. First, the theoretical model in Section 2.2 refers to individual ethical behaviours within an each individual perspective. A similar approach (i.e., a theoretical model of individual ethics) has been adopted by utilitarianism going back to Bentham (e.g., Morey, 2018; Zielinska, 2018) or egalitarianism going back to Rawls (e.g., Coker, 2021). To the best of my knowledge, a theoretical model to depict individual ethics by Hegel or Schopenhauer has not been developed, although influences by Hegel's ethics on individual behaviours are likely to be important (e.g., Miettinen, 2020). Second, the empirical model in Section 3.2 is estimated for ethical behaviours within an average individual perspective, where social institutions affect individual ethical behaviours. A similar approach (i.e., the empirical impacts of social institutions on individual ethical behaviours) has been adopted by utilitarianism going back to Bentham in UK (e.g., Hodgson, 2015; Merrill, 2015), egalitarianism going back to Rawls in Europe (e.g., Kuch, 2021), and historicism going back to Hegel in continental Europe (e.g., Ferro, 2023). To the best of my knowledge, an empirical model to depict the impacts of ethics by Schopenhauer on institutions has not been developed, since influences by Schopenhauer's ethics on social institutions are likely to be unimportant (e.g., Northover, 2022).

The purpose of testing whether individuals *consciously* or *unconsciously* adopt Schopenhauer's ethics (i.e., research question #1) suggested to depict the main theoretical features of the individual ethics by Schopenhauer as empirically *observable* at a country level within an each individual or cultural individual perspective (Section 2.1). The possible statistical support should be emphasised (Section 4.1), since individual ethical behaviours are unlikely to be affected by social institutions moulded by Schopenhauer's ethics, whereas institutions were moulded by Bentham's ethics in UK and by Hegel's ethics in continental Europe.

Note that Zagonari (2020) translates into analytical models the religious precepts about environmental sustainability in the five main religions at an individual level, while Zagonari (2021) estimates these models at a country level, where individual ethical behaviours are likely to be affected by religious institutions and secular institutions moulded by religious precepts. Moreover, the purpose of testing whether the same theoretical features of the individual ethics by Schopenhauer can depict the representative individual at global level (i.e., research question #3) suggested to weigh variables by the relative world's populations at a country level. Finally, research questions #2 and #4 apply the estimated coefficient values of the statistically significant variables obtained in answering research questions #1 and #3, respectively.

2.1. Schopenhauer's ethics

The main steps towards the Will denial in Schopenhauer's ethics are as follows:

1. Art provides a temporary alleviation of suffering (Gordon, 2020; Norman, 2017). Note that contemplation of art for the vast majority of people amount to enjoyment of popular uses of established art achievements (e.g., pop music, pop painting)
2. Compassion (i.e., I want good for others: it can be based on virtue of justice which would imply not inflicting harm on others; it can be based on virtue of loving which would imply helping others) provides a permanent alleviation of suffering (i.e., low level of Will denial), where compassion can be based on both religious precepts and secular principles (Northover, 2022). However, the expected ranking of the 5 main religions depends on the division between pessimistic religions (i.e., Christianity > Buddhism > Hinduism) (Mannion, 2020; Reilly, 2020; Ryan, 2017, 2020; Singh, 2020) vs. optimistic religions (i.e., Islam > Judaism) (Golomb, 2020; Wicks, 2017). In particular, pessimistic religions are here characterised as religions where existence is perceived as punishment, salvation is not attained through moral or intellectual work, compassion leads to asceticism and self-renunciation, its doctrine is surrounded by an aura of mystery, and its creeds have some allegorical sense. In contrast, optimistic religions are here characterised as religions where existence is perceived as a divine gift or the purpose of life is found in worldly works, salvation can be reached by human works, moral virtue is not a preparation for an ascetic life, they aim at rendering their doctrines fully intelligible, and they want to be literally true as a factual description of reality (Vanden Auweele, 2015). Next, the expected average significance of tertiary education is small (i.e., intellectual reflection is reserved for the few), although sharing values from primary education is a precondition for acts of compassion (Hassan, 2022). Note that inequity amounts to inequality and injustice, inequality shows a lack of compassion, and rights to approach equality will never compensate egoism (i.e., I want good for myself) or malice (i.e., I want bad for others)
3. Either religious or secular asceticism (i.e., intellectual reflection) provides a permanent alleviation of suffering (i.e., high level of Will denial based on eternal justice). However, its expected average significance is small (i.e., it is reserved for the few) (Janaway, 2020)

Note that science does not provide meaning to life, where science for the vast majority of people amounts to technological applications of beneficial knowledge (e.g., medicine, facilities) (Segala, 2017). Moreover, Christianity includes also the minoritarian Protestantism, although this is included in optimistic religions (Janaway, 2017). Finally,

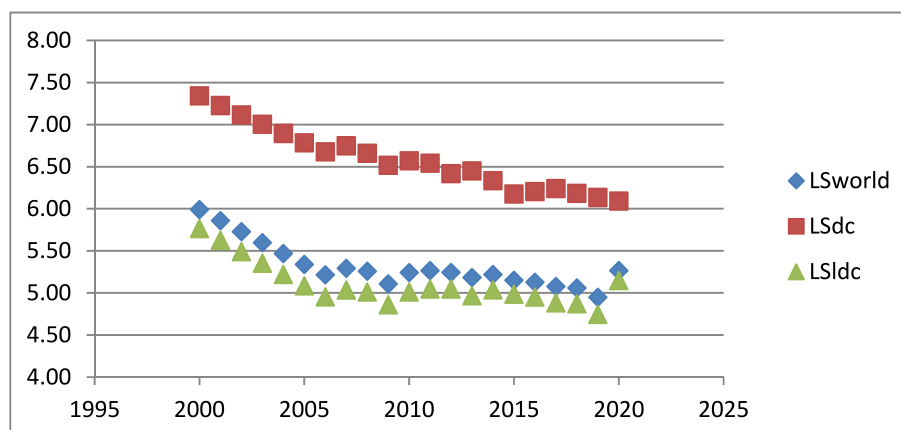


Fig. 1. Life Satisfaction (LS) in [0,10] for OECD (dc), non-OECD (l dc) and world representative individuals.

(primary) education could make people feel similar to others (i.e., an incentive to “not harm others”), while (pessimistic) religion could make people love others (i.e., an incentive to “help others”) (Woods, 2017).

Table 1 summarises the concepts introduced in this section, by providing expected outcomes and observations to be referred to in Section 3.

Note that the State introduces rights (i.e., the opposite of wrongs) with the aim to implement morally grounded actions or to address the damaging aspects of the Will-to-live at the individual level (i.e., Seneca’s law) (i.e., justice = equality) (Baptista et al., 2021). Moreover, I assume that actions arise from an attitude that makes them moral actions (i.e., they are not based on an egoistic attempt to avoid in-life and after-life punishments). Finally, the illuminated individual perceives the unity of all human and non-human beings and there is an eternal fairness in the primeval Will (i.e., eternal justice = inter-generational equality) (Marcin, 2020).

2.2. The analytical model

Within an *each* individual perspective (i.e., Schopenhauer’s ethics refers to each human being, regardless of the cultural context), Zagonari (2016) represented the dynamic inter-relationship between happiness ($hap[t]$) and health ($hea[t]$) at each time t by using two dynamic equations for an individual’s achievements ($y[t]$), in which standardizations are applied to the original family income fy and to the individual’s original health fh , while parameters are represented by the reference group’s average achievement ay , the education level ed , the feasible set for opportunities os , the ethical freedom fr , the number of past periods that affect the current health me , the occupation type oc , and the employment status em :

$$hap[t] = \alpha\{(y[t] - fs) / fs\} + \beta\{(y[t] - y[t-1]) / y[t-1]\} + \gamma\{(y[t] - ay) / ay\} + hea[t] \tag{1}$$

$$hea[t] = os + \sum_{t-me}^{t-1} hap[t] + y[t] + em + ed + oc \tag{2}$$

where:

$$fs = fy + fh - u[t] + fr; \quad oc \leq 0, \quad em \geq 0, \quad me \geq 1; \quad \text{and } u[t] \text{ is in } [-u^*, +u^*]$$

where α represents Aristotle’s contribution to happiness (achievements with respect to the individual’s opportunity set fs), β represents Epicurus’ contribution (short-run achievements), γ represents Zeno’s contribution (achievements with respect to the individual’s reference group), such that $\alpha + \beta + \gamma = 1$, $u[t]$ is the personal uncertainty, and u^* is the long-run equilibrium uncertainty.

Note that I will refer to equations (1) and (2) as “the life model”, by using capital letters to stress that I am moving from a theoretical to an empirical framework.

3. The empirical framework

In this Section, I will discuss the dynamics of the relevant variables to depict the concepts introduced above (Section 3.1) and provide the statistical model to be estimated below (Section 3.2).

3.1. The dataset

The focus on “a life ethics” suggested to construct a sample of 162 world’s countries, by distinguishing developed countries (i.e., 34 OECD countries) from developing countries (i.e., 128 non-OECD countries) to account for different economic contexts and population dynamics. In particular, I referred to 34 OECD countries as the members in 2010 to avoid peculiar estimations for countries moving from one group to the other. Note that the reference to 162 world’s countries allowed me to miss only 1% of the world’s population.

Table 2 provides the main statistics of the variables used within a

Table 2
Summary statistics.

	Mean	SD	Max	Min	Median
LS	5.41	1.13	8.02	2.38	5.36
GDP	16.990	19.44	141.635	0.435	9.850
GINI	38.57	7.75	65.00	23.00	38.00
POV	17.47	18.21	82.30	0.00	14.40
ART	0.65	1.71	7.70	0.00	0.00
BUD	0.04	0.16	0.87	0.00	0.00
CHR	0.50	0.38	0.99	0.00	0.60
HIN	0.02	0.09	0.74	0.00	0.00
JUD	0.01	0.06	0.74	0.00	0.00
ISL	0.29	0.38	1.00	0.00	0.06
EGP	3026	3695	24283	9	1380
EGS	3539	4657	24357	9	1346
EGT	3101	5181	55287	0	961
HLEB	61.66	8.28	77.00	32.00	64.00
ELE	2.72	4.57	54.80	0.00	0.96
OIL	1.74	2.57	21.42	0.00	0.74
WEB	30.86	29.53	100.00	0.00	21.00

cultural individual perspective at global level. Note that the same variables within a representative individual perspective will be obtained by weighing them according to the relative populations at a country level.

Fig. 1 depicts the LS dynamics of the dependent variable for the representative individuals in 34 developed countries, in 128 less-developed countries and in 162 world’s countries (i.e., a dependent variable in Section 4.1). Note that the higher level of LS in 2020 in developing countries is likely to be due to the COVID pandemic (i.e., more people answered to be satisfied with life simply because they were still alive) (Medina-Hernandez et al., 2023).

Appendix A presents the dynamics of all independent variables for the global, developed and developing representative individuals. In particular, science is depicted by the following variables: HLEB = healthy life expectancy at birth, POW = MWh per capita per year, OIL = ton of oil equivalent per capita per year, WEB = % individuals using internet. In other words, I referred to the main technological advancements that affected the real life of many people. Moreover, I used the household expenditure as a percentage of GDP to represent art enjoyment, the Gini index to depict the virtue of justice (i.e., lack of inequality), and the percentage of poor people as defined at a national level to represent the virtue of loving (i.e., lack of poverty). Finally, REL are depicted by believers in percentages in each country, whereas EDU is depicted by the education expenditure (USD) per student multiplied by the gross enrolment (%) for primary EGP, secondary EGS and tertiary EGT education. In other words, EGP, EGS and EGT combine quality and quantity of the three main education levels.

Note that linear interpolations between data in different years for the same country are applied if some data are missing. In particular, this interpolation method is similar to the item-level imputation for a linear growth model suggested by Enders (2022); it is adequate in my context because it does not imply linear dependence between parameters across panels, since I replace some missing data for each panel separately; the resulting dataset is used to estimate linear relationships; and it provides unbiased parameter estimates and standard errors. In other words, instead of making assumptions about the data distribution to obtain the missing data, I replace missing data under the assumption that they represent a linear growth model.

3.2. The statistical model

Equations (1) and (2) of “the life model” require some *theoretical* adjustments to focus on Schopenhauer’s ethics. Indeed, $hea[t]$ must be replaced by the technological advancements (TEC) which could make life more satisfactory. Thus, the variables expected to be significant and non-significant in affecting LS as a measure of $hap[t]$ specified in Section 2.1 should be included in the following equations:

$$LS_{i,t} = LnGDP_{i,t} + GINI_{i,t} + POV_{i,t} + ART_{i,t} + EDU_{i,t} + REL_{i,t} + TEC_{i,t} + YEAR_i \tag{3}$$

$$TEC_{i,t} = HLEB_{i,t} + ELE_{i,t} + OIL_{i,t} + WEB_{i,t} \tag{4}$$

where

$$REL = BUD + CHR + HIN + ISL + JUD$$

$$EDU = GEP * EEP + GES * EES + GET * EET$$

Note that GINI, POV and ART are outcome variables, whereas EDU and REL are source variables. Moreover, the Epicurus, Aristotle and Zeno contributions will be measured by the impact on LS of an increase in GDP, EGS or EGT and POV, respectively. Finally, the time trend (YEAR) enables to explain dynamics discussed in Section 3.1 (instead of differences for source variables and levels for outcome variables), while the linear relationships are maintained to be consistent with the analytical model presented in Section 3.2 (apart from LnGDP as a well-established result in the literature) and to use the estimated parameter values in Section 4.2 for mathematical calculations on feasibility of statistically significant variables.

Equations (3) and (4) require some empirical adjustments to provide consistent estimations. Indeed, the relatively few observations at the global, OECD and non-OECD levels did not allow me to use latent variables with fixed effects. Thus, the variables expected to be significant and non-significant in affecting LS specified in equations (3) and (4) are included in the following equation:

$$LS_{i,t} = LnGDP_{i,t} + GINI_{i,t} + POV_{i,t} + ART_{i,t} + EDU_{i,t} + REL_{i,t} + TEC_{i,t} + YEAR_i \tag{5}$$

where

$$REL = BUD + CHR + HIN + ISL + JUD$$

$$EDU = GEP * EEP + GES * EES + GET * EET$$

$$TEC = HLEB + ELE + OIL + WEB$$

Note that I will not weigh variables by the world's relative populations to look for statistical support of Schopenhauer's ethics (i.e., to test the impacts on life satisfaction of cultural differences in section 4.1 about reliability), whereas I will weigh variables by the world's relative populations in each country to search for a statistical explanation of LS dynamics (i.e., to test the impacts on life satisfaction of cultural differences in section 4.1 about feasibility). Moreover, natural dynamics in terms of resource use or pollution production is not included, since nature is the driving force in Schopenhauer's ethics, but it is what human ethics should try to cope with. However, the different relationships with nature in OECD and non-OECD countries suggested to perform estimation at global level as well as for developed and developing countries. Finally, some variables depict policies directly (e.g., EDU, TEC), whereas some other variables depict policies only indirectly (e.g., GINI, POV, ART), with variables about religions representing contexts rather than policies.

Therefore, combining theoretical insights from Section 2.1 with statistical variables depicted in this Section leads to the following predictions about impacts on LS:

- a. GDP should have a positive but non-significant impact (i.e., Schopenhauer's ethics could be applied to all people in the world)
- b. GINI should have a negative and significant impact (i.e., compassion is the core of Schopenhauer's ethics)
- c. POV should have a negative but non-significant impact (i.e., a small proportion of compassion translates into altruism)

- d. ART should have a positive but non-significant impact (i.e., art contemplation provides only a temporary alleviation of suffering)
- e. REL should have positive impacts, but ranked in terms of significance and impact levels as CHR > BUD > HIN > ISL > JUD (i.e., pessimistic religions > optimistic religions)
- f. EDU should have positive impacts, although ranked in terms of significance and impact levels as EGP > EGS > EGT (i.e., shared values > intellectual reflections)
- g. TEC should have a positive or negative but non-significant impact (i.e., science translated into technology does not provide a meaning to life)

Note that the predicted non-significant impacts of ART and TEC are peculiar to Schopenhauer's ethics. Moreover, YEAR should have a negative and significant impact, if LS decreased from 2020 to 2020 not only for the average representative individual, but also for the cultural representative individual. Finally, the predicted rankings of REL and EDU are peculiar to Schopenhauer's ethics.

4. The empirical results

In this Section, I will answer the research questions 1 and 3 for the cultural and representative individuals, respectively (Section 4.1) and the research questions 2 and 4 for the cultural and representative individuals, respectively (Section 4.2). In particular, the statistical model obtained in Section 3.2, by modifying the analytical model developed in Section 2.2 according to the dataset presented in Section 3.1, will be tested in Section 4.1 in terms of its reliability, by applying the Levin-Lin-Chu unit root test (i.e., stationarity) to both dependent and (statistically significant) independent variables as well as the Granger test (i.e., causality) to the (statistically significant) independent variables. Section 4.2 will test the independent variables identified as reliable in Section 4.1 in terms of their feasibility.

4.1. Reliability

Table 3 for cultural individuals at global level (i.e., 162 countries) shows that all predictions highlighted in Section 3.2 are confirmed. In particular, LS significantly decreased (i.e., YEAR has a negative significant impact). Moreover, most TEC variables are non-significant, apart from the use of electric power. Finally, differences between countries are crucial (i.e., $\rho = 0.93$).

Note that impacts of GDP, POV and EGP or EGT on LS which represent Epicurus, Zeno and Aristotle contributions to happiness, respectively, turned out to be non-significant.

In addition, Table 4 for developed countries (i.e., 34 OECD countries) and Table 5 for developing countries (i.e., 128 non-OECD countries) show that the main insights are confirmed (i.e., negative impact of GINI, ranks of religions), although some specificities should be stressed. As for developed countries, ELE is replaced by HLEB as the TEC component with a positive and significant impact, while WEB has now a negative and significant impact: in addition, GDP becomes significant and GINI becomes insignificant, although they keep the same signs. As for developing countries, JUD has a larger but non-significant impact and all TEC components become insignificant: in addition, EGP becomes non-significant, although it keeps the same sign.

In summary, ethical precepts or principles affecting the each individual's LS are similar in developed and developing countries.

Table 6 for representative individuals at global level (i.e., 162 countries) shows that only the negative and significant impact of GINI is confirmed, apart from the use of electric power within the TEC components. In particular, apart from the weighed OIL that becomes negative and significant, the weighed GDP becomes significant, the weighed POV becomes positive and significant, the weighed ART becomes significant, the weighed EGS becomes negative and significant, the weighed EGT becomes positive and significant. Moreover, rankings of

Table 3

Life Satisfaction (LS) in [0,10] for the world CULTURAL individuals as a function of relevant variables for the Schopenhauer's ethics. CONS = the constant term. Number of observations = 3402, within $R^2 = 0.056$; $F(17, 161) = 3.80$, $P < 0.001$, $\sigma_u = 1.449$, $\sigma_e = 0.3902$, $\rho = 0.9324$.

LS	Coef.	Robust Std. Err.	t	P > t	[95% Conf. Interval]	
LnGDP	.157652	.1088676	1.45	0.150	-.0573406	.3726446
GINI	-.0262928	.0089378	-2.94	0.004	-.0439432	-.0086424
POV	-.00663	.0046534	-1.42	0.156	-.0158196	.0025596
ART	.0382264	.2178054	0.18	0.861	-.3918974	.4683502
BUD	7.346556	6.974727	1.05	0.294	-6.427191	21.1203
CHR	1.056181	.2612751	4.04	0.000	.5402129	1.572149
HIN	8.070668	8.931391	0.90	0.368	-9.567115	25.70845
ISL	1.008232	2.038563	0.49	0.622	-3.017539	5.034003
JUD	1.050875	8.885745	0.12	0.906	-16.49677	18.59852
EGP	.000034	.0000169	2.02	0.045	7.40e-07	.0000673
EGS	3.85e-06	.0000172	0.22	0.823	-.0000301	.0000378
EGT	-.0000113	.0000115	-0.98	0.330	-.0000341	.0000115
HLEB	.008737	.0178563	0.49	0.625	-.0265257	.0439998
ELE	.0231953	.012465	1.86	0.065	-.0014207	.0478114
OIL	-.0032634	.0428796	-0.08	0.939	-.0879425	.0814156
WEB	.0001034	.0016407	0.06	0.950	-.0031367	.0033436
YEAR	-.0204447	.0094476	-2.16	0.032	-.0391019	-.0017875
CONS	45.28511	18.27558	2.48	0.014	9.194341	81.37587

Table 4

Life Satisfaction (LS) in [0,10] for the OECD CULTURAL individuals as a function of relevant variables for the Schopenhauer's ethics. CONS = the constant term. Number of observations = 714, within $R^2 = 0.238$; $F(17, 33) = 35.73$, $P < 0.001$, $\sigma_u = 2.8747$, $\sigma_e = 0.2442$, $\rho = 0.9928$.

LS	Coef.	Robust Std. Err.	t	P > t	[95% Conf. Interval]	
LnGDP	.7615048	.2854552	2.67	0.012	.1807418	1.342268
GINI	-.0175418	.019095	-0.92	0.365	-.0563908	.0213072
POV	.0032865	.0093537	0.35	0.728	-.0157438	.0223167
ART	.0808043	.0764245	1.06	0.298	-.0746826	.2362912
BUD	3.532679	5.854674	0.60	0.550	-8.378745	15.4441
CHR	1.242866	1.531067	0.81	0.423	-1.872113	4.357846
HIN	-2.861303	11.98565	-0.24	0.813	-27.2463	21.52369
ISL	-3.484289	3.270132	-1.07	0.294	-10.13742	3.168844
JUD	-18.69356	6.271104	-2.98	0.005	-31.45222	-5.934906
EGP	.0000326	.0000164	1.99	0.055	-6.97e-07	.0000659
EGS	6.20e-06	.0000189	0.33	0.745	-.0000323	.0000447
EGT	.0000107	.0000186	0.57	0.571	-.0000272	.0000485
HLEB	.0555597	.0291711	1.90	0.066	-.0037894	.1149088
ELE	.0038019	.0189729	0.20	0.842	-.0347988	.0424026
OIL	.0756714	.0714472	1.06	0.297	-.0696891	.2210319
WEB	-.0076419	.0022444	-3.40	0.002	-.0122082	-.0030755
YEAR	-.031267	.0121094	-2.58	0.014	-.0559037	-.0066302
CONS	62.55247	23.56619	2.65	0.012	14.60669	110.4983

Table 5

Life Satisfaction (LS) in [0,10] for the non-OECD CULTURAL individuals as a function of relevant variables for the Schopenhauer's ethics. CONS = the constant term. Number of observations = 2688, within $R^2 = 0.054$; $F(17, 127) = 2.52$, $P = 0.001$, $\sigma_u = 1.7104$, $\sigma_e = 0.4174$, $\rho = 0.9437$.

LS	Coef.	Robust Std. Err.	t	P > t	[95% Conf. Interval]	
LnGDP	.1381945	.1127455	1.23	0.223	-.0849085	.3612974
GINI	-.0273984	.009744	-2.81	0.006	-.04668	-.0081169
POV	-.0075313	.0046643	-1.61	0.109	-.016761	.0016984
ART	.0912179	.6230256	0.15	0.884	-1.141637	1.324073
BUD	8.564974	7.490409	1.14	0.255	-6.257193	23.38714
CHR	1.091793	.2927952	3.73	0.000	.5124045	1.671182
HIN	7.698977	9.736494	0.79	0.431	-11.56779	26.96574
ISL	1.227434	2.326312	0.53	0.599	-3.375917	5.830786
JUD	34.94729	23.55839	1.48	0.140	-11.67052	81.5651
EGP	.0000193	.0000312	0.62	0.538	-.0000425	.0000811
EGS	6.86e-06	.0000263	0.26	0.795	-.0000452	.0000589
EGT	-.0000157	.0000131	-1.20	0.234	-.0000417	.0000103
HLEB	.0089593	.0190436	0.47	0.639	-.0287245	.0466432
ELE	-.0361558	.0621191	-0.58	0.562	-.1590782	.0867666
OIL	.0208736	.0540264	0.39	0.700	-.0860349	.1277821
WEB	.0015217	.0019211	0.79	0.430	-.0022799	.0053232
YEAR	-.02192	.011296	-1.94	0.055	-.0442727	.0004327
CONS	48.05973	22.12451	2.17	0.032	4.279322	91.84014

Table 6

Life Satisfaction (LS) in [0,10] for the world REPRESENTATIVE individuals (WLS) as a function of relevant variables for the Schopenhauer's ethics. CONS = the constant term. Number of observations = 3353, within $R^2 = 0.750$; $F(17, 160) = 4601.12$, $P < 0.001$, $\sigma_u = 28.1067$, $\sigma_e = 0.7297$, $\rho = 0.9993$.

WLS	Coef.	Robust Std. Err.	t	P > t	[95% Conf. Interval]	
LnWGDP	.2521121	.1449137	1.74	0.084	-.0340782	.5383024
WGINI	-.0380788	.0193519	-1.97	0.051	-.0762969	.0001394
WPOV	.0666158	.0257624	2.59	0.011	.0157376	.117494
WART	2.763699	1.120221	2.47	0.015	.5513724	4.976026
WBUD	-27.22444	13.23989	-2.06	0.041	-53.37193	-1.076957
WCHR	1.432849	2.461574	0.58	0.561	-3.428518	6.294216
WHIN	27.24245	2.991432	9.11	0.000	21.33467	33.15024
WISL	9.217362	7.290584	1.26	0.208	-5.180823	23.61555
WJUD	75.44014	68.31411	1.10	0.271	-59.47351	210.3538
WEGP	.0001363	.0002193	0.62	0.535	-.0002968	.0005694
WEGS	-.0005455	.0002104	-2.59	0.010	-.0009611	-.00013
WEGT	.0001937	.0000499	3.88	0.000	.0000951	.0002922
WHLEB	-.0046205	.022042	-0.21	0.834	-.0481514	.0389104
WELE	1.463754	.8211163	1.78	0.077	-.1578694	3.085378
WOIL	-2.340542	1.25398	-1.87	0.064	-4.817028	.1359449
WWEB	.002947	.0064632	0.46	0.649	-.0098171	.0157112
YEAR	-.01146	.0089056	-1.29	0.200	-.0290476	.0061275
CONS	22.17799	17.19326	1.29	0.199	-11.77701	56.13299

Table 7

Life Satisfaction (LS) in [0,10] for the OECD REPRESENTATIVE individuals (WLS) as a function of relevant variables for the Schopenhauer's ethics. CONS = the constant term. Number of observations = 693, within $R^2 = 0.860$; $F(17, 32) = 98024.76$, $P < 0.001$, $\sigma_u = 2.2168$, $\sigma_e = 0.1868$, $\rho = 0.9929$.

WLS	Coef.	Robust Std. Err.	t	P > t	[95% Conf. Interval]	
LnWGDP	.2430878	.095373	2.55	0.016	.0488193	.4373562
WGINI	.0152623	.0270252	0.56	0.576	-.0397862	.0703109
WPOV	.0089774	.019625	0.46	0.650	-.0309973	.0489522
WART	.1529026	.1644761	0.93	0.360	-.1821242	.4879294
WBUD	6.430952	1.735478	3.71	0.001	2.895899	9.966005
WCHR	2.821437	.8544681	3.30	0.002	1.080943	4.561932
WHIN	41.21534	26.12043	1.58	0.124	-11.99023	94.42091
WISL	2.519267	8.454488	0.30	0.768	-14.70196	19.74049
WJUD	22.87315	9.261766	2.47	0.019	4.007553	41.73875
WEGP	-1.16e-06	.0000757	-0.02	0.988	-.0001554	.0001531
WEGS	.0000142	.0000518	0.27	0.785	-.0000913	.0001198
WEGT	.0000431	.0000123	3.51	0.001	.0000181	.0000681
WHLEB	-.0329079	.0239668	-1.37	0.179	-.0817267	.0159108
WELE	-.071972	.0775973	-0.93	0.361	-.2300325	.0860885
WOIL	.4933986	.1370779	3.60	0.001	.2141801	.7726172
WWEB	-.010751	.0026578	-4.05	0.000	-.0161647	-.0053373
YEAR	-.0075025	.0038602	-1.94	0.061	-.0153654	.0003604
CONS	16.42285	7.507479	2.19	0.036	1.130615	31.71508

Table 8

Life Satisfaction (LS) in [0,10] for the non-OECD REPRESENTATIVE individuals (WLS) as a function of relevant variables for the Schopenhauer's ethics. CONS = the constant term. Number of observations = 2660, within $R^2 = 0.799$; $F(17, 127) = 16295.83$, $P < 0.001$, $\sigma_u = 35.0905$, $\sigma_e = 0.7260$, $\rho = 0.9995$.

WLS	Coef.	Robust Std. Err.	t	P > t	[95% Conf. Interval]	
LnWGDP	.1365662	.1452967	0.94	0.349	-.1509498	.4240821
WGINI	-.050422	.0221001	-2.28	0.024	-.0941542	-.0066899
WPOV	.0550266	.0210555	2.61	0.010	.0133616	.0966917
WART	13.51567	6.763464	2.00	0.048	.1319923	26.89934
WBUD	-45.40608	8.132935	-5.58	0.000	-61.49969	-29.31247
WCHR	5.339391	2.877844	1.86	0.066	-.3553437	11.03413
WHIN	27.18843	2.617067	10.39	0.000	22.00973	32.36713
WISL	10.51325	6.314275	1.66	0.098	-1.981563	23.00806
WJUD	58.32074	44.69481	1.30	0.194	-30.12223	146.7637
WEGP	-.0001717	.0003711	-0.46	0.644	-.000906	.0005627
WEGS	-.0001179	.0003671	-0.32	0.749	-.0008443	.0006084
WEGT	.0000627	.0000691	0.91	0.366	-.000074	.0001993
WHLEB	.0046734	.0219212	0.21	0.832	-.0387048	.0480516
WELE	2.45001	.5331065	4.60	0.000	1.395089	3.504932
WOIL	-4.809605	.953888	-5.04	0.000	-6.697177	-2.922033
WWEB	-.0010977	.0055034	-0.20	0.842	-.0119879	.0097925
YEAR	-.0107886	.009992	-1.08	0.282	-.030561	.0089838
CONS	22.81858	19.31395	1.18	0.240	-15.40025	61.03741

weighted religions are different. Finally, YEAR becomes non-significant. However, Table 7 for developed countries (i.e., 34 OECD countries) and Table 8 for developing countries (i.e., 128 non-OECD countries) show that YEAR is significant for developed countries and non-significant for developing countries. In other words, Tables 7 and 8 represent the LS dynamics depicted in Fig. 1.

Note that impacts of weighed GDP, POV and EGP or EGT on LS which represent Epicurus, Zeno and Aristotle contributions to happiness, respectively, turned out to be significant.

In addition, Table 7 for developed countries (i.e., 34 OECD countries) and Table 8 for developing countries (i.e., 128 non-OECD countries) show that most insights are *not* confirmed (i.e., positive impacts of GDP, POV, ART; negative impact of GINI; ranks of religions), and many specificities should be stressed. As for developed countries, BUD, CHR and JUD in religions show positive and significant impacts (i.e., due to the decrease in believers, these religions could have produced an overall impact on LS by around $4.16 = (0.86-0.73) * 32.12$), while OIL and WEB in TEC components show significant positive and negative impacts, respectively. As for developing countries, CHR, HIN and ISL in religions show positive and significant impacts (i.e., due to the increase in believers, these religions could have produced an overall impact on LS by around $2.58 = (0.78-0.72) * 43.02$), while EGT in EDU levels show a non-significant positive impact.

In summary, governmental policies to increase the *average* individual's LS should be different in developed and developing countries.

Appendix B presents the Granger causality tests and the Levin-Lin-Chu unit root convergence tests for variables that turned out to be statistically significant in Tables 3 and 6. In particular, within the cultural perspective, all significant variables (i.e., GINI, CHR, EGP) show causality and convergence. In contrast, within the representative perspective, only some of the significant variables (i.e., GDP, GINI, POV, ART, BUD, HIN, EGS, EGT) turned out to show causality (i.e., GINI, ART, EGT), with only GINI showing convergence.

Note that LS converges in 8 years. Moreover, POV has a positive and significant impact (i.e., egoism increases the average LS). Finally, apart from GINI (i.e., compassion based on the virtue of justice), sign and significance of impacts are different in Tables 3–5 with respect to Tables 6–8. Indeed, Tables 3–5 represent the Schopenhauer's virtue perspective, whereas Tables 6–8 represent an alternative utilitarian perspective. In particular, duty ethics is deontological and holds that actions are moral if they abide by rules laid down by external sources, regardless of their outcomes. External sources can be religious (e.g., precepts in BUD, CHR, HIN, ISL, JUD) or secular (e.g., categorical imperative in Kant). Duty ethics is problematic if people obey different rules, since a comparison of authorities is required. The focus is on actions by individuals, although many moral individuals can produce social benefits. Note that rights of human beings, non-human beings and nature could be simplistically assumed to enforce duties of human beings to human beings, non-human beings and nature (e.g., Locke).

Virtue ethics is teleological and holds that actions are moral if they were taken by a virtuous person. The identification of what is virtue and what is not virtue is based on the meaning of life which can range from secular and eudemonic versions of virtue (e.g., wisdom, prudence, justice, fortitude, courage, liberality, magnificence, magnanimity, temperance in Aristotle) to religious and non-eudemonic versions of virtue (e.g., respect, benevolence, justice, propriety, wisdom, sincerity, loyalty, filial piety, continence in Confucius). Virtue ethics is problematic if people disagree on the purpose of human life. The focus is on human beings as they-should-be, where many virtuous people will produce a virtuous society.

Utilitarian ethics is teleological and holds that actions are moral if they maximise the greatest good for the greatest number of people. The measure of good or pleasure can be purely quantitative (e.g., no distinction between forms of pleasure in the act utilitarianism by Bentham) or also qualitative (e.g., a greater pleasure is assigned to some particular actions over some other actions in the rule utilitarianism by

Mill). Utilitarian ethics is problematic if some people sustain detrimental outcomes, whereas others have beneficial outcomes from a given action. The focus is on overall benefits for the whole society, so detrimental consequences for some people are acceptable if these are more than compensated by beneficial consequences for many people. Note that a moral society can arise also from egoistic individuals (e.g., Smith) (e.g., Christensen, 2020).

The present paper adopts a secular non-eudemonic virtue ethics for cultural individuals and a secular rule utilitarian ethics for representative individuals, by depicting duty ethics based on religions for both cultural and representative individuals.

4.2. Feasibility

The coefficient values obtained in Table 3 (i.e., within a cultural individual perspective) only for the significant variables depicting Schopenhauer's ethics enables to perform simple calculations to achieve the following insights:

- A reduction of within inequality (i.e., a smaller GINI index of around 1.92) could compensate for the observed LS reduction (i.e., 0.05 point from 5.52 in 2000 to 5.47 in 2020)
- An increase in love for neighbours (i.e., a larger CHR percentage of around 5) could compensate for the observed LS reduction (i.e., 0.05 point from 5.52 in 2000 to 5.47 in 2020)

Note that EGP is unfeasible, whereas the achievement of the inter-generational equality representing asceticism in terms of equal access to Earth's resources (i.e., Ecological Footprint EF = 1.7), under the assumption of an increase in efficiency by 50%, implies an average global GDP in equilibrium at 2230 USD from the current level at 3466 USD (from GDP = 3751 EF - 7335 with EF = 1.7 x 1.5) and a LS reduction of around 1.12 (from Ln(1236) x 0.157).

The coefficient values obtained in Table 6 (i.e., within a representative individual perspective) only for the significant variables depicting Schopenhauer's ethics enables to perform simple calculations to achieve the following insights:

- An increase in the average global GDP (i.e., a larger GDP of around 1.5% with respect to a global average of 3466) could compensate for the observed LS reduction (i.e., 1 point from 6 to 5). However, this variable did not meet the causality test (Appendix B)
- A reduction of the within relative inequality (i.e., a smaller GINI index of around 26 with respect to a global average of 61) could compensate for the observed LS reduction (i.e., 1 point from 6 to 5)
- An increase of household expenditure in recreation and culture in percentage of GDP (i.e., a larger ART of around 0.36% with respect to a global average of 0.9% to be lower than the OECD level at 1.6%) could compensate for the observed LS reduction (i.e., 1 point from 6 to 5). However, this variable did not meet the stationary test (Appendix B)

Note that the weighed EGT is unfeasible, whereas the achievement of the inter-generational equality representing asceticism in terms of equal access to Earth's resources (i.e., Ecological Footprint EF = 1.7), under the assumption of an increase in efficiency by 50%, implies an average global GDP in equilibrium at 2230 USD from the current level at 3466 USD (from GDP = 3751 EF - 7335 with EF = 1.7 x 1.5) and a LS reduction of around 1.79 (from Ln(1236) x 0.252).

5. Discussion

This paper applied mathematics and statistics to moral philosophy (Zagonari, 2019). Insights from statistics are surprising, since Schopenhauer's ethics (i.e., one of the most neglected philosopher in the Western tradition) turned out to be empirically supported (i.e., it can

explain real behaviours of many people), by performing estimations based on *the best available* data (i.e., observations of actual behaviours for individuals in 162 countries) (Migotti, 2020). In other words, Schopenhauer's ethics is reliable at global level. Next, insights from philosophy are intriguing, since a different interpretation of Schopenhauer's ethics (i.e., a Mill's rule utilitarian rather than a virtue approach) was showed to be theoretically possible (i.e., it can cope with life dissatisfaction of many people), by relying on *the only possible* methodology (i.e., mathematical calculations based on statistically significant impacts) (Guay, 2020). In other words, Schopenhauer's ethics is feasible at global level.

Note that Schopenhauer's ethics will never cope with the decreasing life satisfaction of future generations due to the achievement of a long-run ecological equilibrium based on inter-generational equity among human-beings.

The main *strengths* of the present study can be summarised as follows:

- I covered all main theoretical features of Schopenhauer's ethics (Table 1)
- I represented these features in a statistical model (Equation (5))
- I estimated this statistical model by using panel data from 2000 to 2020 on observed behaviours rather stated attitudes or intentions at a country level for 99% of the world's population (Table 3 to Table 8).

Note that data at a country level allowed me to disregard the impacts of fortune and misfortune which are instead crucial in surveys at an individual level.

The main *weaknesses* of the present study can be summarised as follows:

- It does not account for intentions of observed behaviours and so it does not account for morality of observed behaviours within Schopenhauer's ethics. However, under the Schopenhauer's assumption that individuals are egoist, if a behaviour other than egoism is observed, it is likely that it is an intentional behaviour.
- It uses few variables to depict "a life ethics" of all human beings. However, I represented all main features of Schopenhauer's ethics, by referring to 162 different cultures (i.e., one country, one culture) as accounted for by fixed effects (i.e., impacts of the ethical principles are evaluated by excluding cultural differences)
- It does not suggest only governmental policies (e.g., primary education EGP and tertiary education EGT), but also social states (e.g., relative inequality depicted by GINI and household expenditures for recreation and culture depicted by ART). However, a reduction of relative inequality or an increase in household expenditures for recreation and culture can be achieved by many specific policies.

Note that the analyses performed at global level as well as for the developed and developing countries allowed me to confirm that the main insights about Schopenhauer's ethics are statistically supported in all group of countries and to confirm that the observed decreasing life satisfaction is statistically significant in developed but not in developing countries.

6. Conclusion

The present paper achieved both its purposes. First, about reliability, this paper managed to statistically evaluate whether Schopenhauer's ethics is supported by observations (i.e., all predictions are confirmed within an each individual perspective with reliable Gini, Christianity, primary education); and whether it can explain the decreasing life satisfaction (i.e., believers in developed countries decreased from 85% to 73% with reliable Gini, art, tertiary education). Second, about feasibility, this paper managed to mathematically estimate whether some reliable principles of Schopenhauer's ethics can compensate the

decreasing life satisfaction at a cultural individual level (i.e., Gini, Christianity); and whether some of its principles can compensate for the decreasing life satisfaction at a representative individual level (i.e., Gini, art). In other words, intra-generational absolute and relative equity (i.e., compassion based on virtue of justice or virtue of loving from religious precepts or secular principles) is crucial in both cultural and representative perspectives.

In addition, three main insights were obtained by this study. Within an each individual perspective, compassion based on both virtue of justice and virtue of loving, either in pessimistic religions such as Christianity, Buddhism, Hinduism or in education such as gross enrolment in primary education, suggests that religions are useful for individuals, by satisfying a metaphysical need, and religions are beneficial for societies, where religion (i.e., metaphysics of people) cannot be replaced by technology (i.e., science for people). Moreover, within an average individual perspective, religious and secular ethics based on *social* self-conscious can compensate the reduction of life satisfaction due to *natural* self-conscious, by contrasting the III principle of thermodynamics (i.e., self-science succeeded because it increased egoism and entropy) (Dalton, 2018). Finally, within both perspectives, religious or secular asceticism helps the achievement of a long-run ecological equilibrium at small costs in terms of reduced life satisfaction.

Future research should refer to better detailed data (e.g., Protestant believers within Christian believers, household expenditures in music within culture expenditures).

CRedit authorship contribution statement

Fabio Zagonari: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Resources, Funding acquisition, Supervision, Software, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssaho.2023.100706>.

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