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Longevity and Patience

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Abstract

Why does patience vary across individuals and countries? We provide evidence on a widely-hypothesized mechanism, namely that higher longevity fosters patience. Using data on patience for 80,000 individuals in 76 countries, this paper relates exogenous variation in longevity across gender-age-country cells to variation in patience. We find that a ten-year increase in life expectancy implies a 5-percentage point higher discount factor. This relationship emerges for various sub-samples and is unaffected by other determinants including lifetime experiences regarding economic development, institutional quality, or violence. We provide a model to discuss the implications for the emergence of poverty traps.

JEL classification: D10, J10, O10

Keywords: Time Preferences, Mortality, Poverty Traps.

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1 Introduction

Patience constitutes a fundamental determinant of any inter-temporal choice and is generally viewed as a key primitive in both macroeconomic and microeconomic models. Empirical work has presented evidence that variation in patience accounts for a considerable part of the observed heterogeneity in education, savings and per-capita income across individuals, regions as well as across countries (Borghans et al., 2008; Sutter et al., 2013; Dohmen et al., 2018). However, little is known about the determinants of patience.

This paper provides direct evidence for the most prominent hypothesis proposed in the literature, namely that greater longevity leads to greater patience and more future-oriented behavior (Becker and Mulligan, 1997).

Testing this hypothesis requires data on patience that fulfill two key requirements. First, the measure of patience needs to be reliable and predictive of real-world behavior. Second, to identify an effect of longevity on patience, the data sample must exhibit plausibly exogenous variation in longevity. We employ a global dataset of individual patience endowments that fulfills these requirements (Falk et al., 2018). Our measure of patience is elicited by two survey items involving (i) a choice between immediate and delayed monetary rewards and (ii) a self-assessment of the willingness to delay rewards to the future. Both survey items were selected through a rigorous ex-ante experimental selection and validation procedure, thereby ensuring that the survey items are predictive of incentivized economic behavior. The patience measures are elicited for a total of 80,000 individuals in 76 representative country samples that cover all continents and a broad range of economic development providing large variation in longevity levels.

Our identification strategy makes use of objective and exogenous variation in individual life expectancy by combining the individual patience data with granular data from period life tables provided by the *Population Division of the United Nations*. These life tables contain information about the expected remaining years of life for a given gender-age cell in a particular country. To establish a plausibly causal relationship between longevity and patience we apply an identification strategy that relates variation in longevity across gender-age-country cells from period life tables to variation in patience. Importantly, this identification strategy isolates the estimated effect from any systematic differences across countries, age groups and gender groups by applying the logic of a differences-in-difference design.

To illustrate our identification strategy, consider two individuals aged 20 and 50 from the US and two individuals of the same ages from South Africa. We calculate the difference in patience between the 20- and 50-year old in the US in comparison to the difference between the 20- and 50-year old in South Africa. We then relate the resulting difference-in-differences to the corresponding differences in expected remaining years of life to obtain an estimate of the effect of longevity on patience.

Two aspects of our identification strategy are particularly noteworthy. First, our approach isolates the effect of longevity from other country-specific confounding factors shared by individuals from the same country. Potential candidate confounds that may influence patience but are isolated by this strategy include variation in institutional quality or economic development. Following a similar logic, our approach separates the effect of longevity from all age-specific confounding factors shared by individuals of the same age. For instance, patience may follow age patterns that are predetermined by biological or evolutionary factors. Second, the measures of expected remaining years of life from period life tables reflect the life expectancy for an individual of a particular age if they experienced the (age-specific) mortality rates of the given period throughout the remaining life. This implies that expected remaining life years are based on mortality patterns of older cohorts and hence plausibly exogenous to the actions of the individuals of the respective age group. This rules out any reverse causality from patience to longevity, which would be a concern when using subjective beliefs about health and longevity.

Our main result provides evidence for a significant positive effect of longevity on patience. In quantitative terms, a ten-year increase in life expectancy leads to a 5-percentage point increase in the discount factor, constructed from the quantitative patience measure. This effect is robust to the inclusion of an extensive set of control variables. In particular, our point estimates are unaffected when accounting for variation in religion, language and potentially endogenous variables such as proxies for cognitive ability and education.

We provide several additional pieces of evidence that shed light on the robustness, underlying mechanisms, and consequences of this effect. First, the positive association of patience with longevity holds for all geographic regions of the world and is present for both women and men. Second, there is no significant association between variation in longevity and other preference measures such as risk attitudes, altruism, trust or negative reciprocity with longevity. Only for positive reciprocity a similar, albeit smaller, effect emerges. This finding is consistent with the intuition that longevity favors repeated interactions, creating incentives for engaging in positively reciprocal behavior. Third, our point estimates are virtually unaffected when using alternative data or measures of longevity. Fourth, to further mitigate concerns about simultaneity, we instrument current remaining years of life with values based on earlier cohorts, yielding similar results. Fifth, we test for robustness against lifetime experience effects on patience arising from experienced economic development, institutional quality, or political violence throughout an individual's life course. While our results indicate that such experiences may have an effect on patience, the association of patience with longevity remains unaffected. Sixth, we document an effect of subjectively-perceived health on patience. However, this effect appears to be independent as the impact of objective remaining years of life remains virtually unaffected by including the control for subjective health status. Finally, we provide a theoretical model that highlights the consequences of this finding for the emergence of poverty traps through a vicious cycle of high mortality, low patience, and low human capital investments.

In documenting a sizable and significant positive effect of individual life expectancy on patience, this paper contributes to the understanding of the determinants of time preferences. Time preferences are an important determinant for economic outcomes, see Mischel et al. (1989), Chabris et al. (2008), Sutter et al. (2013), and Figlio et al. (2016) for evidence on the level of the individual; see also Falk et al. (2019), which includes an overview table of papers relating preferences to outcomes. Recent work by Dohmen et al. (2018) has provided evidence for the role of patience for economic development at both the individual and the aggregate level.

Only a few studies have investigated the determinants of patience, providing evidence for the role of geographic factors, including in particular agricultural suitability (Galor and Özak, 2016), historical migration patterns (Becker et al., 2018), and language (Chen, 2013; Falk et al., 2018). This paper complements this literature by pointing towards the crucial role of health and longevity for patience. Our results also complement findings regarding the importance of lifetime experiences for (risk) preference formation (Malmendier and Nagel, 2011, 2016) by reporting qualitatively similar results for the domain of time preferences and showing that longevity has a distinct influence on patience.

The remainder of the paper is structured as follows. Section 2 discusses the data and the empirical strategy. Section 3 presents the empirical results. Section 4 concludes by discussing the implications of the empirical findings for long-run development.

2 Data and Empirical Framework

2.1 Patience

Our data stems from the Global Preference Survey (GPS) (Falk et al., 2018). The GPS is a newly-constructed cross-sectional dataset containing measures of fundamental economic preferences for approximately 80,000 individuals in representative samples from 76 countries (see Online Appendix Figure A1 for a world map of countries covered in the data). The countries selected for the survey cover all continents and represent a total of 90% of the world's income and population. The elicitation was implemented as part of the Gallup World Poll using the same survey infrastructure.

The GPS contains two measures of patience that are relevant for the purpose of this study, a quantitative revealed preference measure of patience that captures respondents' indifference point between a payment today and a payment with 12 months delay, and a qualitative measure capturing the respondents' subjective assessment of their patience. The quantitative item presents the participants with a sequence of five interdependent trade-off questions:

> *"Suppose you were given the choice between receiving a payment today or a payment in 12 months. We will now present to you five situations. The payment today is the same in each of these situations. The payment in 12 months is different in every situation. For each of these situations we would like to know which you would choose. Please assume there is no inflation, i.e, future prices are the same as today's prices. Please consider the following: Would you rather receive 100 Euro today or x Euro in 12 months?"*

By varying the amount x, we obtain the indifference point between a payment on the day of the survey and a payment 12 months later which serves as a quantitative measure of patience. The precise elicitation protocol is shown in Appendix D. The qualitative survey item asks participants:

> *"How willing are you to give up something that is beneficial for you today in order to benefit more from that in the future? Please indicate your answer on a scale from 0 to 10, where 0 means you are 'completely unwilling to do so' and a 10 means you are 'very willing to do so'. You can also use any numbers between 0 and 10 to indicate where you fall on the scale, like 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10."*

These two survey items were selected through a rigorous, ex-ante experimental validation before the implementation in the international survey. In this procedure, subjects responded to survey questions but also participated in incentivized state-of-the-art choice experiments. Out of a large set of survey questions, the two survey items were selected for the international survey as the best joint predictors of incentivized behavior. After the implementation of the worldwide survey in 2012, the final measure for patience was generated according to the following procedure. First, each of the two survey items was standardized using the mean and variance of the entire worldwide sample. Next, the relevant z-scores were averaged using weights developed in the experimental validation. Finally, the combined measure was standardized on the worldwide sample to exhibit a mean of zero and standard deviation of one. For further details on the GPS data, see Falk et al. (2018).

2.2 Longevity

We combine the individual-level patience measures with granular period life table data from the *Population Division of the United Nations*.[1] These period life tables provide information about the values of age-specific mortality for gender-age-country cells and can be used to compute the life expectancy in terms of remaining years of life for each gender-age-country cell.

The mortality data by age and gender are obtained from vital registration systems in each country in a given year that are reported to either the United Nations Statistics Division or the World Health Organization (WHO) and combined with data from population censuses to obtain mortality patterns in given years.[2] The use of period life table information implies that the respective remaining years of life for individuals in a particular gender-age-country cell are based on mortality information from older cohorts.

Provided that past mortality patterns are stable, the life table information provides a valid measure of the average longevity expectation for individuals (Smith et al., 2001) and is likely to be more accurate and reliable than subjective beliefs (Hamermesh, 1985; Elder, 2013). For robustness checks, we also make use of alternative life table data provided by the *The Human Mortality Database*.[3]

2.3 Descriptive Evidence and Empirical Strategy

Does longevity affect patience? A first and cursory look at the empirical relevance of the conjectured influence can be obtained by considering the patience data at the country-level. Figure 1 shows that longevity and patience are indeed strongly and positively correlated across countries.[4] However, this correlation is likely to suffer from reverse causality problems and omitted variable bias. Specifically, forward-looking and more patient individuals and countries may be more likely to under-

[1] See http://www.un.org/en/development/desa/population/publications/database/index.shtml.

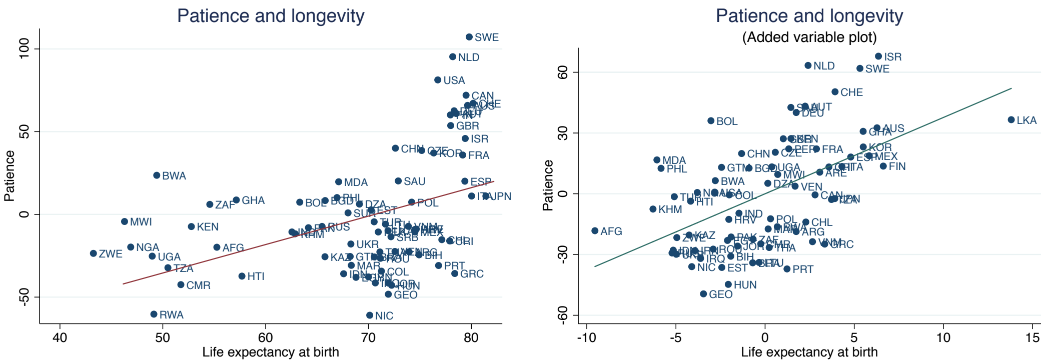
[2] See also http://www.who.int/healthinfo/statistics/LT_method.pdf for details on the methodology.

[3] See www.mortality.org.

[4] For a world map of country-level mean patience see Online Appendix Figure A1.

take investments in their health or implement better, health-promoting, institutions. Furthermore, other potential determinants of patience, such as historical and institutional factors, might be correlated with life expectancy, giving rise to a spurious relationship.

Figure 1: Patience and Life Expectancy



(a) Raw Data

(b) Conditional on Observables

Notes: Figure 1(a) illustrates the association of country-level patience with life expectancy at birth at the country level unconditionally and Figure 1(b) shows the same association conditional on control variables. Controls include indicators for geographic region, absolute latitude, land suitability for agriculture, avg. temperature, avg. precipitation, timing of neolithic revolution, percentage living in (sub-)tropical zones.

Hence, an empirical analysis relying on plain cross-country variation in levels of longevity is not suited to identify the effect of longevity on patience. To obtain a credible causal estimate of this effect, we propose an identification strategy that exploits differences in the remaining years of life across age cells, conditional on country and age fixed effects. Intuitively, the source of identifying variation is the difference in remaining years of life between young and old individuals in a particular country relative to the differences in remaining years of life between young and old individuals in another country. Gender-specific remaining years of life for a given age-country combination serve as an additional source of variation. We use the variation in expected remaining life years across gender-age-country cells and relate it to the variation in patience across the corresponding cells.

Formally, we regress individual-level patience β_{igac} on the expected remaining years of life π_{igac} of an individual i of gender g and age a in country c, controlling for gender ζ_g, a vector of age fixed effects δ_a, a vector of country fixed effects α_c, and additional potentially relevant individual characteristics X_{igac},

$$\beta_{igac} = \gamma \cdot \pi_{igac} + \zeta_g + \delta_a + \alpha_c + \rho \cdot X_{igac} + \varepsilon_{igac}, \qquad (1)$$

where ε_{igac} captures an idiosyncratic error term. To facilitate readibility, the patience measure is multiplied by 100. In the baseline analysis, we cluster standard errors at the country level.

In light of the results in Falk et al. (2018), the vector of individual characteristics X in the baseline specification includes gender, subjective math skills as proxy for cognitive ability, education and the log of household income per capita. Summary statistics of the variables contained in the baseline analysis are displayed in Online Appendix Tables A1 and A2.

The intuition behind the identification strategy is similar to a difference-in-differences approach, as the model uses variation in life expectancy between different age groups in different countries and relates it to the corresponding variation in patience. Importantly, the measure of remaining years of life is constructed based on mortality rates of past cohorts. This captures the best statistical prediction of the remaining life time of an individual in a particular age-gender-country cell without being prone to potential endogeneity problems at the individual level. Concerns about reverse causality are hence mitigated, as the life expectancy measure cannot be altered by the behavior of a given individual or even a gender-age cohort. For this reason, the use of life-table information has a distinct advantage over using subjective measures or beliefs of life expectancy.

3 Empirical Results

3.1 Baseline Results

Table 1 presents the main results. The baseline specification in Column (1) documents a substantial positive association between the expected length of the remaining lifetime and individual patience. A one-year increase in remaining years of life is associated with a 0.0163 (s.e.=0.004) standard deviation increase in patience. Adding other, potentially endogenous, individual-level controls such as cognitive ability, education, or log household income per capita as in Column (2) yields a virtually unaffected point estimate of 0.0173 (s.e.=0.004). We obtain similar point estimates when controlling for within-country regions instead of country fixed effects in Column (3). In addition, given previous evidence emphasizing the potential role of religion (Becker and Woessmann, 2009) or language (Chen, 2013) for education and future orientation, we control for religion and language in Columns (4) to (6). We obtain virtually identical results when controlling for these factors separately or all factors jointly.

In order to quantify the effect sizes, we repeat the estimation using the discount

Table 1: Longevity and Patience at the Individual Level

	Dependent variable: Patience					
	(1)	(2)	(3)	(4)	(5)	(6)
Remaining years of life	1.63***	1.73***	1.67***	1.68***	1.75***	1.59***
	(0.359)	(0.376)	(0.375)	(0.381)	(0.413)	(0.423)
1 if female	-13.5***	-11.5***	-11.6***	-10.8***	-12.4***	-11.2***
	(2.246)	(2.207)	(2.209)	(2.294)	(2.295)	(2.422)
Subj. math skills		2.24***	2.05***	2.22***	2.22***	2.05***
		(0.208)	(0.191)	(0.218)	(0.209)	(0.195)
Education level		8.58***	8.63***	9.32***	8.73***	9.71***
		(1.381)	(1.303)	(1.356)	(1.457)	(1.416)
Log [Household income p/c]		3.28***	3.04***	3.47***	3.31***	3.49***
		(0.562)	(0.553)	(0.581)	(0.607)	(0.627)
Country FE	Yes	Yes	No	Yes	Yes	No
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	No	No	Yes	No	No	Yes
Religion FE	No	No	No	Yes	No	Yes
Language FE	No	No	No	No	Yes	Yes
Observations	79433	77693	76793	69245	71987	62691
R^2	0.161	0.172	0.218	0.176	0.184	0.232

Notes: Table 1 presents OLS estimates of a regression of patience on remaining years of life controlling for gender, country fixed effects, age fixed effects and different sets of control variables. In the specifications using within-country region fixed effects, no country fixed effects are included as they are collinear. Patience is standardized to exhibit a standard deviation of 100. Standard errors clustered at the country level in parentheses. ** $p < 0.05$.

factor as the dependent variable. More specifically, we replicate the analysis using only the quantitative survey item that elicits a participant's indifference point between a payment of 100 Euros today and a payment of x Euros in one year. Hence, the value of x for which the individual is indifferent directly pins down the yearly discount factor as $D(x) = \frac{100}{x}$.[5] Using the value of $D(x)$ as the dependent variable delivers coefficient estimates that allow for a straightforward quantitative interpretation of the effect of a one-year increase in longevity on the discount factor over a one-year horizon. Given that our elicitation procedure invokes bounds on the discount factor, we estimate Tobit regressions. The results indicate that 10 more years of expected remaining life time are associated with an increase in the discount factor by 5-6 percent (Online Appendix Table A3).

The findings remain robust in various alternative specifications. In particular, the findings are unaffected when conducting inference based on alternative assumptions about cross-sectional dependencies and applying two-way clustering on country and

[5]The implicit assumption is that utility is approximately linear for the stakes involved in this trade-off.

age (Online Appendix Table A4). Moreover, the effect of longevity robustly emerges across various geographic sub-samples and for women and men separately (Online Appendix Table A5).[6]

Are other preferences similarly affected by longevity? The GPS data also contain measures of other preferences related to risk taking, altruism, trust, and positive and negative reciprocity, which were elicited in comparable ways to patience by using a combination of qualitative and quantitative survey items (see Falk et al., 2018). While these preferences might also be influenced by longevity, it is conceptually much less obvious to formulate clear empirical hypotheses.[7] We replicate the analysis for other preference measures to explore whether the effect of life expectancy is unique to time preferences or whether it also applies to other preferences. The results document no significant effect of expected remaining life years on any other preference measure, with the exception of positive reciprocity (Online Appendix Table A6). The positive effect on positive reciprocity appears plausible in light of the intrinsic relation between reciprocity and future-oriented behavior, whereby individuals who are willing to reciprocate invest resources today to reap potential social benefits in the future (Kreps et al., 1982).

3.2 Alternative Measures of Longevity and Instrumental Variables

The results are unchanged when using alternative measures of life expectancy. To demonstrate this, we use alternative life table data from the *Human Mortality Database* to compute the remaining years of life for each country-age-gender cell. The results are also robust when longevity is conceptualized as the inverse of the probability of dying within the next year, which captures a more immediate or short-term measure of mortality rather than focusing on the entire remaining life span (Online Appendix Table A7).

Complementarily, we also applied an instrumental variable approach that uses the life expectancy of particular age-gender cells in a given country for earlier periods to instrument life expectancy for the period of observation. In our main specification, reverse causality is unlikely as a consequence of the construction of the measures of longevity: as expected remaining years of life is based on the mortality rates of past

[6]The effect is in fact largely comparable in size across geographic world regions, but somewhat smaller in less developed countries, in particular in African countries and the Middle East. Moreover, the effect of remaining lifetime on patience is positive and significant for both women and men, but larger for women than for men.

[7]Moreover, this analysis contributes to previous research that has found systematic age patterns in preferences, see e.g. Dohmen et al. (2017) for the context of risk preferences.

cohorts, it cannot be directly affected by the patience endowment of an individual in the particular age group. Nevertheless, one might be worried about simultaneity bias. To investigate the robustness of the results and address potential measurement error, we use life table information for 2000, 1990, 1980, and 1970, respectively, to instrument the measure of remaining years of life computed from the period life table for 2010 that has been used in the baseline analysis. The variation used for identification thus pertains to age-specific mortality of cohorts even further in the past. The second-stage results reveal that the coefficient on remaining years of life is statistically significant in all specifications and quantitatively almost identical to the baseline estimates (Online Appendix Table A7).[8]

3.3 Alternative Explanations and Mechanisms

Lifetime Experiences: Development and Institutions. Life expectancy in terms of remaining years of life for an individual in a given age-gender-country cell appears to be a strong predictor of individual patience conditional on country- and age-specific effects. A potential concern regarding this finding involves other factors that vary by age-gender-country cells conditional on country- and age-specific effects. Most importantly, certain lifetime experiences that are crucial for the formation of patience might vary at this level. For instance, the differences in institutional quality over the life course experienced by a 50-year old in the United States and a 50-year old in South Africa might be fundamentally distinct from the corresponding differences experienced by two 20-year olds.

Generally, experience effects – for instance, of economic hardship in times of a depression – have been shown in the context of willingness to take risks (Malmendier and Nagel, 2011, 2016). Other studies find that income, socio-economic background and living conditions in general affect preferences (Tanaka et al., 2010; Fehr and Haushofer, 2014; Falk et al., 2019; Kosse et al., 2019). Likewise, institutional quality has been argued to influence cultural norms, which might include future orientation (Lowes et al., 2017). Moreover, violent conflict has been identified as a source of variation in the willingness to take risks (Callen et al., 2014) and individual exposure to an institutional environment has been shown to affect preferences for democracy (Fuchs-Schündeln and Schündeln, 2015). Finally, the subjective perception of institutional quality or the risk of expropriation and violence might influence individual patience. Consequently, the perception of a very unsafe environment may prevent

[8]We present the first-stage estimates in Online Appendix Table A8. The first-stage results of this exercise reveal that remaining years of life computed from life tables in the past are strong predictors of remaining years of life in the present, with F-statistics exceeding 10 in all specifications.

individuals from undertaking investments with future rewards, for instance in education (Acemoglu et al., 2014).

In order to test whether such experience effects might explain our results, for each cohort in each country we construct average lifetime values for experienced log GDP per capita using data from the *Maddison Project*, institutional quality using the Polity IV index from the *Polity IV Project*, democracy using data from *Freedom House*, and political violence using information from the *Peace Research Institute Oslo*. These variables also exhibit variation across age-country cells and thus allow for a conceptually similar identification as the measure for remaining years of life.[9]

In addition, we also use a measure of subjectively-perceived institutional quality as reported by respondents to the Gallup World Poll. For individual decision-making, subjective perceptions about institutional quality are potentially more important than the objectively experienced institutional environment. However, in contrast to the other institutional background variables, which exhibit plausibly exogenous variation in the present context, subjective perceptions might constitute a bad control (in the sense of Angrist and Pischke, 2006, p. 64.). We nevertheless include this variable in some of the analysis to explore the implications for the coefficient of interest.

Table 2 shows empirical results from the estimation of an extended specification that includes remaining years of life as well as measures of lifetime experiences, separately as well as jointly. The findings reveal no systematic association between patience and experienced log GDP per capita, a marginally significant association with experienced institutional quality, and negative associations with experienced political violence. The results also show a positive and significant relationship between patience and subjective institutional quality. In sum, this evidence suggests that certain life time experiences – particularly in terms of the institutional environment – indeed matter for the formation of patience.

The regressions also show, however, that the effect of remaining years of life on patience is essentially unaffected by the effects of these lifetime experiences. Additional robustness checks focusing on income, institutional quality or democracy and violence at birth or the age of 15 instead of aggregating over the life cycle provide very similar conclusions (Online Appendix Tables A9 and A10). In sum, these results support the conjecture that the impact of longevity on patience is largely unaffected by potential experience effects or subjective perceptions of institutional quality.

[9]The only difference is that the measures of experiences exhibit no variation across gender groups.

Table 2: Life Expectancy and Patience: The Role of Life Experiences of Development and Institutions

	Dependent variable: Patience							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Remaining years of life	1.62***	1.73***	1.72***	1.62***	1.68***	1.66***	1.50***	1.38***
	(0.394)	(0.379)	(0.377)	(0.397)	(0.380)	(0.387)	(0.424)	(0.448)
Avg. log GDP p/c lifetime	5.14						7.20	8.03
	(5.235)						(5.251)	(8.638)
Avg. institutional quality lifetime		0.89*					1.49**	1.53**
		(0.455)					(0.575)	(0.622)
Avg. democracy lifetime			6.49				-10.0	-11.4
			(6.494)				(7.411)	(8.152)
Avg. societal political violence lifetime				-2.46**			-1.92**	-2.13
				(1.137)			(0.866)	(1.325)
Avg. interstate political violence lifetime					-6.71		-4.94	-5.20
					(4.385)		(4.127)	(4.878)
Subjective institutional quality						0.15***		0.15***
						(0.025)		(0.024)
Gender	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	77693	77693	77693	77693	58062	77693	77693	58062
R^2	0.172	0.172	0.172	0.172	0.167	0.172	0.172	0.167

Notes: Table 2 presents OLS estimates of a regression of patience on remaining years of life controlling for gender, country fixed effects, age fixed effects, experienced development and institutional quality. Additional controls include subjective math skills, education level, and log household income per capita. Patience is standardized to exhibit a standard deviation of 100. Standard errors clustered at the country level in parentheses. ** $p < 0.05$.

Subjective Health Status and the Formation of Patience. The results so far are strongly suggestive of an important role of longevity for patience. Importantly, the identification has been based on longevity measured by the expected remaining years of life from period life tables, i.e., based on period mortality, which refers to previous cohorts in the respective age-gender-country cells. This captures unbiased and objective information about the remaining life time for an individual in a given gender-age-country cell. Recent evidence has pointed to the influence of health perceptions for individual subjective life expectancy, which itself is a predictor of individual mortality (van Solinge and Henkens, 2018).

In order to explore the role of subjective health conditions for patience and assess the robustness of the results obtained with objective longevity information from life tables, we repeat the analysis controlling for subjective health perceptions.[10] When interpreting these results, however, it is necessary to keep in mind, that similar to subjective perceptions about institutional quality, subjectively-perceived health status might be prone to endogeneity or simultaneity problems.

Table 3 presents the corresponding estimation results, which indeed show that individuals with a better subjective perception of their health status also exhibit greater patience, conditional on age and other control variables. Nevertheless, the effect of the objective measure of average remaining years of life based on life table statistics remains significant and quantitatively virtually unchanged compared to the baseline results.

Finally, we investigate whether expected longevity forms patience early in life or whether patience is predominantly determined by contemporaneous life expectancy. To do so, we add to our baseline specification as an additional independent variable the expected length of an individual at their birth.[11]

The results in Online Appendix Table A11 affirm the robust effects of contemporaneous life expectancy with coefficients similar to the baseline specifications in Table 1. In contrast, there is no robust effect of life expectancy at birth. These results underscore that an individual's patience endowment is not fixed but rather a function of the contemporaneous life expectancy, consistent with the conjecture by Becker and Mulligan (1997).

[10]Individual health perceptions are measured in terms of a personal health index that is constructed from combining individual responses to six questions about self-reported personal health assessments. These include satisfaction with personal health, health problems leading to behavioral limitations, and perception of stress, physical pain, worries, or sadness.

[11]Information on life expectancy at birth is taken from past period life tables provided by the *Population Division of the United Nations*. As these data are only available back to 1950, we conduct a linear extrapolation to impute life expectancy at birth for older cohorts.

Table 3: Life Expectancy and Patience: The Role of Subjective Health Perceptions

	Dependent variable: Patience					
	(1)	(2)	(3)	(4)	(5)	(6)
Remaining years of life	1.72***	1.78***	1.72***	1.74***	1.82***	1.66***
	(0.369)	(0.382)	(0.383)	(0.389)	(0.420)	(0.432)
Subjective health perceptions	0.13***	0.083***	0.086***	0.10***	0.086***	0.11***
	(0.021)	(0.019)	(0.019)	(0.017)	(0.020)	(0.018)
Country FE	Yes	Yes	No	Yes	Yes	No
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	No	No	Yes	No	No	Yes
Gender	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	No	Yes	Yes	Yes	Yes	Yes
Religion FE	No	No	No	Yes	No	Yes
Language FE	No	No	No	No	Yes	Yes
Observations	77411	75707	74807	67353	70001	60799
R^2	0.151	0.161	0.208	0.164	0.173	0.221

Notes: Table 3 presents OLS estimates of a regression of patience on remaining years of life controlling for gender, country fixed effects, age fixed effects, subjective health perceptions and different sets of control variables. Additional controls include subjective math skills, education level, and log household income per capita In the specifications using within-country region fixed effects, no country fixed effects are included as they are collinear. Patience is standardized to exhibit a standard deviation of 100. Standard errors clustered at the country level in parentheses. ** $p < 0.05$.

4 Discussion

Patience constitutes a fundamental determinant of inter-temporal choices and economic outcomes in canonical models of economic behavior. This paper contributes to the small body of literature on the determinants of patience by providing evidence for the impact of a widely-hypothesized factor: longevity. Using globally representative data on patience in combination with plausibly exogenous variation in country-specific and cohort-specific longevity, we establish a quantitatively substantial and robust empirical link between patience and expected life time. In more detail, greater longevity is associated with higher patience: a 10-year increase in remaining years of life implies a 5-percentage point increase in the discount factor.

This finding emerges robustly for various sub-samples and different proxies for longevity, as well as when applying instrumental variable estimations. We also show that potential experience effects arising from experienced economic development, institutional quality, or violence over the life course might affect patience but do not affect the main result for longevity.

The significant positive effect of longevity on patience can have far-reaching implications for the emergence of poverty traps. Recent work on poverty traps has isolated various factors that can lead to detrimental feedback loops, including bio-physical and psychological factors, low levels or loss of human capital, bad health conditions, or financial market imperfections (see the introductory discussion by Barrett et al. (2019) and the contributions in their collected volume). Past research has argued that improvements in life expectancy are crucial for countries' transition from quasi-stagnation to sustained growth due to their effects on human capital investment (Cervellati and Sunde, 2005; Castello-Climent and Domenech, 2008; Cervellati and Sunde, 2015).

As patience is also a crucial determinant of health and human capital investments (Jayachandran and Lleras-Muney, 2009; Fortson, 2011; Oster et al., 2013), our evidence provides scope for a negative feedback effect that amplifies the consequences of bad health and low life expectancy for long-run development. Such a longevity-patience development trap arises through a vicious cycle of high mortality, low patience, and low investments into human capital and health. Vice versa, the results suggest that improvements in longevity, for instance as a consequence of health interventions, imply greater patience and thereby propel long-term investments and ultimately boost a county's economic development.

In Section C in the Appendix, we formalize these intuitions in a simple overlapping generations model that captures the interdependencies between patience and longevity and that highlights the potential for a longevity-patience poverty trap. This mechanism complements standard mechanisms leading to poverty traps, which are usually related to either external frictions or non-homothetic preferences (Ghatak, 2015). At the same time, the link between health and patience extends previous work on endogenous time preferences (Becker and Mulligan, 1997; Strulik, 2012).

In sum, the evidence presented in this paper points towards an important feedback loop between bio-physical and psychological factors that can have important consequences for development. In terms of policy implications, our findings suggest that health interventions that improve longevity might have positive externalities: besides increasing individual productivity and well-being, higher longevity shifts greater weight to future outcomes, thereby fostering future-oriented decision-making such as investment in human or physical capital.

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Supplementary Material For Publication as Online Appendix

Longevity and Patience

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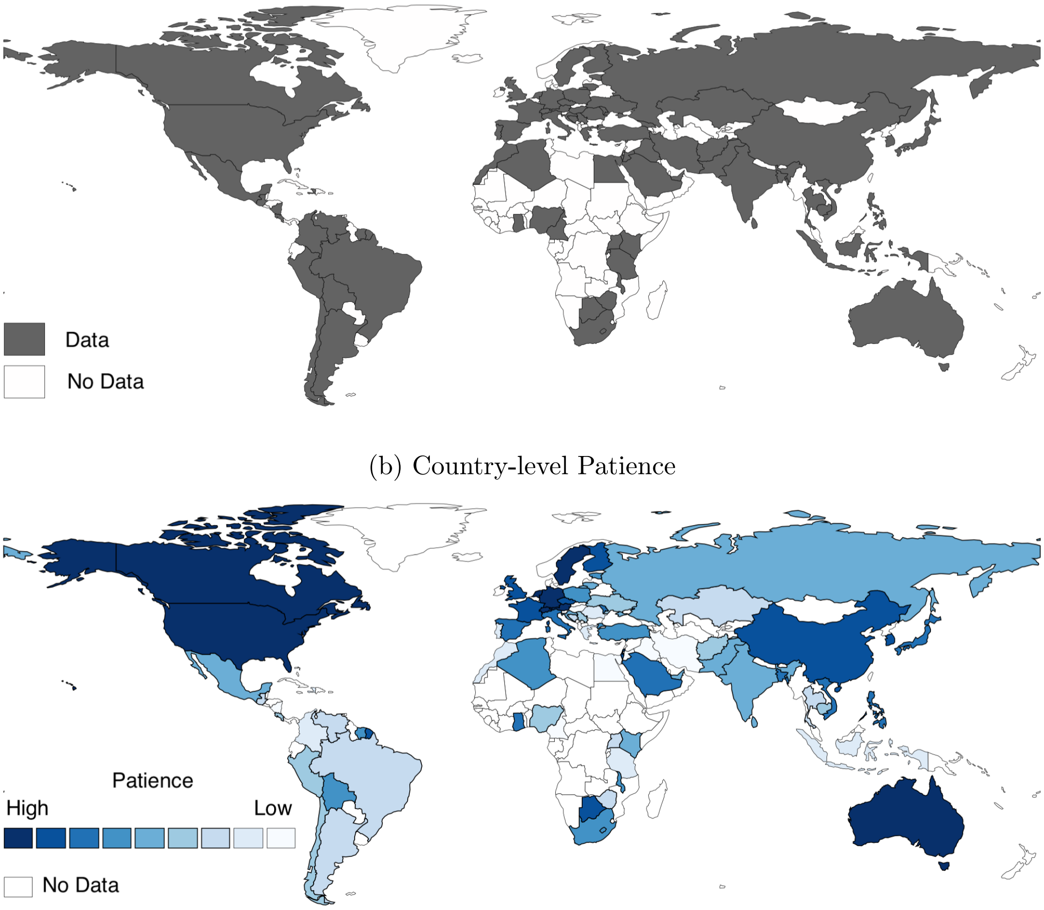
A Online Appendix Figures

Figure A1: World Maps

(a) Data Availability

(b) Country-level Patience



Notes: Figure A1(a) provides a world map of countries covered in the data. Figure A1(b) visualizes mean country-level patience across countries.

B Online Appendix Tables

Table A1: Summary Statistics: Main Variables

Baseline Specification					
	Mean	Std. Dev.	Min	Max	N
Patience	0.00	100.00	-131	276	79,730
Remaining years of life	36.21	14.43	2	72	80,021
1 if female	0.55	0.50	0	1	80,337
Age	41.82	17.49	15	99	80,061
Subj. math skills	5.18	2.82	0	10	79,211
Education level	1.86	0.66	1	3	79,945
Log [Household income p/c]	7.92	1.52	-4	15	79,848

Table A2: Summary Statistics: Additional Variables

Additional Variables	Mean	Std. Dev.	Min	Max	N
Discount Factor	0.56	0.16	0	1	74,124
Remaining years of life (mortality.org)	33.20	15.45	2	72	25,419
1/(Probablity of Dying)	616.40	839.76	4	7,933	79,498
Avg. log GDP p/c lifetime	8.26	1.16	0	10	80,061
Avg. institutional quality lifetime	2.03	5.97	-10	10	80,061
Avg. democracy lifetime	0.53	0.41	0	1	80,061
Subjective institutional quality	49.08	35.47	0	100	60,096
Avg. societal political violence lifetime	0.97	1.54	0	8	80,061
Avg. interstate political violence lifetime	0.21	0.49	0	4	80,061
Will. to take risks	-0.00	100.00	-187	247	79,703
Altruism	-0.00	100.00	-261	233	79,903
Trust	0.00	100.00	-197	168	78,774
Positive reciprocity	0.00	100.00	-384	133	80,189
Negative reciprocity	0.00	100.00	-159	233	78,536

Table A3: Life Expectancy and Patience: Quantitative Effects

	Dependent variable: Discount factor					
	(1)	(2)	(3)	(4)	(5)	(6)
Remaining years of life	0.0055***	0.0060***	0.0057***	0.0057***	0.0058***	0.0050***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
1 if female	-0.039***	-0.034***	-0.035***	-0.031***	-0.036***	-0.032***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.000)	(0.000)
Subj. math skills		0.0049***	0.0042***	0.0047***	0.0047***	0.0039***
		(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Education level		0.029***	0.029***	0.030***	0.030***	0.033***
		(0.005)	(0.005)	(0.005)	(0.000)	(0.000)
Log [Household income p/c]		0.014***	0.012***	0.014***	0.014***	0.013***
		(0.002)	(0.002)	(0.003)	(0.000)	(0.000)
Country FE	Yes	Yes	No	Yes	Yes	No
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	No	No	Yes	No	No	Yes
Religion FE	No	No	No	Yes	No	Yes
Language FE	No	No	No	No	Yes	Yes
Observations	73887	72454	71732	64872	67075	58814

Notes: Online Appendix Table A3 presents Tobit estimates of a regression of the discount factor on remaining years of life controlling for gender, country fixed effects, age fixed effects and different sets of control variables. In the specifications using within-country region fixed effects, no country fixed effects are included as they are collinear. Standard errors clustered at the country level in parentheses. ** $p < 0.05$.

Table A4: Life Expectancy and Patience: Inference with two-way clustered S.E.

	Dependent variable: Patience					
	(1)	(2)	(3)	(4)	(5)	(6)
Remaining years of life	1.63***	1.73***	1.67***	1.68***	1.75***	1.59***
	(0.368)	(0.391)	(0.380)	(0.394)	(0.437)	(0.438)
1 if female	-13.5***	-11.5***	-11.6***	-10.8***	-12.4***	-11.2***
	(2.331)	(2.291)	(2.265)	(2.386)	(2.437)	(2.561)
Subj. math skills		2.24***	2.05***	2.22***	2.22***	2.05***
		(0.200)	(0.184)	(0.212)	(0.198)	(0.189)
Education level		8.58***	8.63***	9.32***	8.73***	9.71***
		(1.379)	(1.303)	(1.366)	(1.463)	(1.435)
Log [Household income p/c]		3.28***	3.04***	3.47***	3.31***	3.49***
		(0.576)	(0.559)	(0.610)	(0.621)	(0.638)
Country FE	Yes	Yes	No	Yes	Yes	No
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	No	No	Yes	No	No	Yes
Religion FE	No	No	No	Yes	No	Yes
Language FE	No	No	No	No	Yes	Yes
Observations	79433	77693	76793	69245	71987	62691
R^2	0.161	0.172	0.218	0.176	0.184	0.232

Notes: Online Appendix Table A4 presents OLS estimates of a regression of patience on remaining years of life controlling for gender, country fixed effects, age fixed effects and different sets of control variables. In the specifications using within-country region fixed effects, no country fixed effects are included as they are collinear. Patience is standardized to exhibit a standard deviation of 100. Standard errors two-way clustered at country and age level in parentheses. ** $p < 0.05$.

Table A5: Life Expectancy and Patience: Results for Different Sub-Samples

	Dependent variable: Patience in ...							
	Europe & CA (1)	Americas (2)	Africa & ME (3)	SE Asia & Pacific (4)	OECD (5)	Non-OECD (6)	Men (7)	Women (8)
Remaining years of life	2.34***	1.60*	1.14***	3.52***	3.67**	1.14***	1.59***	3.84***
	(0.745)	(0.784)	(0.364)	(1.025)	(1.524)	(0.401)	(0.557)	(0.665)
1 if female	-22.3***	-11.5**	-3.21*	-14.1**	-28.3***	-5.96***		
	(4.504)	(4.700)	(1.753)	(6.018)	(6.346)	(2.149)		
Subj. math skills	2.53***	1.92**	1.85***	2.63***	2.78***	2.12***	2.82***	1.76***
	(0.343)	(0.686)	(0.293)	(0.366)	(0.519)	(0.206)	(0.274)	(0.216)
Education level	14.1***	14.8***	2.09	3.72	21.1***	4.11***	9.64***	7.99***
	(2.271)	(3.085)	(1.392)	(2.909)	(2.341)	(1.123)	(1.682)	(1.507)
Log [Household income p/c]	7.86***	2.39**	0.63	3.84***	8.07***	1.95***	2.91***	3.60***
	(1.102)	(0.933)	(0.889)	(1.100)	(1.138)	(0.544)	(0.736)	(0.712)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26312	13525	21235	16621	21332	56361	35364	42329
R^2	0.219	0.203	0.107	0.099	0.207	0.088	0.196	0.156

Notes: Online Appendix Table A5 presents for different sub-samples OLS estimates of a regression of patience on remaining years of life controlling for gender, country fixed effects, age fixed effects and additional controls that include subjective math skills, education level, and log household income per capita. Patience is standardized to exhibit a standard deviation of 100. Standard errors clustered at the country level in parentheses. ** $p < 0.05$.

Table A6: Longevity and Other Preferences

	Alternative Outcome				
Dep. Var.:	Risk Taking	Altruism	Trust	Pos. Recip.	Neg. Recip.
	(1)	(2)	(3)	(4)	(5)
Remaining years of life	0.69	-0.050	-0.57	0.92***	0.56
	(0.596)	(0.381)	(0.437)	(0.343)	(0.431)
1 if female	-19.5***	10.7***	8.65***	1.93	-15.0***
	(2.687)	(2.066)	(2.240)	(1.805)	(1.820)
Subj. math skills	4.01***	3.80***	5.88***	3.32***	3.94***
	(0.345)	(0.308)	(0.271)	(0.264)	(0.418)
Education level	7.27***	7.66***	-4.39***	7.68***	-0.28
	(1.029)	(1.211)	(1.309)	(1.112)	(1.002)
Log [Household income p/c]	5.26***	3.20***	-0.97	2.82***	1.56*
	(0.680)	(0.615)	(0.661)	(0.720)	(0.904)
Country FE	Yes	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes	Yes
Observations	77641	77822	77040	78053	76728
R^2	0.174	0.139	0.113	0.131	0.113

Notes: Online Appendix Table A6 presents OLS estimates of a regression of different preferences on remaining years of life controlling for gender, country fixed effects, age fixed effects and additional controls that include subjective math skills, education level, and log household income per capita. All preferences are standardized to exhibit a standard deviation of 100. Standard errors clustered at the country level in parentheses. ** $p < 0.05$.

Table A7: Longevity and Patience: Alternative Measures of Mortality and Instrumental Variables

	Dependent variable: Patience					
	Alternative Measures		Instrument: Remaining years of life in...			
			2000	1990	1980	1970
	(1)	(2)	(3)	(4)	(5)	(6)
Remaining years of life (mortality.org)	1.78***					
	(0.621)					
1/(Probablity of Dying)		0.0056***				
		(0.001)				
Remaining years of life (instrumented)			1.72***	1.44***	1.66***	2.02***
			(0.373)	(0.399)	(0.465)	(0.424)
1 if female	-19.9***	-7.21***	-11.5***	-10.4***	-11.3***	-12.6***
	(3.741)	(1.308)	(2.107)	(2.178)	(2.320)	(2.242)
Subj. math skills	2.79***	2.24***	2.24***	2.24***	2.24***	2.25***
	(0.378)	(0.206)	(0.206)	(0.206)	(0.207)	(0.207)
Education level	20.2***	8.85***	8.58***	8.59***	8.58***	8.56***
	(2.242)	(1.408)	(1.373)	(1.370)	(1.375)	(1.376)
Log [Household income p/c]	9.37***	3.29***	3.28***	3.26***	3.28***	3.31***
	(1.201)	(0.571)	(0.557)	(0.552)	(0.552)	(0.557)
Gender	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24716	77235	77693	77693	77693	77693
R^2	0.218	0.172	0.172	0.172	0.172	0.172

Notes: Columns (1) and (2) of Online Appendix Table A7 present OLS estimates of a regression of patience on two measures of longevity controlling for gender, country fixed effects, age fixed effects, development and additional controls that include subjective math skills, education level, and log household income per capita. Columns (3) to (6) present IV estimates of a regression of patience on remaining years of life controlling for the same control variables. Instruments employed are the remaining years of life for a given gender-age-country cell in previous decades (for the first stage see Online Appendix Table A8. Patience is standardized to exhibit a standard deviation of 100. Standard errors clustered at the country level in parentheses. ** $p < 0.05$.

Table A8: Life Expectancy and Patience: IV Estimates (First Stage)

Dep. Variable:	First Stage Remaining years of life (2010) (3)	(4)	(5)	(6)
Remaining years of life 2000	0.63*** (0.049)			
Remaining years of life 1990		0.78*** (0.068)		
Remaining years of life 1980			0.63*** (0.167)	
Remaining years of life 1970				0.75*** (0.074)
Gender	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes
Observations	77693	77693	77693	77693
F	162.66	131.98	14.27	102.76

Notes: Online Appendix Table A8 presents the first-stage estimates of the IV regressions in Columns (3) to (6) of Online Appendix Table A7. Additional controls include subjective math skills, education level, and log household income per capita.

Table A9: Life Expectancy and Patience: Experience Effects (Robustness 1: At Birth)

	Dependent variable: Patience					
	(1)	(2)	(3)	(4)	(5)	(6)
Remaining years of life	1.45***	1.52***	1.52***	1.62***	1.64***	1.31***
	(0.403)	(0.378)	(0.373)	(0.374)	(0.371)	(0.399)
Log GDP p/c at birth	3.33*					2.10
	(1.832)					(1.588)
Inst. quality at birth		0.037				0.062
		(0.139)				(0.174)
Democracy at birth			-0.11			-1.55
			(1.728)			(2.050)
Societal pol. violence at birth				-0.47		-0.45
				(0.364)		(0.359)
Interstate pol. violence at birth					0.27	0.32
					(0.694)	(0.554)
Gender	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	77693	77693	77693	77693	77693	77693
R^2	0.172	0.172	0.172	0.172	0.172	0.172

Notes: Online Appendix Table A9 presents OLS estimates of a regression of patience on remaining years of life controlling for gender, country fixed effects, age fixed effects, development and institutional quality experienced at birth. Additional controls include subjective math skills, education level, and log household income per capita. Patience is standardized to exhibit a standard deviation of 100. Standard errors clustered at the country level in parentheses. ** $p < 0.05$.

Table A10: Life Expectancy and Patience: Experience Effects (Robustness 2: At Age 15)

	Dependent variable: Patience					
	(1)	(2)	(3)	(4)	(5)	(6)
Remaining years of life	1.71***	1.66***	1.68***	1.53***	1.56***	1.54***
	(0.382)	(0.371)	(0.370)	(0.371)	(0.372)	(0.376)
Log GDP p/c at age 15	-0.40					-0.92
	(1.360)					(1.350)
Inst. quality at age 15		0.18				0.12
		(0.135)				(0.189)
Democracy at age 15			2.01			0.33
			(1.652)			(2.184)
Societal pol. violence at age 15				-0.70***		-0.69**
				(0.265)		(0.268)
Interstate pol. violence at age 15					-0.33	-0.27
					(0.514)	(0.528)
Gender	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	77693	77693	77693	77693	77693	77693
R^2	0.172	0.172	0.172	0.172	0.172	0.172

Notes: Online Appendix Table A10 presents OLS estimates of a regression of patience on remaining years of life controlling for gender, country fixed effects, age fixed effects, development and institutional quality experienced at age 15. Additional controls include subjective math skills, education level, and log household income per capita. Patience is standardized to exhibit a standard deviation of 100. Standard errors clustered at the country level in parentheses. ** $p < 0.05$.

Table A11: Life Expectancy at Birth and Patience

	Dependent variable: Patience					
	(1)	(2)	(3)	(4)	(5)	(6)
Remaining years of life	1.66***	1.87***	1.80***	1.79***	1.88***	1.68***
	(0.385)	(0.405)	(0.405)	(0.407)	(0.439)	(0.445)
Life expectancy at birth	-0.078	-0.29*	-0.26*	-0.26*	-0.30*	-0.26
	(0.139)	(0.153)	(0.150)	(0.157)	(0.165)	(0.172)
1 if female	-13.3***	-10.7***	-10.9***	-9.94***	-11.5***	-10.3***
	(2.147)	(2.074)	(2.068)	(2.086)	(2.126)	(2.144)
Subj. math skills		2.25***	2.05***	2.22***	2.22***	2.05***
		(0.208)	(0.191)	(0.218)	(0.209)	(0.195)
Education level		8.79***	8.83***	9.52***	8.95***	9.91***
		(1.429)	(1.352)	(1.398)	(1.511)	(1.466)
Log [Household income p/c]		3.30***	3.05***	3.47***	3.33***	3.50***
		(0.564)	(0.556)	(0.583)	(0.611)	(0.630)
Country FE	Yes	Yes	No	Yes	Yes	No
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	No	No	Yes	No	No	Yes
Religion FE	No	No	No	Yes	No	Yes
Language FE	No	No	No	No	Yes	Yes
Observations	79433	77693	76793	69245	71987	62691
R^2	0.161	0.172	0.218	0.176	0.184	0.232

Notes: Table A11 presents OLS estimates of a regression of patience on remaining years of life as well as life expectancy at birth controlling for gender, country fixed effects, age fixed effects, and additional controls that include subjective math skills, education level, and log household income per capita. Patience is standardized to exhibit a standard deviation of 100. Standard errors clustered at the country level in parentheses. ** $p < 0.05$.

C Longevity, Patience, and Poverty Traps

This section presents a simple model that highlights the interdependencies between patience, longevity, and economic development and illustrates how these interdependencies can lead to a longevity-patience poverty trap.

Consider an overlapping generations economy. Each generation t has a unit mass of individuals that live for two periods. Individuals are endowed with one unit of time during each period, and exhibit heterogeneity with respect to their innate ability. Ability is distributed uniformly, $a_i \sim U[0,1]$. At the beginning of the first period of life, individuals can decide to either work as unskilled workers throughout their life or to spend a share of their time $\bar{e} > 0$ on acquiring education in order to work of skilled workers during the second period of life. Individuals with higher ability acquire more productive knowledge during their education, with productivity as skilled workers being given by a_i. This specification assumes that time spent in education and individual ability are complements in the education process. Unskilled individuals earn a wage w_t^L, while skilled workers receive a wage w_t^H. For simplicity, we assume a linear production function, which implies a skill premium of $\sigma_t > 0$ (such that $w^L/w^H = 1/(1+\sigma)$).[12] Individuals discount the future with their time preference $0 < \beta < 1$ as well as with their expected survival probability until the second period of life, π_t. Then, with logarithmic preferences, the individual chooses education time $e_i = \{0, \bar{e}\}$ optimally to maximize lifetime utility. An individual prefers becoming skilled depending on

$$\begin{aligned} U(e_i = \bar{e}) &\gtrless U(e_i = 0) \\ \Leftrightarrow \ln w_t^L(1-\bar{e}) + \beta\pi_t \ln w_t^H a_i &\gtrless \ln w_t^L + \beta\pi_t \ln w_t^L \end{aligned}$$

This delivers an ability threshold at which an individual of generation t is indifferent between becoming skilled and remaining unskilled

$$a_t^* = \left(\frac{1}{1+\sigma_t}\right)\left(\frac{1}{1-\bar{e}}\right)^{\frac{1}{\beta\pi_t}} . \tag{-1}$$

For a given β, the ability threshold is decreasing and convex in π, and vice versa.

Without loss of generality, consider as a benchmark a scenario in which all individuals are endowed with a time preference $1 > \underline{\beta} > 0$ and let the survival probability be given by $0 < \underline{\pi} < 1$. Moreover, assume that the time cost for education is suffi-

[12]This allows us to make the main point while endogenizing the wage in a general equilibrium OLG framework with $Y = L + (1+\sigma)H$. Using a neoclassical production function would not deliver substantially different insights but would ensure interior equilibria throughout.

ciently high compared to the skill premium such that $\bar{e} > 1 - \frac{1}{(1+\sigma)^{\underline{\beta}\underline{\pi}}}$. This implies with $\underline{\beta}$ given that for a survival probability of $\underline{\pi}$ or less, the ability threshold is above 1. In other words, no individual, not even the most able, is willing to become skilled. However, given $\underline{\beta}$ an increase in life expectancy, reflected by $\pi_t > \underline{\pi}$ would induce some individuals of generation t to invest in education.

In the following, we consider a dynamic version of this benchmark scenario that shows the consequences of endogenizing the survival probability as a function of the education composition of the population. This will allow us, in a next step, to illustrate the broader implications of the empirical finding of individual life expectancy (i.e., the survival probability) affecting patience. In particular, assume an intertemporal externality at the aggregate level (along the lines of Cervellati and Sunde, 2005), where life expectancy, reflected by the survival probability π, is positively affected by the share of skilled individuals in the previous generation. For simplicity, consider a linear relationship between π_t and a^*_{t-1} such as

$$\pi_t = \pi(a^*_{t-1}) = \bar{\pi} - \zeta \cdot a^*_{t-1} \qquad \text{(-1)}$$

where ζ is assumed to be sufficiently large in absolute terms to ensure that $\pi(1) < \underline{\pi}$. Hence, even with this externality the steady state remains to be characterized by no individual being willing to become skilled, as characterized by $a^*(\pi(1)) = 1, \pi(1))$.

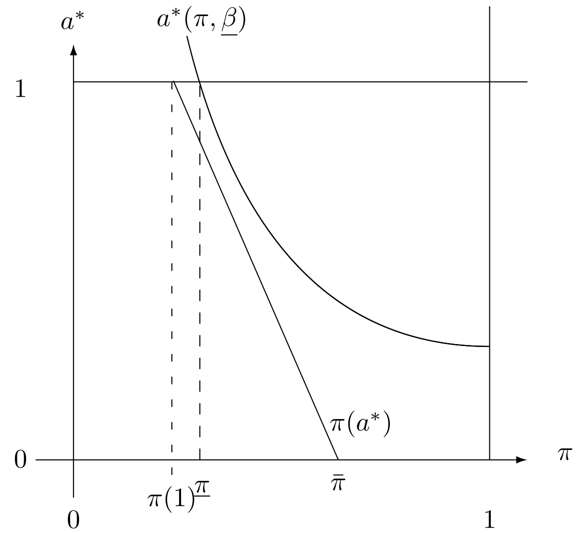
This situation is depicted in Figure B1, where the ability threshold $a^*(\pi, \underline{\beta})$ described by (C) implies no education acquired by any individual if the survival probability is at or below $\underline{\pi}$. Whatever the survival probability to start with is, the steady state equilibrium of this economy is one of no education (i.e. an ability threshold of $a^* = 1$ and a low survival probability $\pi(1)$ that is consistent with no education). In other words, in this setting the model exhibits a development trap due to a lack of forward-looking behavior, since for any π the equilibrium share of skilled individuals is smaller (the ability threshold is higher) than what is required to establish an equilibrium with a higher survival probability than π.

Now consider the consequences of individual life expectancy in terms of π affecting patience as suggested by the empirical results shown before. In particular, consider the following generalization with

$$\beta_t = \underline{\beta} + \rho(\bar{\beta} - \underline{\beta})\pi_t \, , \qquad \text{(-1)}$$

where $\rho \in [0, 1]$ and $1 > \bar{\beta} > \underline{\beta}$, which relaxes the implicit assumption of $\rho = 0$ considered so far. Since the condition for the ability threshold (C) implies that an increase in β shifts the ability threshold down for any π, thereby increasing the

Figure B1: A Longevity-Patience Development Trap



tendency to acquire education.[13] Hence, for any π the ability threshold is lower, i.e. $a^*(\pi, \beta) < a^*(\pi, \underline{\beta})$. Obviously, a sufficiently pronounced shift (a sufficiently high choice of $\bar{\beta}$) implies the emergence of two interior steady states, a stable steady state that features a strictly positive share of the population acquiring education (in terms of $a^*(\tilde{\pi}, \beta(\tilde{\pi})) < 1$), and a corresponding survival probability $\tilde{\pi} > \underline{\pi}$, as well as an unstable steady state. Figure B2 depicts this situation with the unstable steady state being characterized by the intersection of the two curves between $\pi(1)$ and $\underline{\pi}$. For any survival probability above the level of this intersection of the unstable steady state, the economy will converge to the interior steady state $\{a^*(\tilde{\pi}, \beta(\tilde{\pi})), \tilde{\pi}\}$, whereas for any survival probability below that the economy will remain in the steady state with $\{a^*(\pi(1)) = 1, \pi(1)\}$.

Obviously, with a stronger effect of longevity on patience (a larger ρ), the positive feedback loop can even lead to the disappearance of the development trap altogether, as depicted in Figure B3.

Taken together, these considerations suggest that the empirical finding that life expectancy influences patience can generate feedback mechanisms that can lead to poverty traps. Through its effect on individual patience, this feedback amplifies the effects of low life expectancy for future-oriented decisions long-run development, as suggested by Cervellati and Sunde (2005, 2015).

[13]Taking cross derivatives, it becomes clear that the shift of a^* is more pronounced for smaller π.

Figure B2: Longevity and Patience: Multiple Development Equilibria and Development Traps

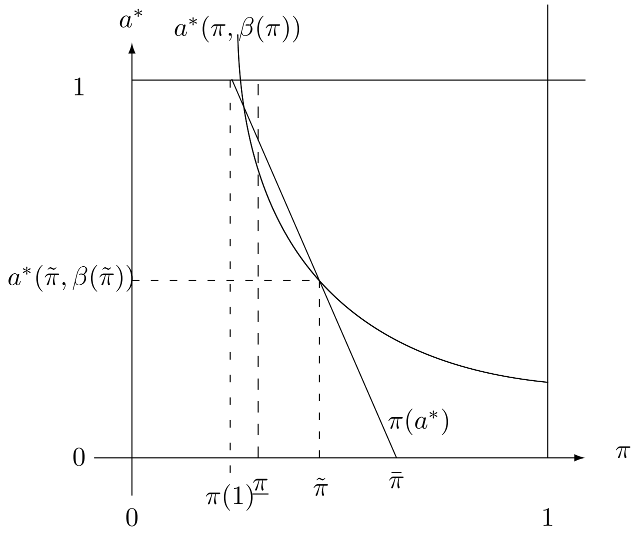
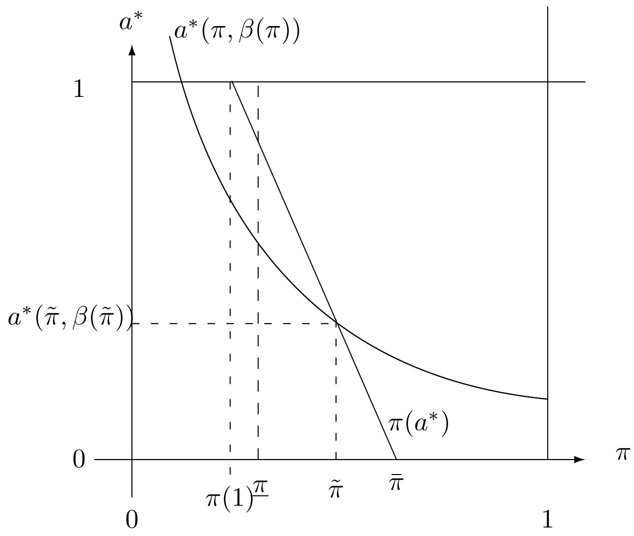


Figure B3: Eliminating the Longevity-Patience Development Trap



D Data

Staircase procedure The sequence of survey questions that form the basis for the quantitative patience measure is given by the "tree" logic depicted in Figure C1 for the benchmark of the German questionnaire. Each respondent faced five interdependent choices between receiving 100 euros today or varying amounts of money in 12 months. The values in the tree denote the amounts of money to be received in 12 months. The rightmost level of the tree (5th decision) contains 16 distinct monetary amounts, so that responses can be classified into 32 categories which are ordered in the sense that the (visually) lowest path / endpoint indicates the highest level of patience. As in the experimental validation procedure in Falk et al. (2015), we assign values 1-32 to these endpoints, with 32 denoting the highest level of patience.

Computation of Preference Indices at Individual Level The individual-level index of patience is computed by (i) computing the z-scores of each survey item at the individual level and (ii) weighing these z-scores using the weights resulting from the experimental validation procedure of Falk et al. (2015). Formally, these weights are given by the coefficients of an OLS regression of observed behavior on responses to the respective survey items, such that the coefficients sum to one. These weights are given by (see above for the precise survey items):

$$\text{Patience } = 0.7115185 \times \text{ Quantitative measure } + 0.2884815 \times \text{ Qualitative item}$$

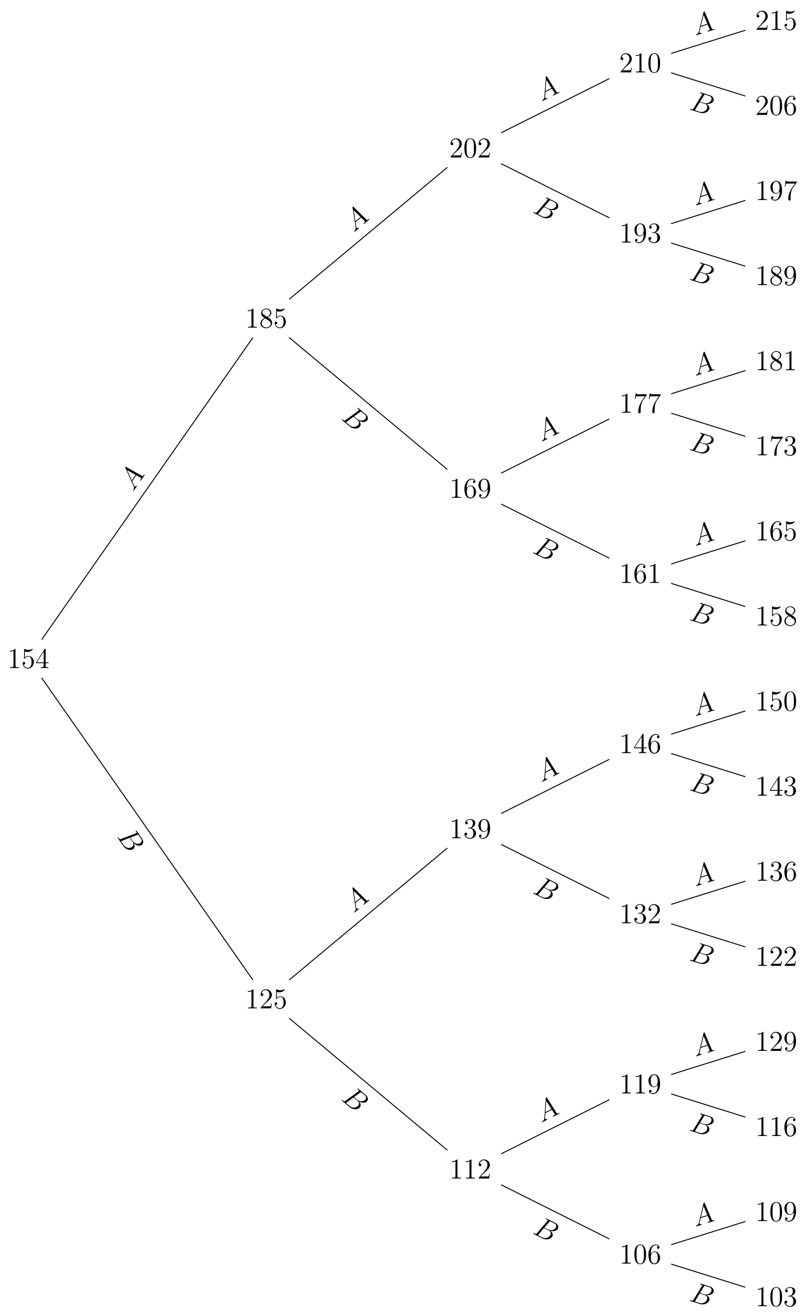


Figure C1: Decision Tree for the Staircase Time Task, Stakes for Germany

Notes. Numbers correspond to payment in 12 months, A = choice of "100 euros today", B = choice of "x euros in 12 months". The staircase procedure worked as follows. First, each respondent was asked whether they would prefer to receive 100 euros today or 154 euros 12 months from now (leftmost decision node). In case the respondent opted for the payment today ("A"), in the second question the payment in 12 months was adjusted upwards to 185 euros. On the other hand, if the respondent chose the payment in 12 months, the corresponding payment was adjusted down to 125 euros. Working further through the tree follows the same logic.