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Scientists' views on economic growth versus the environment: a questionnaire survey among economists and non-economists

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ABSTRACT

The academic debate on economic growth, the environment and prosperity has continued for many decades now. In 2015, we conducted an online survey of researchers' views on various aspects of this debate, such as the compatibility of global GDP growth with the 2 °C climate policy target, and the timing and factors of (never-) ending growth. The 814 respondents have a wide range of backgrounds, including growth theory, general economics, environmental economics, ecological economics, environmental social sciences, and natural sciences. The two main aims are: (1) to provide an overview of agreements and disagreements across research fields, and (2) to understand why opinions differ. The survey results indicate substantial disagreement across research fields on almost every posed question. Environmental problems are most frequently mentioned as a very important factor contributing to an end of economic growth. Furthermore, we find that researchers are more skeptical about growth in the context of a concrete problem like the compatibility with the 2 °C climate target than when considering environmental problems more generally. Many respondents suggest ideology, values and worldviews as important reasons for disagreement. This is supported by the statistical analysis, showing that researchers' political orientation is consistently correlated with views on growth.

1. Introduction

The old debate about economic growth and the environment has recently been revived. A general skepticism about the idea of an ever-growing economy was already expressed a long time ago by such eminent scholars as John Stuart Mill (1848) and John Maynard Keynes (1930). The particular focus on the environmental aspects of growth essentially emerged in the 1960s (e.g., Mishan, 1967) and received considerable attention in the 1970s, notably through the publication of the "The Limits to Growth" report by Meadows et al. (1972) other relevant contributions include Nordhaus and Tobin, 1972; Daly, 1973; Easterlin, 1974; Hirsch, 1976; Scitovsky, 1976; Sen, 1976; Hueting, 1980). For various reasons, these discussions eventually waned somewhat (Buttel et al., 1990). However, following the recent global economic crisis and the challenges posed by climate change, biodiversity loss and other global environmental changes, economic growth has become again a contested issue in academia (Turner, 2008; Victor, 2010a,b; Schneider et al., 2010; Jackson, 2011; Daly, 2013; Antal and van den Bergh, 2014; Costanza et al., 2014; Victor and Dolter, 2017) as

well as among the general public (Drews and van den Bergh, 2016). Even certain influential mainstream economists express particular forms of skepticism about economic growth: some argue that the times of high economic growth in rich countries like the US are over (Gordon, 2012, 2014), others point out a "GDP fetishism" (Stiglitz, 2009), while again others ask whether it is time to reconsider the "growth imperative" (Rogoff, 2012).

Due to the complex nature of the growth-versus-environment debate, several research fields are involved in the analysis. Among these, ecological economics is probably most actively engaged in growth criticism (see the review by Victor, 2010a,b). Regarding climate science, it has been claimed that many of its researchers tacitly agree that "climate change commitments are incompatible with short- to medium-term economic growth" (Anderson and Bows, 2012). In mainstream (environmental) economics, these messages seem to go either mainly unnoticed, or the Environmental Kuznets curve is referred to, which suggests a positive relationship between economic growth and environmental quality above a certain threshold of GDP per capita (Grossman and Krueger, 1994; see also the review by Stern, 2004).

Influential global reports such as "Better Growth, Better Climate" (New Climate Economy, 2014) convey outright optimism with respect to combining growth and reducing the risks of climate change (see also Hatfield-Dodds et al., 2015).

The main purpose of this paper is to improve our understanding of the described controversy by combining information on many aspects of it, moving beyond dichotomous frames of pro/anti-growth, and identifying connections between academic groups and opinions. We examine various aspects of the debate using a questionnaire survey that was specifically designed to this end. In general terms, our approach is inspired by Javeline and Shufeldt (2014) who have recently called attention to the role of "scientific opinion" in policy making. They argued that scientific opinion can be measured by systematic surveys employing similar quality standards as public opinion surveys. Considerable research of scientific opinion is available on a range of topics, including climate change (Doran and Zimmerman, 2009; Rosenberg et al., 2010; Verheggen et al., 2014; Carlton et al., 2015) biodiversity (Rudd, 2011; Javeline et al., 2013; Hagerman and Satterfield, 2013), climate economics (Nordhaus, 1994), and other general economic issues (Fuchs et al., 1998). Only a few surveys have touched upon the relation between growth and the environment (Spash and Ryan, 2012; van Dalen and Koedijk, 2013; Howard and Sylvan, 2015; Carattini and Tavoni, 2016; Haab and Whitehead, 2017). For example, one study found that the "steady-state economy" was rated as a significantly more important concept by ecological economists than by other groups of economists (Spash and Ryan, 2012). In addition, previous surveys have mainly focused on views within and between environmental and ecological economics. Our questionnaire survey goes beyond these studies by including a wider range of relevant disciplines as well as aspects of the growth controversy. Finally, our sample of over 800 researchers is considerably larger than that in previous studies.

This article has two main research aims. The first is to examine which issues in the economic growth debate indicate most agreement or disagreement across the range of researchers. In view of previous literature, a central hypothesis of this study is that specific, different views can be linked to each research field. The second aim is to investigate which factors apart from disciplinary differences explain variation in researchers' views about growth and the environment. Prior studies demonstrate that scientific opinion, just like public opinion, are influenced by a range of factors (e.g., Carlton et al., 2015; Randazzo and Haidt, 2015). Here we examine statistically how variables capturing expertise, political orientation, country of origin and several other factors are related to the researchers' views. In addition, we explore which reasons researchers give to explain disagreement on growth and the environment.

2. Method

2.1. Selection of respondents

To select relevant scientists and obtain their contact information, we used 'Scopus' as it is the largest global database of peer-reviewed literature. Moreover, it was convenient as it provided the email addresses of corresponding authors of documents resulting from search activities.

There were two main stages in the selection. In the first, we tried to assure that our sample included an adequate number of researchers with relevant expertise on the issue. To this end, we identified articles in whose titles both "economic growth" and various environmental terms ("environment", "climate", "emissions", "sustainability", etc.) appeared. For several search terms, we used an asterisk at the end of the word to include variations (e.g. "environment*", which delivered results including both "environment" and "environmental"). This search was conducted for the period 2005–2014, resulting in 697 documents (i.e., corresponding authors). Additionally, we searched in article keywords with the same combinations of search terms as for the article titles. This step resulted in 3425 additional researchers. We checked all

resulting documents for their relevance by screening the article title and, where necessary, the abstract, removing the irrelevant documents. This means we excluded articles if they combined, for example, "economic growth" and "*sustainable* management of debt", or "human *resources*". Overall, this process resulted in 2369 unique names.

The second stage of selection involved collecting names of researchers who may not have published with a focus on the growth-environment relationship, but whose knowledge and opinions are nevertheless relevant to the growth debate. To this end, we chose a number of important scientific journals in economics and environmental science, mainly based on their impact factor or scientific prestige. We drew random samples of authors who contributed to these journals. An obvious first choice was the *Journal of Economic Growth*: we invited all authors who published in this journal in the past ten years (2005–2014) and for who contact information was available. This resulted in 238 names. Next, we collected 3160 email addresses of authors from five prestigious, general economics journals – sometimes called the "Top 5" (Card and DellaVigna, 2013): *American Economic Review*, *Econometrica*, *Journal of Political Economy*, *Quarterly Journal of Economics*, and *The Review of Economic Studies*. This resulted in 1582 names after duplicates were removed.

The last part of the second search stage was to collect names of authors who published in a number of journals with an environmental focus. Here we used the period 2009–2014, because the volume of relevant published articles is much higher in these environmental journals. First, we collected 471 authors from two journals on environmental economics (*Journal of Environmental Economics and Management* and *Environmental and Resource Economics*) and another 500 randomly from *Ecological Economics*. Furthermore, 486 authors were added from the journal with the highest impact factor in the environmental social sciences: *Global Environmental Change*. Environmental scientists were randomly selected from several important journals: *Environmental Science and Technology* (500), *Journal of Climate* (500), and *Frontiers in Ecology and the Environment* (261). Finally, 320 authors were drawn from the multidisciplinary journal *Nature Climate Change*. In total, our sampling frame included 7434 authors (2369 first phase, 5065 second phase). Finally, it should be noted that reproducibility of the sampling frame is limited: performing a search with the exact same keywords and algorithms at a later date will not deliver the exact same results; as Scopus continuously updates its database by including both recent and old publications.

2.2. Survey implementation

An email invitation to participate anonymously in the survey was sent on 24 March 2015 to the individuals of the sampling frame described above. A unique identifier was used to avoid duplicate responses. A small professional incentive was offered by giving respondents the option to be added to an email list which would inform them about potential survey results, ensuring that anonymity would be maintained. About 20% of all survey respondents used this option. On April 7 and 28 we sent out reminder emails to those individuals who had not yet responded. The survey was closed on 10 May. It had a response rate of 12% ($N = 814$), after accounting for invalid email addresses, meaning those surveys which could not be delivered to the respective researchers. This rate may seem comparatively low, but it is understandable for two reasons. First, surveys in general suffer recently from declining response rates, and web surveys in particular have significantly lower response rates than other survey modes (Fan and Yan, 2010; Keusch, 2015). Second, considering our sampling strategy (Section 2.1), we invited many researchers whose main research focus or interest is not economic growth but environmental problems. In fact, response rates varied across subsamples. Higher rates can be observed for authors who we identified based on relevant article titles (18%) and keywords (16%). Among the researchers who were randomly chosen, response rates ranged from 22% (*Environmental and Resource Economics*)

to 3% ("Top 5" Economics journals).

2.3. Survey questions and sample characteristics

The survey questions intended to cover main aspects of the economic growth debate as outlined in Section 1. To motivate researchers from various disciplines to provide their opinions, we used non-technical question wordings and response options. The survey was kept short to an approximate completion time of ten minutes.

There were two main sections. The first comprised more than 20 questions on economic growth and the environment. The participants could give additional comments following each question. We will draw on these comments only where notable patterns emerged, or where comments clearly help to qualify the responses. Analyzing all of them would go beyond the scope of this paper.

The second survey section included items that we expected to influence researchers' views on economic growth and the environment. We asked for the respondents' research focus (see Section 2.4 for how respondents were categorized into research fields), publication record (i.e., total number of peer-reviewed publications, on growth in general, and specifically on growth and the environment), formal education, professional affiliation, country of origin, age, gender, and political orientation (coded 1 = very left to 7 = very right). All exact question wordings can be found in the supporting material. Table 1 provides a summary of the key characteristics of the survey respondents.

2.4. Categorization of respondents into research fields

The survey provided the respondents the option to indicate up to two main research areas. Based on these self-reports, we categorized the respondents into various groups of research fields (percentage distributions are shown in Table 1). The procedure for this categorization is summarized in Table 2 and explained in more detail as follows.

A first group comprises economists who described their main research areas as "growth theory" and/or "empirical analysis of growth", and who did not select an environmental research area as a possible second option. In other words, this group is supposed to represent

economists who focus purely on economic growth (hereafter simply called *GrowEc*). In addition, this group was cross-checked with responses to the questions on the number of publications (growth/environment, growth in general). A few respondents (n = 6) who were initially in this group had more publications on growth and environment than on growth in general. Among these, those who had selected theoretical or empirical analysis of growth as their primary area, combined with an environmental (or energy) field, were moved to the second group (*GrowEnv*). A third group includes other economists, such as macroeconomists or development economists, whose research areas include neither economic growth nor environment or energy (*OthEc*). A fourth group represents environmental & resource economics, that is, all respondents who selected this research area except those who had growth or ecological economics as the second choice (*EnvEc*). Accordingly, ecological economics is the fifth group (*EcoEc*). This also includes 36 respondents who chose both environmental & resource economics and ecological economics as their research areas. This decision was motivated by an initial analysis of the survey data which showed that there were no statistically significant differences between (almost all) responses by the groups of ecological economists and those selecting both environmental & resource and ecological economics as their research areas. A sixth group consists of other environmental social scientists (e.g., environmental sociologists, psychologists), who were not classified into any of the prior groups (*EnvSoc*). Finally, a seventh group encompasses environmental scientists, that is, respondents from the natural or environmental sciences, who did not belong to any of the previously mentioned social sciences (*EnvSci*). Finally, note that hereafter we will use the term "research fields" to refer to these seven groups, as they involve (sub-)disciplines of economics as well as broader areas of research, like ecological economics, and even sets of distinct disciplines, like environmental social sciences.

2.5. Empirical analysis

The responses to the closed-format questions were analyzed using different statistical techniques. In each subsection, we present the descriptive results for the total sample as well as for the research fields. This is followed by regression analyses using all independent variables expected to influence views on growth. We used multinomial logistic regression for the analyses reported in Tables 5–9 as the dependent variables can be considered to be categorical in nature. On the other hand, the dependent variables of the analyses shown in Table 4 (1 = strongly disagree to 7 = strongly agree) and Table 7 (1 = very unlikely to 5 = very likely) we regarded to be continuous. Hence we chose OLS regression. We used the Breusch-Pagan test to check for heteroscedasticity in the 17 OLS regression models (underlying Tables 4 and 7). In seven models underlying Table 4 we detected heteroscedasticity. For these we computed robust standard errors, using White's heteroscedasticity-corrected estimators (Hayes and Cai, 2007). Further note that in all analyses we added missing responses to the response category labeled as "no opinion".

One survey question was designed in an open-ended format, namely regarding the reasons for disagreement on growth and environment. The provided answers were coded systematically involving the authors as well as two independent coders. An initial coding scheme was established by the first author after examining 20% of the responses. This initial scheme was discussed with the second author and subsequently modified. Two research assistants were trained in the use of the final scheme and eventually coded all responses independently. Percentage agreement between the three coders (the first author and the two assistants) was 58%. All remaining disagreements were resolved in a subsequent discussion among the three coders.

Relatively few respondents (always less than 25% for each question) used the option to provide additional comments. The first author analyzed and coded all answers in order to look for important emerging themes. The use of three coders was avoided here for two reasons: a) a

Table 1
Key characteristics of the survey respondents (N = 814).

Variable	n	Variable	n	Variable	n
Age		Research field		Political ideology	
< 30 years	29	GrowEc	34	Very left	61
30–39	263	GrowEnv	31	Left	260
40–49	239	OthEc	75	Slightly left	230
50–59	142	EnvEc	228	Center	121
≥60	105	EcoEc	131	Slightly right	59
Gender		EnvSoc	156	Right	34
female	193	EnvSci	159	Very right	4
male	609	# publications growth/ env.		Don't know	34
Education		0	288		
PhD	714	1–3	224		
Other	100	4–10	208		
Professional affiliation		11–29	57		
Academia	655	≥30	37		
Government	54	# publications growth			
Private	40	0	522		
Other	63	1–3	117		
Income of country of origin[a]		4–9	67		
High	669	10–19	35		
Middle/low	102	≥20	26		

[a] We use the classification of The World Bank for high and middle/low income countries: http://data.worldbank.org/about/country-and-lending-groups. The research fields are described in subsection 2.4. Not all numbers add up to N = 814 due to missing data.

Table 2
Categorization of respondents into research fields.

Research field	Abbre-viation	Combinations of fields
Growth economists with non-environmental focus	*GrowEc*	"Empirical analysis of growth" and "growth theory" together or as single choice, possibly combined with another non-environmental research area.
Growth economists with environmental focus	*GrowEnv*	"Empirical analysis of growth" or "growth theory" combined with another environmental or energy research area.
Other economists with non-environmental focus	*OthEc*	All other economic fields (e.g., "public economics" and/or "development economics"); without environmental research area.
Environmental & resource economists	*EnvEc*	"Environmental & resource economics", possibly combined with another environmental or energy research area, except "ecological economics".
Ecological economists	*EcoEc*	"Ecological economics", possibly combined with another environmental or energy research area.
Other environmental social scientists	*EnvSoc*	All other environmental social sciences, such as "environmental politics", "environmental psychology" or "environmental sociology".
Environmental scientists	*EnvSci*	"Atmospheric sciences", "ecology", "biology", "geosciences", "chemistry" or "physics"; not combined with any social sciences.

detailed analysis of all comments is not a main research aim; b) time and resource constraints.

3. Findings

3.1. Responses to diverse statements about economic growth

We begin by analyzing a series of 16 statements on economic growth to which the participants responded. Response options for all questions were provided on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). Table 3 reports the original statements and the percentage distribution of responses for the total sample. The accompanying Fig. 1 shows the means and standard deviations of average responses by respondents in each of the seven research fields. In the following we will illustrate the main results and insights.

The overall results show a wide distribution of views on all of the 16 statements (Table 3). For example, the sample is almost equally divided on whether growth is necessary to improve life satisfaction (statement 3 in both tables), or whether people care more about the environment when their incomes rise (statement 7). In contrast, most agreement (~80%) is found for the propositions that the GDP is a seriously flawed welfare indicator (statement 8), and that growth generates energy rebound (statement 14).

A key insight from the disaggregated results is that for all 16 questions there are statistically significant differences in mean values between the seven research fields (using one-way ANOVA tests). To examine exactly which research fields differ in their views, we conducted Bonferroni post-hoc tests. Overall, the results show that for most statements the differences have similar patterns: On the one hand, *GrowEc*, *OthEc*, and *EnvEc* tended to give similar answers. On the other, responses of *EcoEc*, *EnvSoc* and *EnvSci* were much alike. *GrowEnv* is positioned somewhat in between these two main clusters, depending on the specific statements. As to the concrete research fields, *EcoEc* is the group with mean values at one end of the spectrum for most statements, while *GrowEc* represented the group that most often was at the other end of the spectrum of views.

To examine which factors may be related to the distinct views, we ran multivariate OLS regression analyses for each of the 16 statements. Table 4 presents a summary of the results, indicating whether an independent variable has a statistically significant positive or negative effect on the dependent variable (detailed regression results are available upon request). Overall, the results substantiate the prior findings regarding the existence of two main clusters of research fields with distinct views in our sample. There are some interesting exceptions to these patterns. For two questions we find very small differences between research fields, namely regarding the flaws in GDP as a welfare measure (statement 8), and the possibility of governmental control of growth (statement 15).

The most noteworthy finding concerning the additional

independent variables is that political orientation is statistically significant for all 16 statements. Moreover, its standardized regression coefficients are typically the highest of all variables. In other words, this indicates that views on economic growth are relatively strongly affected by political ideology. The results for the first variable of expertise, the number of publications on growth and environment, generally show no significant relationships with the expressed views on growth. The second variable, number of publications on growth in general, shows that occasionally more expertise is related to more favorable views regarding the link between growth and prosperity (e.g., statement 13 on public services).

Finally, we make several observations based on the optional comments related to these 16 survey questions. Most comments concerned the general nature of the statements. About 5% of the comments can be considered as general reflections on the relationship between growth and the environment (e.g., respondents stating that there is no conflict). Some respondents criticized the lack of definition and/or context of economic growth (i.e., growth in rich or poor countries). However, we regard such criticism as invalid because the introductory text of the first survey section clearly stated that the questions refer to "GDP" growth, "rich industrialized" countries, and "global" environmental problems (see also the footnote of Table 3). As to the specific survey questions: since none of the 16 statements was commented on by more than 2% of the respondents, we do not further consider these comments here.

3.2. Favored GDP growth rate

The next question on the desirability of economic growth asked respondents which rate of GDP growth the governments of rich countries should aim for in the next decade. Fig. 2 presents a comparison of median and mean values of the favored growth rate across the seven research fields.

The overall results show that 4.5% of the respondents favored a negative growth rate, 9.3% a zero growth rate, 10.4% a 1% growth rate, 25.8% a 2–3% growth rate, and 6.5% a growth rate of more than 3%. The median preferred growth rate was 2%.

There is some diversity of views between the seven groups as shown by Fig. 2, revealing similar patterns compared to the previously analyzed attitude statements. In general, *GrowEc*, *GrowEnv*, *OthEc*, and *EnvEc* have fairly similar preferences, namely a median GDP growth rate of 2%. On the other hand, *EcoEc*, *EnvSoc* and *EnvSci* have median favored growth rates of 1%. We performed a Kruskal-Wallis test which shows that group differences are statistically significant ($p < 0.01$). Pairwise comparisons between research fields using Wilcoxon rank sum tests indicate that *GrowEc*, *OthEc* and *EnvEc* are significantly different from *EcoEc*, *EnvSoc* and *EnvSci* ($p < 0.05$, BH adjustment), with the exception of the comparison between *GrowEc* and *EnvSci* ($p = 0.1$). *GrowEnv* is not significantly different from any other field. However, considering the mean values and standard deviations suggests that (a)

Table 3
Percentage distribution of responses to 16 statements on economic growth.

	Abbreviation	Original statement	Strongly disagree	Dis-agree	Some-what disagree	Nei-ther/nor	Some-what agree	Agree	Strongly agree	No opinion
1	Environmen-tal protection	Economic growth is necessary to finance environmental protection.	12.2	22.0	13.1	7.9	17.6	16.8	9.0	1.5
2	Income inequality	Making the income distribution more equal should get a higher priority than economic growth.	3.1	6.6	10.1	9.0	15.1	22.9	32.2	1.1
3	Life satisfaction	Continued economic growth is essential for improving people's life satisfaction.	12.8	21.0	15.2	8.0	15.6	18.4	7.6	1.4
4	Development space	In view of limited natural resources, rich countries may have to give up their economic growth to assure that all poor people in the world can reach a fair standard of living.	5.9	15.5	14.1	10.3	19.3	16.8	16.7	1.4
5	Techno-fix	Technology can solve all environmental problems associated with economic growth.	29.4	27.3	15.8	5.9	13.1	4.5	2.8	1.1
6	Excessive political attention	Politicians are overly concerned about economic growth.	3.1	7.1	6.4	8.7	14.1	28.0	31.1	1.5
7	Post-Materialism	Economic growth raises incomes which in turn make people care more about the environment.	10.6	14.7	13.0	10.6	24.6	19.0	6.4	1.1
8	Flawed welfare measure	The GDP is a flawed measure of social welfare.	1.6	4.1	6.1	6.3	15.1	24.9	40.2	1.7
9	Stability	Without economic growth the economy will become less stable.	3.1	14.7	13.3	15.6	22.4	22.0	6.8	2.2
10	Environmental damage	Economic growth always harms the environment.	10.9	29.0	22.1	7.6	18.4	8.6	2.6	0.7
11	Recovery	Future economic growth will recover and again be as high as in the past.	5.5	18.6	19.3	24.9	13.0	11.1	1.4	6.3
12	Full employment	Full employment can be achieved without economic growth.	6.1	17.2	15.1	12.0	18.6	21.0	6.0	3.9
13	Public services	Economic growth is necessary to finance public services like health and pensions.	3.7	14.4	15.6	13.3	21.7	20.9	8.6	1.8
14	Energy rebound	Energy savings due to technological advances are partly undone by further economic growth.	0.9	2.6	5.0	8.6	25.2	33.0	20.9	3.8
15	Governmen-tal control	Economic growth can be controlled by the government.	3.4	15.4	15.7	13.9	31.2	14.5	3.3	2.6
16	Good life	A 'good life' without economic growth is possible.	2.9	5.2	9.1	8.7	16.2	30.3	25.3	2.2

Notes: The following sentence introduced the series of statements in the questionnaire: "Here is a list of statements about the GDP, economic (GDP) growth, and social and environmental issues. All statements refer generally to rich industrialized countries (Canada, European countries, Japan, USA, etc.) and global environmental problems (biodiversity loss, climate change, etc.), except when stated otherwise. Please try to give us your opinion about each statement even if you are not completely sure."
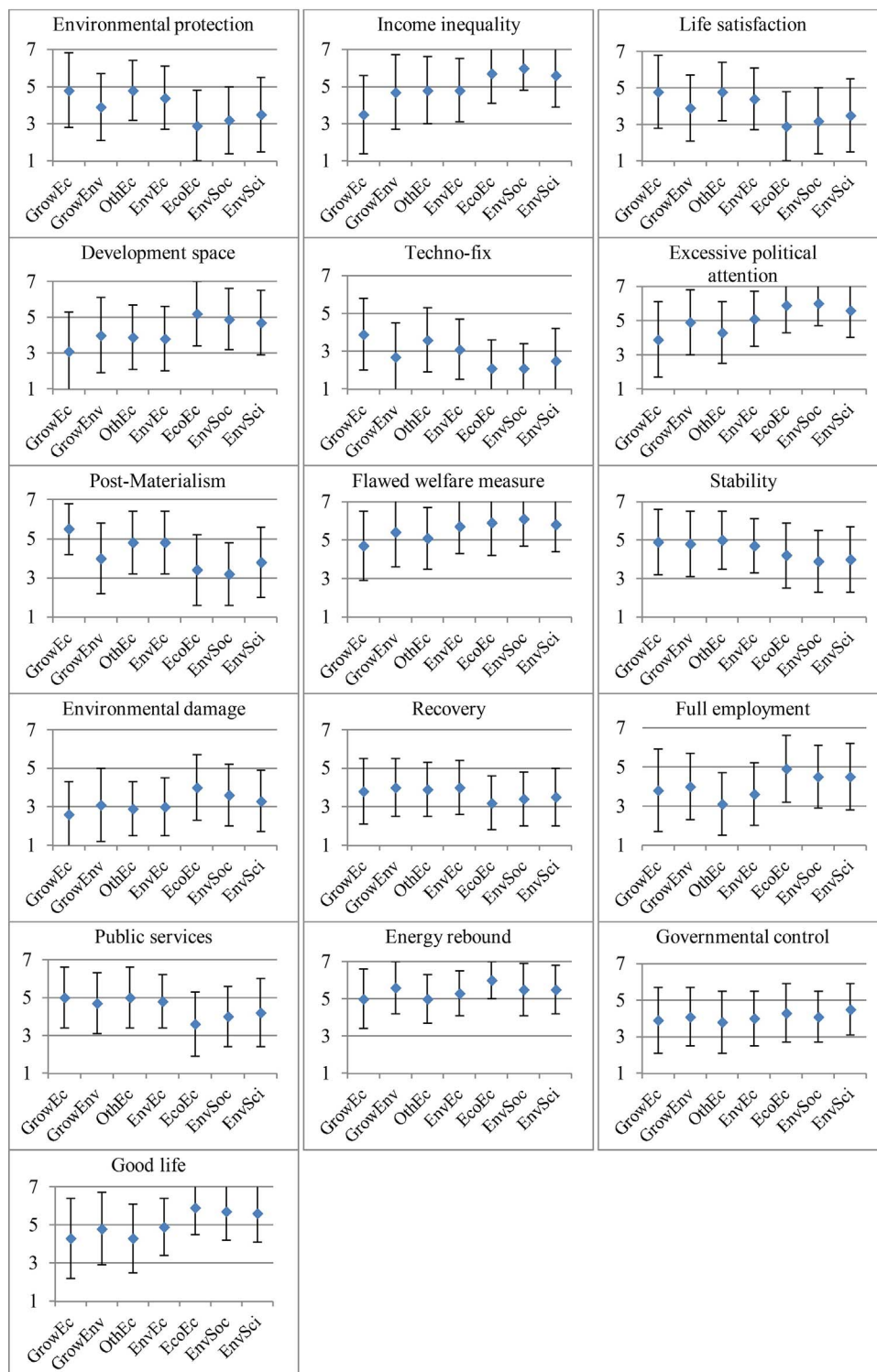
Fig. 1. Means and standard deviations of average responses to the 16 statements on economic growth across the seven research fields.

Note: The horizontal axes represent the seven research fields. The vertical axes range from 1 (strongly disagree) to 7 (strongly agree).

the differences between groups may be larger than what the median values indicate, and (b) that within-group variation is considerable, especially for *GrowEnv*, *EcoEc* and *EnvSci*.

An additional important finding is that 353 respondents (43%) did not state a favored growth rate (see the light blue bars in Fig. 2). This may appear high, but is consistent with non-responses found in other studies of scientific opinion (e.g., Fuchs et al., 1998). Non-response is roughly the same across the research fields, as can be seen in Table 6. This indicates high uncertainty in the responses to this question. What may explain this high percentage of non-response? The optional

comments provided for this question give us some insight into this. An often mentioned comment is that governments should not aim for any specific growth target, either because growth is not a desirable end itself, because it is plainly undesirable, or because the government has no control over it anyway.

We recoded responses to this question into three categories and conducted a multinomial logistic regression comparing those who favored a positive growth rate (the reference category) with those who preferred a zero or negative growth rate, and those who had no opinion (Table 5). The results show that *EcoEc*, *EnvSoc* and *EnvSci* are

Table 4
Relation between views and factors: Summary of multiple regression results for the 16 statements.

	1. Environmental protection	2. Income inequality	3. Life satisfaction	4. Development space	5. Techno-fix	6. Excessive political attention	7. Post-materialism	8. Flawed welfare measure	9. Stability	10. Environmental damage	11. Recovery	12. Full employment	13. Public services	14. Energy rebound	15. Governmental control	16. Good life
GrowEc								(−)								
GrowEnv																
OthEc						−	−	−						(−)		
EcoEc	−	+	−	+	−	+	−			+	−	+	−	+		+
EnvSoc	−	+	−	+	−	+	−		−	+	−	+	−			+
EnvSci	−	+	−	+	−	+	−		−	+	−	+	−	+		+
# publicat. growth/env.	+		(+)				+	(−)								
# publicat. growth													+			
PhD					+			(+)								
Political orientation	+	−	+	−	+	−	+	−	+	−	+	−	+	−	−	−
Low/middle income country	(+)	+	+					(−)		(+)		(−)	+		−	−
Age					−											
Male gender		−	+	(−)			+		+							
Governmental affiliation			(+)				(−)	−								
Private affiliation				−												
R^2	0.224	0.274	0.254	0.155	0.207	0.185	0.268	0.132	0.101	0.107	0.100	0.215	0.219	0.105	0.029	0.197
N	802	805	803	803	805	802	805	800	796	808	763	782	799	783	793	796

Note: " + " indicates a significant positive effect at $p < 0.05$, i.e. more likely to agree with the statement. "−" indicates a significant negative effect at $p < 0.05$, i.e. more likely to disagree with the statement. "(±)" indicates a marginally significant effect at $p < 0.1$.
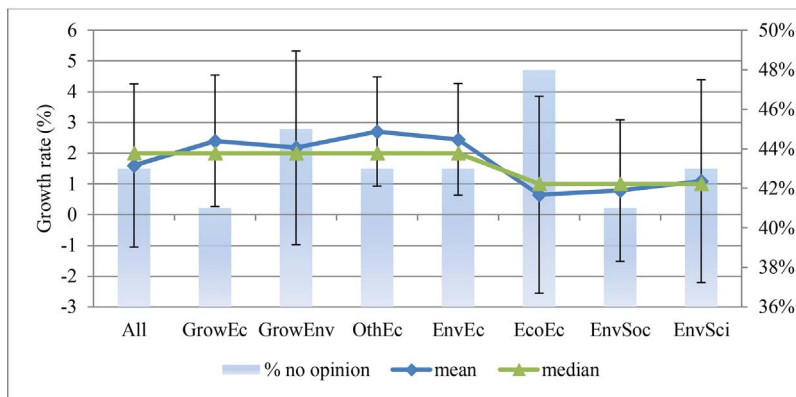
Fig. 2. Mean and median of favored GDP growth rate (left vertical axis), by research field.
Note: Original question wording: "Which average annual rate of economic growth should governments of rich industrialized countries aim for in the next decade?"Blue bars denote the percentage of responses indicating no opinion (right vertical axis).

Table 5
Multinomial logistic regression analyses predicting preferred growth rates.

Variable	zero/negative growth			no opinion		
	B	p	Odds Ratio	B	p	Odds Ratio
Intercept	0.034	0.966		0.207	0.720	
GrowEc	0.724	0.435	2.063	−0.269	0.588	0.764
GrowEnv	0.994	0.262	2.702	0.419	0.369	1.520
OthEc	−0.290	0.725	0.748	−0.106	0.731	0.899
EcoEc	1.683	0.000	5.381	0.461	0.076	1.586
EnvSoc	2.208	0.000	9.099	0.327	0.210	1.387
EnvSci	1.917	0.000	6.798	0.479	0.056	1.615
# publicat. growth/ env.	0.000	0.998	1.000	−0.001	0.875	0.999
# publicat. growth	−0.008	0.793	0.992	−0.010	0.557	0.990
PhD	−0.421	0.247	0.656	−0.006	0.982	0.994
Political orientation	−0.484	0.000	0.617	−0.156	0.024	0.855
Low/middle income country	−0.676	0.141	0.509	−0.393	0.139	0.675
Age	−0.002	0.833	0.998	0.009	0.224	1.009
Male gender	−0.327	0.256	0.721	−0.143	0.504	0.867
Governmental affiliation	−0.546	0.282	0.579	−0.871	0.015	0.419
Private affiliation	0.674	0.216	1.962	0.554	0.180	1.740
Nagelkerke R²	0.18					
N	701					

Note: The reference category of the dependent variable is the preference for "positive growth".

significantly more likely to prefer a zero or negative growth rate than *EnvEc* (the reference group). Respondents with a political left-wing orientation are significantly more likely to favor a zero or negative growth rate, but also to have no opinion on this question.

3.3. When and why economic growth may end or not

Now we examine answers to the question of when economic growth in rich countries may or may not come to a permanent end. Many respondents (43%) believed that this will be the case sooner or later. Fewer respondents (33%) thought that this will never happen, while 24% had no opinion. The median response of the 621 researchers who expressed an opinion was "in more than 100 years".

The disaggregated responses, as shown in Fig. 3, are in line with expectations about differences between research fields. Median responses suggest that *GrowEc*, *OthEc* and *EnvEc* are the most convinced that growth will "never" end. The median response by *GrowEnv* is "in more than 100 years" and therefore differs slightly from the aforementioned groups of economists. The remaining groups of research fields are less convinced. The nearest end of economic growth is expected by *EcoEc* and *EnvSci*, with a median response of "25–50 years", while for *EnvSoc* it is "50–100 years".

According to a Kruskal-Wallis test, medians across the fields are significantly different from one another ($p < 0.01$). Subsequent Wilcoxon rank sum tests show that *GrowEc*, *OthEc* and *EnvEc* are all significantly different from *EcoEc*, *EnvSoc* and *EnvSci* ($p < 0.05$).

Table 6 presents the results of a multinomial logistic regression analysis. It shows that *OthEc*, *EcoEc*, *EnvSoc* and *EnvSci* are all significantly more likely to believe in an end to economic growth than *EnvEc* (the reference group). This belief is also more likely held by researchers with a higher number of publications on growth and the environment, those with left political orientation or female gender. The second category of the dependent variable used in the regression model is "no opinion". The results show that the same variables as before predict a more likely association with having no opinion on this question. In addition, we find that respondents are more likely to have no opinion when they: (a) have fewer publications on growth in general, (b) have a PhD, and (c) are not affiliated with the government.

We make some observations based on the optional comments by respondents. Some 3% of respondents mentioned they found it difficult, if not impossible, to make a long-term prediction as asked in this question. Others mentioned that the possibility of endless growth depends on issues such as technological progress, rates of dematerialization, and how growth is measured. In general, each of these and other reasons was mentioned by no more than 2% of respondents.

Next, we elicited views on various factors that may contribute to either an end or a continuation of economic growth. Those respondents who indicated in the preceding question that growth will end were presented with a different set of factors than those who indicated a belief in never-ending growth or who had no opinion.

Fig. 4 shows the factors contributing to an end of economic growth. Overall, "environmental problems" is mentioned most often as a "very important" factor (53%), followed by scarcity of "energy resources", "material resources", and "growing inequality". Differences across the research fields are very small (see Table B1 in Appendix B). This is probably due to the survey design, which (dichotomously) separated respondents based on their beliefs about whether growth will never end or not.

Fig. 5 reports the results for the factors that contribute to never-ending growth. Overall, the statement "the increase in knowledge is boundless" was indicated most frequently as a "very important" factor, followed by the conceptually similar factors "technological change has no limits" and "all non-renewable energy resources can be replaced by renewable ones". At least moderate importance was given to the "opportunities that international trade affords". This pattern holds generally for the research fields as well (Table B2 in Appendix B).

The finding that environmental problems are considered the most important factor seems to be broadly consistent with a study by Howard and Sylvan (2015) who find that most of their surveyed economists think that climate change will negatively affect future economic growth.
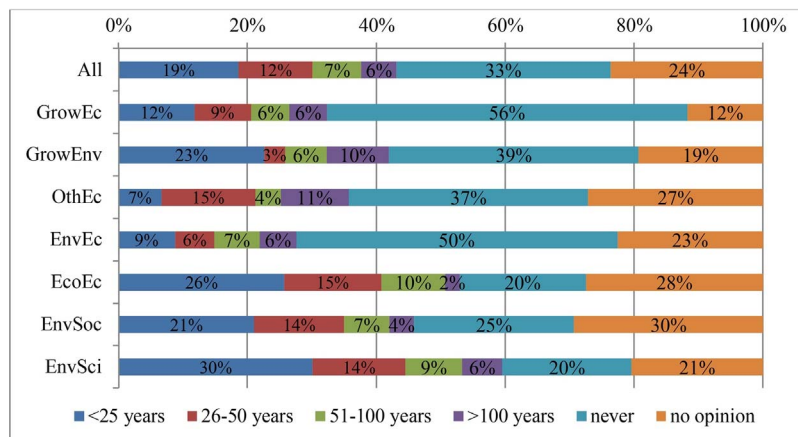
Fig. 3. Beliefs about the timing of an end to growth, by research field.
Note: Original question wording: "Roughly speaking, when do you think economic growth in rich industrialized countries will permanently come to an end?" Response options: 1 = in less than 10 years; 2 = in 10–25 years; 3 = 25–50 years; 4 = 50–100 years; 5 = more than 100 years; 6 = never. Response options 1 and 2 are integrate here to improve clarity of the presentation.

Table 6
Multinomial logistic regression analysis of "belief in end of growth" and "no opinion".

Variable	Belief that growth will end			No opinion		
	B	p	Odds Ratio	B	p	Odds Ratio
Intercept	1.388	0.031		1.283	0.079	
GrowEc	0.748	0.165	2.113	0.220	0.768	1.246
GrowEnv	0.813	0.119	2.254	0.542	0.383	1.719
OthEc	0.877	0.017	2.405	1.040	0.007	2.830
EcoEc	1.590	0.000	4.904	0.995	0.004	2.705
EnvSoc	1.201	0.000	3.325	0.814	0.010	2.258
EnvSci	1.945	0.000	6.995	0.752	0.031	2.122
# publicat. growth/env.	0.025	0.016	1.025	0.022	0.047	1.023
# publicat. growth	−0.020	0.275	0.980	−0.054	0.059	0.948
PhD	0.259	0.383	1.296	0.939	0.016	2.558
Political orientation	−0.383	0.000	0.682	−0.416	0.000	0.660
Low/middle income country	0.034	0.908	1.035	−0.392	0.299	0.676
Age	−0.010	0.233	0.990	−0.012	0.207	0.988
Male gender	−0.466	0.061	0.627	−0.721	0.008	0.486
Governmental affiliation	0.389	0.335	1.475	0.807	0.059	2.242
Private affiliation	−0.077	0.867	0.925	0.679	0.147	1.973
Nagelkerke R^2	21.7					
N	701					

Note: reference category is the belief that growth will "never" end

3.4. Compatibility of growth with 2 °C climate policy target

We continue by reporting the results for a question regarding growth and climate policy, namely whether global GDP growth can be made compatible with the internationally agreed 2 °C target. The responses to this question are summarized in Fig. 6. First of all, the responses of the total sample indicate a somewhat lower variation of views compared to the previous questions. 61% of the respondents judged the compatibility as unlikely or very unlikely, 14.1% think there is about an even chance, and 18.7% estimated it as likely or very likely. The median answer is "unlikely". Non-response was relatively low to this question (6.3%). These results suggest that the respondents are generally quite pessimistic. The only two research fields that are slightly more optimistic were *GrowEc* and *OthEc* which both had a median response of 2.5, that is, between "unlikely" and "about an even chance" (Fig. 5). A Kruskal-Wallis test indicates that the group medians are significantly different from one another ($p < 0.01$). Subsequent Wilcoxon rank sum tests show that *GrowEc*, *OthEc* and *EnvEc* are all significantly different from *EcoEc*, *EnvSoc* and *EnvSci* ($p < 0.05$).

Table 7 presents the results of a multiple regression analysis showing that researchers who self-identified as *EcoEc*, *EnvSoc* and *GrowEnv* are all significantly associated with seeing the compatibility of global GDP growth and reaching the 2 °C climate policy target as more unlikely (marginally significant at p < 0.1 in the case of *GrowEnv*). Right-wing political orientation and low/middle income country of origin are related to more pessimistic views. Neither expertise nor any other variable has a significant influence on the responses to this question.
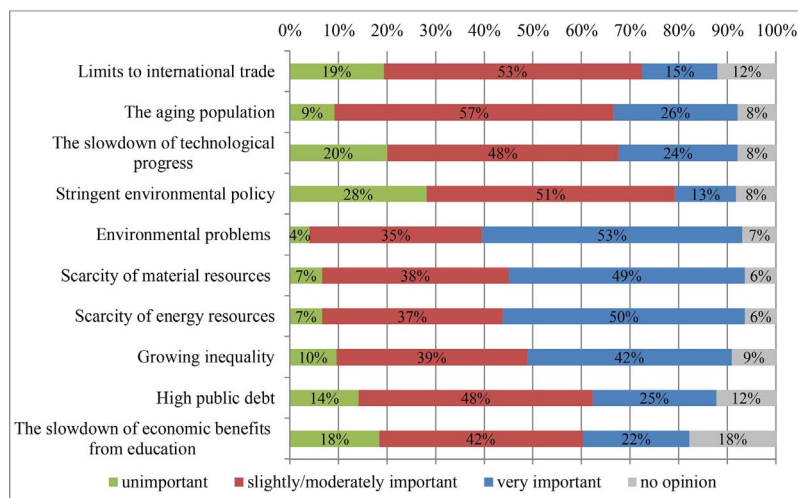

Fig. 4. Importance of factors contributing to end of growth, for subsample of respondents ($n = 544$) who previously did not indicate that growth may be never-ending.
Note: Original question wording: "How important do you consider the following factors as contributing to a permanent end of economic growth in rich countries?"
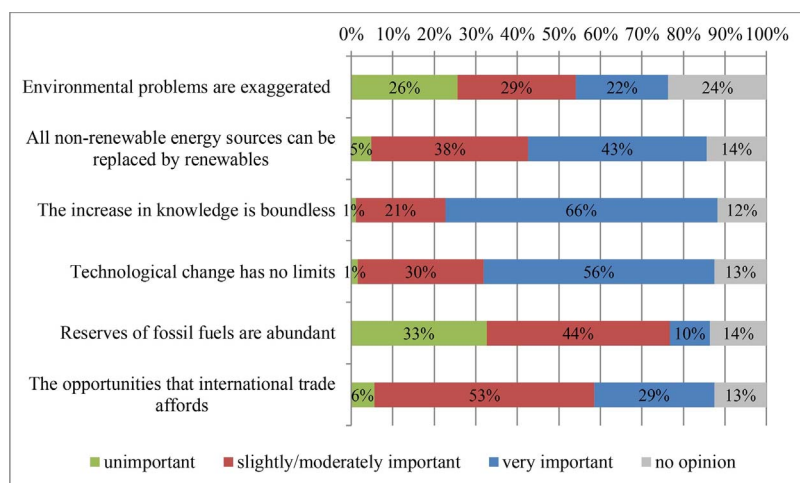
Fig. 5. Importance of factors contributing to never-ending growth, for subsample of respondents (n = 270) who previously indicated that growth may be never-ending.
Note: "How important do you consider the following factors as contributing to a permanent end of economic growth in rich countries?"

3.5. Favored growth-environment strategy

Next, we analyze responses to a general question about which growth-environment strategy the governments of rich countries should pursue. The overall distribution of responses, shown in Fig. 7, looks as follows: less than 1% favored pursuing growth despite its environmental impacts ("growth-at-all-costs"), 42% favored to pursue economic growth as it can be made compatible with environmental sustainability ("green growth", e.g., Bowen and Fankhauser, 2011; Smulders et al., 2014), 31% supported a strategy of ignoring economic growth as a policy aim ("indifferent about growth", e.g., van den Bergh, 2011, who calls this "agrowth"; Jakob and Edenhofer, 2014), and 17% preferred stopping economic growth altogether ("zero or de-growth", e.g., Kallis, 2011; O'Neill 2012). Moreover, 8% of the respondents preferred another strategy which they could specify in an open-response field. An analysis of these answers shows that the most frequent theme (n = 21) can be considered as slightly modified versions of the "green growth" strategy. A few more answers are very similar to either "indifferent about growth" or "zero or de-growth". Additional distinct opinions were that the government should have no welfare goals or should not interfere with markets.

We find similar patterns as before in the disaggregated results. *GrowEc, OthEc,* and *EnvEc* are the most committed to a pro-growth

Table 7
OLS regression analysis predicting likelihood of combining the goal of growth and the 2 °C climate target.

|	B	Std. error	β	p
Constant	1.760	0.291		0.000
GrowEc	0.293	0.264	0.049	0.268
GrowEnv	−0.451	0.260	−0.069	0.083
OthEc	0.047	0.172	0.011	0.787
EcoEc	−0.390	0.140	−0.122	0.005
EnvSoc	−0.379	0.132	−0.130	0.004
EnvSci	−0.214	0.129	−0.074	0.097
# publicat. growth/env.	0.001	0.004	0.012	0.779
# publicat. growth	−0.001	0.009	−0.003	0.953
PhD	0.024	0.140	0.006	0.867
Political orientation	0.141	0.036	0.152	0.000
Low/middle income country	0.514	0.139	0.145	0.000
Age	0.005	0.004	0.051	0.208
Male gender	0.027	0.110	0.010	0.807
Governmental affiliation	−0.066	0.173	−0.014	0.704
Private affiliation	−0.112	0.202	−0.021	0.579
R^2	7.2			
N	718			
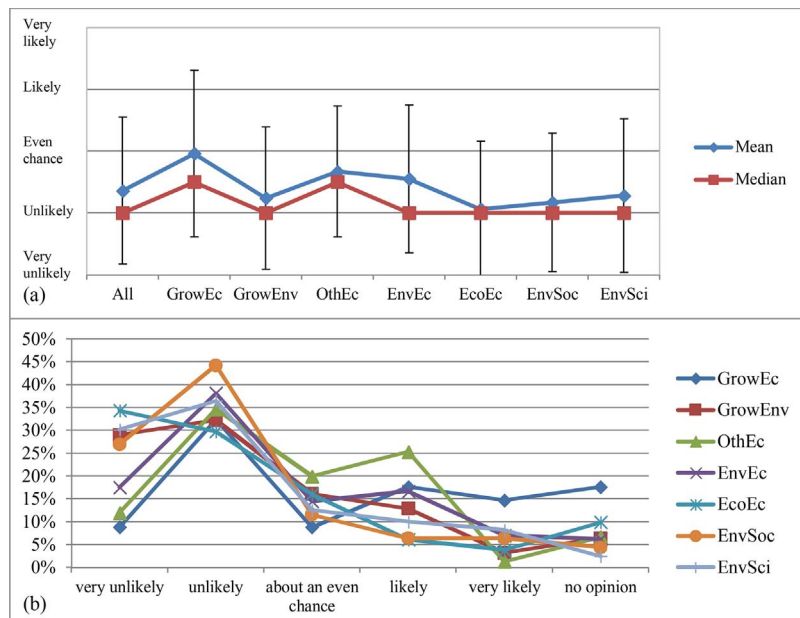
Fig. 6. Likelihood of combining global GDP growth and the 2° C climate target, by research field. a shows mean (SD) and median responses. b shows percentage distributions.
Note: Original question wording: "Globally, greenhouse gas emissions per unit of GDP were reduced by less than 1.5% per year in the period 1970–2013. Studies indicate that to have a fair chance of staying below 2 °C warming by the end of the century, at least a 4.4% emissions reduction is required per year until 2050. This assumes that per capita GDP growth continues at an average 1.5% annual rate. All other things being equal, how likely do you think it is that this GDP growth goal and the 4.4% emission reduction goal can be combined?"
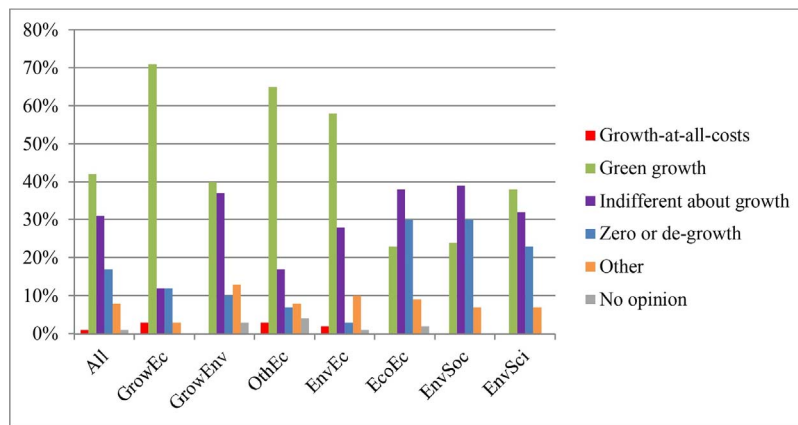
Fig. 7. Favored growth-environment strategy in rich countries, by research field.
Note: Original question wording: "Here are several positions on the relation between economic growth and the environment. Which of them is closest to your own opinion? Public policy in rich industrialized countries should … (1) further pursue economic growth in spite of its environmental impacts. (2) further pursue economic growth. There are many ways to make economic growth compatible with environmental sustainability. (3) ignore economic growth as a policy aim, that is, be completely neutral about growth. This will amplify the policy spectrum to combine well-being and environmental sustainability goals. (4) stop pursuing economic growth. Production and consumption need to be downscaled in an equitable way to achieve environmental sustainability. (5) other (please specify).

view, as the majority of respondents in each of these research fields chose "green growth" as their preferred option. For all other fields the preferences for the different strategies are more evenly distributed. We conducted Chi-square and post-hoc tests for multiple comparisons of preferences. *Grow*, *OthEc*, *EnvEc* were more likely to favor "green growth" than *EcoEc*, *EnvSoc* and *EnvSci* ($p < 0.05$). Responses by *GrowEnv* were not significantly different from those of any other group, which shows again the middle position of this group.

Table 8 reports the results of a multinomial logistic regression analysis, in which "green growth" served as the reference category of the dependent variable. The results show that *EcoEc*, *EnvSoc*, and left-wing political orientation are significantly more likely to be associated with favoring "indifferent about growth" or "zero or de-growth". In addition, *GrowEc*, *GrowEnv*, *EnvSci* are more likely to favor "zero or de-growth" than EnvEc, which serves as the reference group. Note that *EnvEc* had the lowest percentage of preference for "zero or de-growth", as shown in Fig. 7.

Furthermore, researchers from high income countries are more likely to favor being "indifferent about growth" than those from low and middle income countries. We also find that researchers with more publications on growth in general are less likely to be associated with "indifferent about growth" or "zero or de-growth" (though statistically this is only marginally significant at $p < 0.1$).

Table 8
Multinomial regression analysis comparing preferences for three growth-environment strategies, with "green growth" as reference category.

Variable	Indifferent about growth			Zero or de-growth		
	B	p	Odds Ratio	B	p	Odds Ratio
Intercept	1.513	0.022		−0.623	0.521	
GrowEc	−2.056	0.056	0.128	2.756	0.003	15.735
GrowEnv	0.952	0.077	2.592	2.298	0.027	9.953
OthEc	−0.612	0.118	0.542	1.285	0.112	3.613
EcoEc	1.152	0.000	3.164	3.632	0.000	37.798
EnvSoc	0.946	0.001	2.576	3.616	0.000	37.192
EnvSci	0.467	0.088	1.596	2.986	0.000	19.811
# publicat. growth/ env.	−0.006	0.567	0.994	−0.006	0.662	0.994
# publicat. growth	−0.035	0.171	0.966	−0.062	0.095	0.940
PhD	−0.463	0.179	0.630	−0.193	0.652	0.824
Political orientation	−0.337	0.000	0.714	−0.872	0.000	0.418
Low/middle income country	−1.048	0.002	0.351	−0.143	0.723	0.867
Age	−0.011	0.236	0.989	0.013	0.262	1.013
Male gender	0.063	0.798	1.065	−0.368	0.218	0.692
Governm. affiliation	−0.505	0.167	0.603	−0.636	0.238	0.529
Private affiliation	−0.549	0.224	0.578	−0.426	0.454	0.653
Nagelkerke R^2	0.36					
N	639					

Table 9
Multinomial logistic regression for growth-environment strategy, using the 16 statements about growth as predictors.

Variable	Indifferent about growth			Zero or de-growth		
	B	p	Odds Ratio	B	p	Odds Ratio
Intercept	−0.295	0.817		−6.760	0.005	
Environmental protection	−0.295	0.002	0.744	−0.240	0.133	0.787
Income inequality	0.089	0.333	1.093	0.276	0.068	1.317
Life satisfaction	−0.272	0.006	0.762	−0.595	0.000	0.552
Development space	0.125	0.158	1.133	0.444	0.001	1.559
Techno-fix	0.031	0.749	1.031	−0.215	0.181	0.807
Excessive political attention	0.243	0.016	1.275	0.203	0.203	1.225
Post-Materialism	−0.085	0.376	0.919	−0.189	0.160	0.828
Flawed welfare measure	−0.010	0.917	0.990	0.205	0.192	1.228
Stability	−0.141	0.191	0.869	−0.057	0.685	0.945
Environmental damage	0.180	0.074	1.198	0.648	0.000	1.912
Recovery	−0.121	0.217	0.886	0.065	0.643	1.067
Full employment	0.253	0.010	1.287	0.457	0.003	1.579
Public services	−0.321	0.003	0.725	−0.577	0.000	0.561
Energy rebound	0.203	0.094	1.226	0.217	0.261	1.242
Governmental control	−0.105	0.265	0.900	0.077	0.561	1.080
Good life	0.156	0.210	1.169	0.069	0.738	1.071
Nagelkerke R^2	0.70					
N	609					

We conducted another multinomial logistic regression using the 16 statements of Section 3.1 as independent variables (Table 9). This aims to understand which specific views on growth underlie a favored growth-environment strategy. The results show that those preferring either "indifferent about growth" or "zero or de-growth" are more likely to be associated with disagreement to the ideas that growth is necessary for improving happiness and for maintaining public services, and with agreement to the idea that full employment can be achieved without growth. There are also differences between the two strategies.

Those who favor being "indifferent about growth" are significantly more likely to disagree that growth is necessary for environmental protection, and more likely to agree that politicians are overly concerned about growth. In contrast, favoring "zero or de-growth" is associated with a concern about development space for poorer countries, with a priority for reducing inequality, and with believing in environmental harm from growth.

Finally, it makes sense to examine how the growth-environment strategy corresponds to the preferences regarding the GDP growth rate. To this end, we performed a cross-tabulation. That is, we calculated the average preferred GDP growth rate for the people who supported any of the five growth-environment response options. This is shown in Fig. 8.
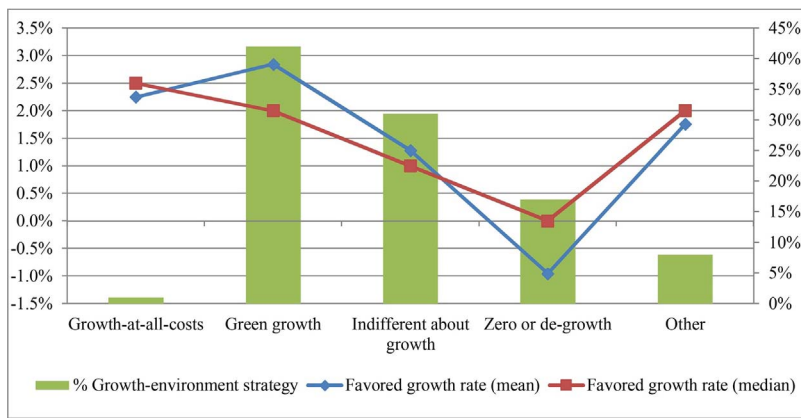
Fig. 8. Combination of responses to favored growth-environment strategy (associated with the right vertical axis) with mean and median of preferred growth rates for each strategy (left vertical axis).

The few people who favored "growth-at-all-costs" had the highest preferred economic growth rate (median = 2.5%), followed by those supporting "green growth" (median = 2%). The findings further show that the third option ("indifferent about growth") was associated with a median GDP growth rate of 1%, while the fourth one ("zero or de-growth") with 0% rate. In addition, note that those who support being "indifferent about growth" most often did not state a favored GDP rate among the four presented options (which is consistent with its basic motivation). The fifth option (*other*) has a median of 2%, which is consistent with the impression that many respondents here are close to the *green growth* position. According to a Kruskal-Wallis test, the differences in median growth rates across the groups are statistically significant ($p < 0.01$).

Post-hoc tests show that the decreasing growth rates favored by supporters of "green growth", "indifferent about growth" and "zero or de-growth" (the three main groups of interest) are significantly different from each other ($p < 0.01$).

3.6. Why researchers disagree

A final question was posed to gain insight into the sources of disagreement among researchers on growth and the environment. Most of the respondents (70%, n = 573) provided at least one reason. Using the coding procedure as described in the methods Section (2.5), we developed 21 categories. These are classified into four broad themes: (1) disciplines and theories, (2) knowledge and understanding, (3) ideology and worldviews, and (4) miscellaneous reasons. Table 10 shows the results of these categorized reasons.

The first theme ("disciplines") includes three categories. The most important one covers terms like "disciplines" or "research areas", suggesting that different disciplines almost necessarily seem to imply different perspectives. This was mentioned by 15% of those respondents who gave at least one reason. It is supported by the many differences reported in this paper between the seven research fields from Table 2. The second category is called "theories, assumptions and schools of thought" (9%). It includes mentions of the words of the title, as well as other phrases such as frameworks, paradigms and approaches. It is worth noting that these reasons and statements were generic, i.e. respondents did not refer here to any specific theories etc. The third category, stated by 7% of the respondents, contains explicit or implicit criticisms of one specific discipline, namely (mainstream) economics. Common examples include phrases like "dominance of neoclassical economics", "economic is not a hard science", and others with similar meanings.

The second theme is called "knowledge and understanding". Its first category ("knowledge and its limits") mainly covers single terms such as "ignorance", "knowledge", and "understanding" (9%). In addition, respondents gave more detailed explanations, such as academic over-specialization and the lack of a "well-informed overview of the big

Table 10
Suggested reasons for disagreement on growth and the environment.

Themes	Categories	Frequency
Disciplines	Disciplines and research foci	15%
	Theories, assumptions and schools of thought	9%
	Implicit and explicit criticisms of economics/economists	7%
Knowledge and understanding	Knowledge and its limits	10%
	Understanding of economic growth	10%
	Understanding of economics	6%
	Understanding of environment	11%
	Understanding of relationship between growth and the environment	3%
	Complexity and uncertainty	6%
	Lack of familiarity with alternatives	2%
Ideology	Ideology, values, worldviews	31%
	Growthism	4%
	Environmentalism	2%
Miscellaneous	Technology	6%
	Time horizons	4%
	Psychological factors	7%
	Country	5%
	Cultural background	6%
	Interests and power	8%
	Markets, policy and governance	4%
	Other	4%

Notes: Original question wording: "As the final question of part I, we would like to ask you why researchers' views on economic growth and the environment differ. Please state briefly a main reason." Percentages add up to more than 100% because some respondents provided more than one reason.

picture". Most of these phrases and explanations were kept rather general. In contrast, the next four knowledge-related categories are more specific. They refer to different understandings of (1) economic growth, (2) economics or the economy, (3) the environment, and (4) the relationship between growth and the environment. It is worth noting that the tone of the provided responses differs considerably among these four categories. For example, while some respondents pointed out differences of knowledge or understandings in a neutral way, other responses can easily interpreted as dismissive remarks about the lack of knowledge by those with dissenting views. In addition, some respondents acknowledged the lack of understanding of other disciplines, as can be seen in the following statement: "Lack of understanding of either the concepts of economic growth (for non-economists) or of the functioning of the environment (for many economists)".

The third theme is called "ideology". It includes a general category "ideology, values and worldviews", which has the highest frequency of occurrence among all categories (31%). Here, respondents tended to mention (political) ideology, values, worldviews, beliefs and related

ideas in more general way. Two specific and opposing ideologies were categorized in addition to the general category. They are labeled "environmentalism" and "growthism". The first refers to the valuation of and concern for the environment. The second includes statements which express a strong commitment to economic growth, that is, growth for growth's sake.

The fourth theme ("miscellaneous") contains a diverse set of reasons. An important category of reasons is "technology". It includes phrases ranging from more neutral ones (e.g., "understanding of technology") to more ideological ones (e.g., "faith in technology"). So, it partly overlaps with the categories "ideology" and "understanding". Another category is about different views on the role of "markets, policy and governance". The category "time horizons" involves mentions of differences in historical and future perspectives. Two further categories relate to the context in which researchers work. One is the country. That is, different views may emerge depending on whether researchers come from developed or developing countries. Our previous statistical analyses lend some support to this claim. Other contextual factors mentioned are culture, socialization and upbringing. A further category is called "interests and power". A frequently mentioned example is that research funding may depend on a country's economic growth. Finally, the category "psychological factors" encompasses an array of factors and issues, such as "fear of change", "emotions", "lack of empathy", "personality", "optimism/pessimism", and so on.

Overall, the presented variety of reasons both enriches our understanding and shows the complexity of the controversy over growth and the environment. It should be noted that there are obviously relationships between these reasons. For example, some respondents stated that different disciplines have different ideologies, which shows the possible relation between the first and third themes.

4. Discussion

Several key findings emerge from this study. Overall, there is substantial diversity of opinion related to almost every posed survey question. To give examples: The sample was almost equally divided on whether growth is necessary to improve life satisfaction in rich countries. Some 14% of respondents favored a zero (or even negative) GDP growth rate as a policy objective, while the remaining ones about equally either supported positive GDP growth rates or had no specific opinion. Slightly more respondents believe that economic growth in rich countries will sooner or later come to an end rather than it being never-ending. Considering different growth-environment strategies for public policy, 42% favored continuing to pursue growth as it is compatible with environmental goals ("green growth"), 31% preferred ignoring growth as a policy objective ("indifferent about growth"), and 17% favored stopping growth altogether ("zero or de-growth").

An issue where more agreement exists concerns the low likelihood of reconciling global GDP growth with the 2 °C climate policy target. This is largely consistent with the claims that many climate scientists tacitly view climate and GDP growth goals as incompatible (Anderson and Bows, 2012). It is also in line with other analyses of green growth and climate change (Jackson, 2011; Antal and van den Bergh, 2014; Raftery et al., 2017). Furthermore, it suggests that researchers are more skeptical about growth in the context of solving a concrete, challenging problem like climate change than when considering 'the environment' in general.

Disciplinary background is a key explanation for disagreement. There are two main groups of disciplines in our survey with broadly similar views: on the one hand, growth economists, other economists, and environmental and resource economists; on the other, ecological economists, environmental social scientists, and environmental scientists. Given that ecological economics has traditionally taken a more critical perspective on economic growth (e.g., Victor, 2010a,b; Daly 2013), the differences with environmental & resource economics are not surprising. Our results are also consistent with the differences found

in earlier surveys using smaller samples (Spash and Ryan, 2012; Carattini and Tavoni, 2016). The group that is probably the most intensively involved in the central theme – growth economists focusing on environmental issues – is positioned somewhat between these two clusters with regard to many questions. The most plausible explanation is that this group includes researchers from mainstream economics as well as heterodox fields like ecological economics.

The survey results generally suggest that expertise – operationalized here as publication record – is related to views on growth only in a few cases. First, a higher number of publications on growth in general are associated with slightly more favorable views on the link between growth and prosperity. Second, more publications on growth and the environment are associated with more skepticism that endless growth is possible. On the whole, however, expertise explains only very little of the variation in views. The reason for this may be that expertise probably interacts with theory, school of thought and ideology. Moreover, it is important to bear in mind that our survey measure (i.e., number of peer-reviewed publications on growth-and-environment) is of course only one facet of expertise (see e.g., Burgman et al., 2011).

We find that political ideology best and most consistently explains variation in researchers' views. It is significantly associated with the responses to every survey question on growth, even after controlling for other variables such as research fields. The latter point is noteworthy, because one might think that some fields (e.g., environmental social sciences) are somewhat more left-of-centre than others (e.g., mainstream economics; see also Table B3 in the Appendix B). This suggests that the debate about growth and the environment is ideologically charged, which goes beyond ideologies related to disciplines. This finding is in line with many respondents mentioning ideology, values, beliefs and worldviews as main reasons for disagreement in views. More generally, our study may be related to the concept of ideologically motivated reasoning (e.g. Kahan, 2013), in the sense that ideology colors views on the link between economic growth and the environment.

Some economists may argue that the survey questions are mixing "positive" and "normative" propositions. However, while theoretical arguments against the fact-value dichotomy have been made for a long time (e.g., Myrdal, 1953), there is now ample empirical research on opinions of economists showing that this line is blurry, to say the least (Randazzo and Haidt 2015; Mayer, 2001; Fuchs et al., 1998). Of course, also many environmental scientists believe that values cannot be entirely separated from 'positive' features of basic and applied research (Reiners et al., 2013). Our study is the first to empirically show this in the context of the growth-vs-environment debate. This and the many mentions of other psychological factors resonate with recent calls for keeping various types of biases in mind when interpreting scientific evidence (Baddeley, 2015; see also Nuzzo, 2015).

In addition to ideology and related notions, further insights can be derived from the reasons that researcher provided to explain disagreement. For example, it may appear self-evident, but given that many researchers mentioned different "understandings", "definitions" and "meanings" related to growth and the environment, it is possible that some researchers are talking past each other. This suggests the need for more and improved multidisciplinary communication or even research on growth and environment, involving economists, other social scientists, engineers and environmental or climate scientists.

It is possible to compare our findings with a recent public opinion study on growth-and-environment (Drews and van den Bergh, 2016). Public opinion about the desirability of economic growth is closer to the mainstream view in economics (*GrowEc, OthEc, EnvEc*), as expressed for example in the favored growth-environment strategy. At the same time, public views and those of ecological economists and environmental (social) scientists are similar on certain questions, such as regarding the doubt about the possibility of never-ending growth. In addition, public as well as scientific opinion is influenced by political ideology. In a broader sense, our findings resonate with one of the facets of the well-

known 'New Environmental Paradigm' scale, namely the 'limits to growth' (Dunlap and Van Liere, 1978; Dunlap et al., 2000). One of the items of its original scale reads "There are limits to growth beyond which our industrialized society cannot expand". This idea seems to be in line with the result of our study that only a minority of all respondents think that growth will never stop.

A couple of potential caveats are worth noting. It is possible that our study has a self-selection bias. Some researchers may have used the survey to express either their discontent with the deep commitment towards growth in mainstream economics. Or it could be the other way, that is, researchers with strong views in favor of growth may have felt compelled to participate. Therefore, frequency distributions for the total sample should be taken perhaps with a grain of salt. However, the diversity of results for groups shows a clear and systematic pattern that may be expected to reflect the views in the wider research community.

Another point concerns the grouping of respondents into research fields which was done by having respondents select two of their primary research areas. Future studies might classify respondents by other means than self-identification. For example, one could tag respondents based on where they have published most of their research. It should further be noted that some groups could involve significant within-group variation in terms of opinions about growth-and-environment. For example, *EnvSoc* includes a range of disciplines such as psychology, sociology or geography. The same is true for *EnvSci*, which includes fields ranging from physics through chemistry to biology. As findings of another recent survey show, there is even considerable disagreement about growth among environmental and resource economists (Haab and Whitehead, 2017), although this might partly be because some respondents were rather ecological economists. Taken together, future opinion studies should clearly capture and compare (sub)disciplines and schools of thought to understand variation in views on growth. In terms of sampling, it may also be worthwhile to survey researchers at annual conferences or to reach out to members of professional organizations.

5. Conclusion

The purpose of this article was to shed new light on the old debate about economic (GDP) growth and the environment. Using a questionnaire survey of 814 scientists, we showed how opinions on main aspects of the debate are distributed across various research fields, and examined how these views are related to expertise, political ideology and other factors.

Overall, views on both the desirability and possibility of endless economic growth are divided across research fields, notably between mainstream growth, general and environmental economics on the one hand, and ecological economics, environmental social sciences, and natural sciences on the other. Those having a stronger research focus or more publications on growth and the environment are somewhat less convinced of the possibility of endless growth. In general, however, greater expertise does not point strongly to one or another perspective.

In contrast, political ideology plays the most consistent and important role in shaping opinions in the debate on growth and environment, even after taking into account disciplinary and other variations. We further find that ideology and related notions, such as values and worldviews, are the most frequently mentioned reasons to explain disagreement on growth and environment. This and the wide range of other stated reasons – complexity, psychology, power, to name a few – suggest that disagreement on growth and the environment is about much more than mere facts.

Future research may test more nuanced measures of ideology and values than the left-right political scale used here. It can try to examine what, if anything, could be done about the role of political ideology in the growth debate. Can its influence be minimized, and if so, how? Further studies should be undertaken with different samples and perhaps on more concrete problems like climate change.

Appendix A. Survey items whose wording is not described in detail in the main text

What is the highest level of education that you have obtained?
Bachelor's degree ☐ Master's degree ☐ PhD ☐
Other (please specify) ☐_____
10. Please choose the option that best describes with what type of organization are you employed by or engaged with:
☐ Academia (faculty, research associates, post-docs)
☐ Academia (student)
☐ Government
☐ Non-governmental organization
☐ Other (please specify):_____
11. Please select your primary area(s) of expertise. Please select two at most.

Empirical analysis of economic growth	Ecological economics	Atmospheric sciences
Growth theory	Energy studies	Biology
Development economics	Environmental and resource economics	Chemistry
Economics of technological innovation	Environmental engineering (incl. Industrial ecology)	Geosciences
Macroeconomics (not specifically growth)	Environmental politics	Physics
Public economics	Environmental sociology	Ecology
Financial economics	Geography	Other research (please specify)
Business economics and finance		Other research area (please specify)

12a. Approximately how many peer-reviewed articles have you published (as author or co-author) in academic journals?
[__]
12b. How many of your published articles mainly focus on economic growth and environmental and/or energy issues?
[__]
12c. How many of your published articles focus on economic growth without covering environmental and/or energy issues?
[__]
13. What is your sex? Male ☐ Female ☐ Other ☐
14. What is your age? [___]

15. What is your country of citizenship? _____

16. In politics people sometimes talk of "left" and "right" (or "liberal" and "conservative" in the US). Where would you place yourself on the following scale?

Very left □ left □ slightly left □ centre □ slightly right □ right □ very right □ I don't know □

Appendix B

Table B1
Importance of factors contributing to end of growth, by research field

Factor	GrowEc	GrowEnv	OthEc	EnvEc	EcoEc	EnvSoc	EnvSci
Slowdown economic benefits from education	3.00	2.76	2.85	2.92	2.34	2.51	2.47
High public debt	2.57	2.41	2.75	2.53	2.71	2.86	2.90
Growing inequality	3.21	3.06	3.13	3.08	2.91	3.28	3.14
Scarcity of energy resources (fossil fuels, renewables, etc)	3.57	3.17	3.14	3.04	3.41	3.34	3.32
Scarcity of material resources (metal ores, water, etc)	3.36	3.00	3.16	3.10	3.30	3.41	3.27
Environmental problems (biodiversity loss, climate change, etc)	3.57	3.11	3.24	3.25	3.37	3.54	3.42
Stringent environmental policy	2.50	2.00	2.50	1.90	2.34	2.24	2.20
Slowdown of technological advances	3.07	3.24	2.93	2.97	2.46	2.30	2.50
Aging population	3.14	2.63	2.82	2.88	2.63	2.81	2.97
Limits to international trade	2.86	2.25	2.60	2.33	2.46	2.29	2.52
n	15	19	47	114	105	117	129

Note: Shown are means based on a scale from 1 (unimportant) to 4 (very important)

Table B2
Importance of factors contributing to never-ending growth, by research field.

Factor	GrowEc	GrowEnv	OthEc	EnvEc	EcoEc	EnvSoc	EnvSci
Environmental problems (biodiversity loss, climate change, etc) are exaggerated	2.69	2.42	2.42	2.21	2.58	3.03	2.63
Reserves of fossil fuels are abundant	2.35	2.00	2.00	1.92	2.36	2.15	2.13
All non-renewable energy sources can be replaced by renewable ones	3.53	2.84	2.84	3.16	3.67	3.38	3.60
Increase in knowledge is boundless	3.94	3.64	3.64	3.63	3.57	3.57	3.80
Technological progress has no limits	3.59	3.61	3.61	3.53	3.65	3.50	3.50
Opportunities in international trade	2.59	2.85	2.85	2.96	2.64	3.29	3.30
n	19	12	28	114	26	39	32

Note: Shown are means based on a scale from 1 (unimportant) to 4 (very important).

Table B3
Mean values of political orientation, by research field.

Research field	GrowEc	GrowEnv	OthEc	EnvEc	EcoEc	EnvSoc	EnvSci
Mean (SD)	3.79 (1.41)	3.36 (1.39)	3.21 (1.17)	3.15 (1.17)	2.76 (1.26)	2.66 (1.19)	2.83 (1.32)

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