The Impact of Growth on the Transmission of Patience

Domenico Delli Gatti[a], Jakob Grazzini[b], Domenico Massaro[c], and Fabrizio Panebianco[a]

[a]Department of Economics and Finance, Università Cattolica, Milan, Italy. domenico.delligatti@unicatt.it; fabrizio.panebianco@unicatt.it
[b]Department of Economics and Management, University of Pavia, Italy. jakob.grazzini@unipv.it
[c]Department of Economics, Management and Quantitative Methods, University of Milan, Italy. domenico.massaro1@unimi.it

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Abstract

The idea that patience is an important determinant of economic growth is well rooted in the economic literature. This paper investigates the causal relationship going in the opposite direction, i.e., from growth to patience. We propose a simple theoretical framework where patience evolves endogenously over time as a result of parental effort to transmit it to their offspring. Our model links such effort, and thus the overall level of patience in an economy, to economic growth. We corroborate our theoretical mechanism by estimating the impact of an exogenous growth shock on a proxy of parental engagement to educate children to patience. Theoretical and empirical results suggest that the effort to transmit patience is procyclical.

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1 Introduction

The causal link relating patience to economic growth is well established in the economic literature. Much less explored is the causal relationship that goes in the opposite direction, from economic performance to patience. In this paper we focus on the latter, making two contributions. First, we show that, in an OLG model of consumption/saving behavior augmented with a process of cultural socialization *à la* Bisin-Verdier, the transmission of the patience trait across generations is positively affected by growth. The channel through which economic performance affects patience is parental *effort* to transmit this cultural trait to children. Second, we empirically validate this theoretical prediction by exploiting a growth shock exogenous to the dynamics of patience. In particular, our findings suggest that changes in growth positively correlate with parental engagement to educate children to patience.

Model preview and main results. We frame our analysis in an endowment economy with two overlapping generations – young (adults) and old – in which each agent can have either high or low patience (i.e., discount factor). Economic growth in this context is summarized by the endowment change from one generation to the next. In order to isolate the impact of growth on the transmission of patience, we consider an *exogenous* growth rate. In our main analysis we thus abstract from the two-way feedback mechanism between patience and economic performance. However, we also provide a discussion about how this two-way relationship can be taken into account in our framework and show that this simplification implies only a minor loss of generality. Due to the heterogeneity in discount factors, agents borrow and lend resources in a credit market at an endogenously determined interest rate. Agents with high or low patience experience different utilities that are determined in equilibrium by the preference parameters of both types, by economic growth, and by the shares of the two types in the population. Parents are then willing to transmit the trait (i.e., patience level) that delivers the highest expected utility to their children. As in the Bisin-Verdier framework, parents can only exert effort to bias transmission in favor of their own trait with respect to random transmission according to population shares. In our context the incentives that parents have to exert effort endogenously depend on the forces at play in the credit market.

The proposed model has a testable implication concerning the effect of economic growth on parental effort to induce patience in children. When the growth rate increases, parents want their children to be *more* patient, hence triggering dynamics that lead to an increase of the average level of patience in the economy. To the best of our knowledge, this is the first paper that shows how growth affects the intergenerational transmission (and evolution) of patience by changing the parental incentives to transmit intertemporal preferences to children. The empirical validation of this prediction leverages on variation in income growth rates in US local labor markets due to the Great Recession shock. By exploiting the geolocation of US respondents to the 7th wave of the World Value Survey, we show that areas more exposed to the Great Recession, display a lower parental effort to educate children to patience. This exercise thus offers empirical support to the idea that patience evolves in response to the economic environment through transmission from parents to children.

Related literature. The causal relationship running from patience to economic performance has been widely studied in the literature. At the microeconomic level, theory generally predicts a positive effect of patience on individual outcomes, such as education, health, and income. The reason is straightforward. The higher the degree of patience, the higher the "weight" of future welfare in individual decision making – i.e., the discount factor – and the greater the investment in human and physical capital. This individual-level prediction has been corroborated by a sizable strand of empirical literature (e.g., Mischel et al., 1989; Sunde et al., 2021). At the macroeconomic level, a higher degree of patience – i.e., a higher discount factor – leads to higher GDP growth and higher levels of per capita income, capital and consumption (e.g., Becker, 1962; Romer, 1990; Aghion and Howitt, 1992).

The positive relationship between patience and macroeconomic performance, albeit clearly established in theory, has not been convincingly validated empirically for a long time due to lack of reliable data on time preferences across countries. This difficulty has been recently overcome thanks to the Global Preference Survey (Falk et al., 2018), that documents the preferences expressed by 80,000 people across 76 countries. Using data concerning time preferences, Falk et al. (2018) show that, at the individual level, patience is positively correlated with saving and education, while at the country level, (average) patience is positively correlated with GDP per capita. Moreover, using the same survey data, Sunde et al. (2021) show that (average) patience is positively correlated with income levels, income growth, accumulation of physical and human capital and productivity. This line of research considers patience as an *exogenous* deep parameter and, accordingly, assumes that causality runs from the degree of patience to economic performance.

As anticipated above, the causal link that goes in the opposite direction, from economic performance to patience is certainly under-researched. The idea that patience may be *endogenous* can be found in Böhm-Bawerk and Fisher and has been put forward in analytical terms by Becker and Mulligan (1997). They present a model of households' behavior in which the discount factor is increasing with the households' investment in "future-oriented capital", i.e., resources spent on imagining future pleasures and making them less remote.

In their setting, quite straightforwardly, the higher households' wealth, the greater investment in imagining the future and the higher the discount factor. In a series of more recent papers Doepke and Zilibotti explore the link going from economic conditions to patience by conceiving the discount factor as the outcome of an inter-generational transmission process. In Doepke and Zilibotti (2008, 2014) altruistic parents put effort in shaping their children's time preference, instilling patience in response to economic incentives. The parental effort to instill patience is increasing with the steepness of lifetime earning profile: since the acquisition of skills takes time and requires investment in human capital, parents that benefit from high returns to labor late in life put more effort in teaching patience to their children than parents with a flat lifetime earning profile. Doepke and Zilibotti (2017) endogenize the choice of parenting style as a function of individual preferences and the socioeconomic environment. Galor and Özak (2016) explore empirically the relation between time preference and economic development and establish a causal relationship that goes from economic variables to patience. The empirical analysis exploits the exogenous variation of agricultural yields in the pre-industrial era to explain modern day levels of patience. They find that regions where ancestral populations were exposed to higher potential crop yields display higher levels of patience in the present period. The empirical findings are interpreted through the lenses of a model in which parents experiencing higher returns to (agricultural) investments learn to delay gratification and transmit their higher level of patience to their offspring.

We contribute to this literature by explaining the endogenous evolution of time preferences with a cultural transmission mechanism. The idea that preferences are shaped by cultural transmission is coherent with the findings in Michalopoulos and Xue (2021). They show that recurrent themes in oral traditions, i.e., "folklore", are correlated with average cultural traits in societies. Folklore is thus a way to transmit cultural traits to next generations. In our model, cultural transmission is determined by parental effort to transmit patience, and this effort is chosen optimally in response to the economic environment. After developing the theoretical model, we provide empirical evidence validating its core mechanism relating parental effort and economic performances. Therefore, this paper offers support to the idea that patience evolves in response to the economic environment through transmission from parents to children and provides empirical support also to the theoretical results presented in Doepke and Zilibotti (2008, 2014). Moreover, this paper extends the results in Galor and Özak (2016) by showing that the effort to educate to patience reacts to business cycle conditions and is procyclical. This implies that patience does not depend only on ancestral economic success, but it also depends on current economic dynamics.

Layout. The paper is organized as follows. In Section 2 we describe our model and derive the main result that positively relates growth and parental effort to transmit patience to children. This relation is investigated empirically in Section 3. Finally, Section 4 concludes.

2 Model

We consider an overlapping generation model in which each generation, or cohort of agents, has a unit mass. Agents of a given generation live for two periods, t and $t+1$. At time t they are *adults*, receive an exogenous endowment of a unique, undifferentiated consumption good, make consumption/saving decisions, and have children, who must be socialized to some cultural traits. At time $t+1$ agents become *old*, consume the proceeds of their savings, and their offspring become adults, entering the first period of their life.

We assume within-cohort intertemporal *preference heterogeneity*: in each cohort there are two types of agents, characterized by different time preferences, which we model as different discrete cultural traits. The set of possible traits is $I := \{l, h\}$ where l stands for *low patience* and h for *high patience*. For each $i \in I$, let $\beta^i \in [0, 1]$ be the discount factor, i.e., the reciprocal of the (gross) rate of time preference. Without loss of generality, we assume that $\beta^l < \beta^h$, so that we can characterize agents with trait l as *impatient* and agents with trait h as *patient*. Hence, we define two groups in each cohort, one for each trait. Assuming that there is a representative agent for each group, we can abuse notation indexing the representative agent of group $i \in I$ with the index i itself. We denote with $q_t \in [0, 1]$ the fraction of the adult population consisting of agents of type l at time t, so that $1 - q_t$ is the share of type h. Therefore, in period t the economy is populated by patient and impatient adults of generation t and patient and impatient old people of generation $t-1$. In Section 2.2 we model the law governing the transmission of cultural types across generations by using a standard cultural transmission technology and no bequests.

2.1 Single cohort choice

We start by considering the decision-making process of a single cohort. As we will show momentarily (Section 2.2), the cultural transmission process makes the fraction of impatient agents q_t time-varying. However, in consumption/saving decision making, each cohort takes this fraction as given, and thus, in this section, we omit the time index and denote this variable with q.

For each $i \in I$, let c^i_{t+s} and y^i_{t+s} be the agent's consumption and (exogenous) endowment of the good in period $t+s$, with $s \in \{0,1\}$. We assume a log-linear intertemporal material payoff function for adults at time t:

$$v_t^i := v(c_t^i, c_{t+1}^i; \beta^i) = \log(c_t^i) + \beta^i \log(c_{t+1}^i). \tag{1}$$

Following Bisin and Verdier (2001), we assume that, at time t, an adult of type $i \in I$ asexually gives birth to one child and exerts an effort $\tau_t^i \in [0,1]$ to induce her own trait to the child. We denote with $\mathbb{E}^i_{\tau_t^i}[v_{t+1}^{ch^i}]$ the utility that a parent of trait i expects to gain from own child's material payoff when choosing effort τ_t^i. We will describe how this future expected utility is formed in Section 2.2. For the time being we just assume that it is independent of the parent's consumption/saving choices, and that parents do not care about the child's type *per se*, but about the material well-being of the child delivered by the child's type.[1]

An agent of type i in each cohort maximizes her intertemporal utility under the lifetime budget constraint. Intertemporal utility, in turn, is the sum of the agent's material payoff and the expected utility that the agent receives from the material payoff of the child. For each $i \in I$, the maximization problem of the adult in t is

$$\max_{c_t^i, c_{t+1}^i, \tau_t^i} \; U(c_t^i, c_{t+1}^i, \tau_t^i; \beta^i) = v^i(c_t^i, c_{t+1}^i; \beta^i) + \mathbb{E}^i_{\tau_t^i}[v_{t+1}^{ch^i}], \tag{2}$$

$$\text{s.t.} \;\; Ry_t^i + y_{t+1}^i = Rc_t^i + c_{t+1}^i, \tag{3}$$

where $R := 1+r$ is the (gross) real interest rate which, in our setting, will be endogenously determined by market clearing on the credit market. We omit the time index because – as we will see below – the equilibrium interest rate is a function of the discount factors of the two groups and of the fraction q of impatient agents, which in this section is not time-varying.

We assume that the endowment of agents in each cohort is uniform across types and that it changes across cohorts at a given growth rate. Formally:

Assumption **1.** *For each* $t \in \mathbb{N}$, $y_{t+1}^l = y_{t+1}^h = y_{t+1} = gy_t$.

The scalar $g \in \mathbb{R}_+$ represents the (gross) growth rate of the endowment between adulthood (period t) and old age (period $t+1$), i.e., $g = y_{t+1}/y_t$. Therefore, $g > 1$ indicates an expansion of the macroeconomy and an increase of the endowment accruing to the agent when old, while $0 < g < 1$ identifies macroeconomic decline and a reduction of the endowment in old age.

[1] We could have added an element capturing the parent's ideological concerns, usually referred to as *paternalism* in the literature on cultural transmission. This additional element would complicate the analysis without changing the results.

In what follows, we treat g as an exogenous parameter while in Appendix B we discuss the case of endogenous growth.

For each $i \in I$, the optimal consumption and saving choice of adults at time t and the consumption of the old at time $t+1$ are given by (see Appendix D.1 for details)

$$c_t^i = \frac{(R+g)y_t}{R(1+\beta^i)}, \tag{4}$$

$$s_t^i = \frac{(R\beta^i - g)y_t}{R(1+\beta^i)}, \tag{5}$$

$$c_{t+1}^i = Rs_t^i + gy_t = \frac{\beta^i(R+g)y_t}{1+\beta^i}. \tag{6}$$

The optimal consumption and saving choices are functions of the interest rate, the agent's discount factor, the current endowment, and the growth rate. It is easy to see that the adult is a saver if and only if

$$\frac{R}{g} > \frac{1}{\beta^i}. \tag{7}$$

Since the right hand side of the inequality is the (gross) rate of time preference, equation (7) states that the agent is a saver if and only if the interest rate (normalized to growth) is higher than her own rate of time preference.

In period $t+1$ the agent is *old*, receives interest payments if she was a saver/lender at t or pays back her debt if a dissaver/borrower, and spends in goods the endowment, augmented or reduced by interest payments depending on saving/dissaving behavior when adult. Therefore, only *adult* agents participate to the credit market as lenders or borrowers.

In a pure exchange economy, the credit market is in equilibrium when aggregate savings are zero.[2] The credit market clearing condition therefore reads as $qs_t^l + (1-q)s_t^h = 0$, where qs_t^l is total savings in t by type l agents and $(1-q)s_t^h$ is total savings in t by type h agents. This allows to determine the equilibrium interest rate as

$$R^* = g \cdot \frac{(1-q)(1+\beta^l) + q(1+\beta^h)}{(1-q)(1+\beta^l)\beta^h + q(1+\beta^h)\beta^l}, \tag{8}$$

where $R^* > 1$ for any $0 < \beta^l < \beta^h < 1$ (see Appendix D.2 for details). The equilibrium interest rate is a function of relative endowments (captured by g), intertemporal preferences (captured by the discount factors), and, crucially for our purposes, the composition of the population in terms of patient and impatient agents (captured by q). As intuition suggests,

[2]This condition assures also that total adults' consumption is equal to total adults' endowments.

in equilibrium patient agents lend their endowment to impatient agents. Indeed, it is easy to show that

$$\frac{1}{\beta^h} < \frac{R^*}{g} < \frac{1}{\beta^l}. \tag{9}$$

Since $\beta^l < \beta^h$, in equilibrium $s_t^l < 0$ and $s_t^h > 0$, so that agents of type l (impatient) are borrowers, and agents of type h (patient) are lenders. This is true for any q, i.e., independently of the composition of the population.

Consider now how the equilibrium interest rate changes with g and q. When g increases, the endowment in old age goes up relative to the endowment when adult. The desire to smooth consumption implies a higher interest rate because patient adults save less and therefore the supply of credit goes down while impatient adults dissave more increasing the demand for credit. The effect of a change in the composition of the population, q, on the equilibrium interest rate is also in line with the intuition. As the fraction of impatient agents q increases, the aggregate demand for funds on the part of dissavers increases and the supply of funds coming from savers decreases, pushing up the equilibrium interest rate.

The material payoff in equilibrium. We now dig deeper into the features of the economy in equilibrium. Substituting the equilibrium interest rate in (8) into the optimal consumption choices (4) and (6), we get the equilibrium consumption of the adult and the old representative agents of type i, which we denote with c_t^{i*}, c_{t+1}^{i*}. Substituting the latter into the material payoff function, we get the material payoff function *in equilibrium*, which allows to express the payoff as a function of the discount factors (β^h, β^l) and of q, given g. With a slight abuse of notation, in the following we will denote the *equilibrium* payoffs with v^i, $i \in I$, dropping the star from the superscript. Therefore $v^i := v^i(c_t^{i*}, c_{t+1}^{i*}) = v^i(q, \beta^l, \beta^h, g)$. In particular:

$$v^l = \log\left[\frac{1+\beta^h}{1+q\beta^h+(1-q)\beta^l}\right] + \beta^l \log\left[\frac{\beta^l(1+\beta^h)}{\beta^l\beta^h+q\beta^l+(1-q)\beta^h}\cdot g\right], \tag{10}$$

$$v^h = \log\left[\frac{1+\beta^l}{1+q\beta^h+(1-q)\beta^l}\right] + \beta^h \log\left[\frac{\beta^h(1+\beta^l)}{\beta^l\beta^h+q\beta^l+(1-q)\beta^h}\cdot g\right]. \tag{11}$$

The growth rate g affects only the equilibrium consumption of the old agent, whereas changes in the composition of the population, q, affect material payoffs both in adulthood and in old age. In Appendix A.1 we prove the following

PROPOSITION 1. *Given $q \in (0,1)$, the material payoff of the impatient (resp. patient) agent* *is monotonically decreasing (increasing) with q, that is:*

$$\frac{\partial v^l}{\partial q} < 0, \tag{12}$$

$$\frac{\partial v^h}{\partial q} > 0. \tag{13}$$

Proof. See Appendix A.1 □

The intuition behind this proposition goes as follows. Suppose that the fraction of the impatient agents q increases. From equation (8) it follows that the interest rate increases. The equilibrium consumption of the adults decreases both for patient and impatient agents (substitution effect): the saver saves more and the dissaver dissaves less, i.e., she asks for a loan of a smaller size. When the saver grows old, she will tap into a larger pool of resources (the old's endowment and interest payments) to consume. The increase of discounted utility from consumption when old prevails over the reduction of utility from consumption when adult and the overall payoff of the patient agent increases. When the dissaver grows old, she is forced to pay a higher interest rate but on a loan of a smaller size. Interest payments indeed decrease and also the old dissaver consumes more. However, the increase of discounted utility from consumption when old does not prevail over the reduction of utility from consumption when adult and the overall payoff of the impatient agent decreases. This has repercussions on the cultural transmission of traits that we will analyze later.

We now compare utilities of patient and impatient agents depending on their relative shares. Given that utilities are monotonic in q, as shown in Proposition 1, we proceed by identifying the value of q equating the two utilities. This will be useful in the analysis of the intergenerational transmission of patience developed in Section 2.2. Denoting by $\bar{q}$ the value of q such that $v^h = v^l$, we can write (see Appendix D.3 for details)

$$\bar{q} := \frac{(1+\beta^l)\beta^h - g\left(\beta^l\left(1+\beta^l\right)\left(\left(1+\beta^l\right)\beta^h\right)^{\beta^h}\left(\beta^l\left(1+\beta^h\right)\right)^{-\beta^l-1}\right)^{\frac{1}{\beta^h-\beta^l}}}{\beta^h-\beta^l}. \tag{14}$$

According to (14) the cutoff value $\bar{q}$ is a decreasing function of the growth rate g. In the following proposition we will exploit this feature to characterize the relative payoff of the patient and impatient agents as functions of g.

Proposition **2.** *For each pair (β^l, β^h), there exist $\underline{g} \in (0,1]$, and $\bar{g} \in [1,\infty)$ such that*

1. *if $g < \underline{g}$, then $\bar{q} > 1$ and $v^l > v^h$ for all $q \in [0,1]$;*

2. *if* $g > \bar{g}$*, then* $\bar{q} < 0$ *and* $v^l < v^h$ *for all* $q \in [0, 1]$*;*

3. *if* $g \in [\underline{g}, \bar{g}]$*, then* $\bar{q} \in [0, 1]$ *and* $v^l = v^h$ *if and only if* $q = \bar{q}$*.*

Proof. See Appendix A.2 □

Proposition 2 identifies two cutoff values for g, namely $\underline{g}$ and $\bar{g}$, which are polynomials of the discount factors of the patient and impatient agents defined in Appendix A.2. These thresholds determine three scenarios.

Scenario 1 is characterized by $g < \underline{g}$. The economy is in a period of sizable economic decline, the interest rate is "very low", and impatient agents are always better off than patient agents.

Scenario 2 is the opposite polar case, characterized by $g > \bar{g}$. In this case there is strong economic growth, the interest rate is "very high" and patient agents are always better off than impatient agents.

Scenario 3 is characterized by economic growth in the interval $[\underline{g}, \bar{g}]$. In this case there is either a mild decline $\underline{g} < g < 1$ or a weak expansion $1 < g < \bar{g}$ and the payoffs of patient and impatient agents are equal at $\bar{q} \in (0, 1)$. In this scenario, if the fraction of impatient agents is "low" ($q < \bar{q}$), the interest rate is also relatively low and, therefore, impatient agents are better off, otherwise the opposite occurs.

Proposition 2 is going to be important to characterize the steady state of the cultural transmission process that we will discuss in Section 2.2. To clarify the implications of this proposition, we display the behavior of the material payoff function of the two types of agents as g and q change in Figure 1. Each panel shows the material payoffs of agent l and h as functions of q for different values of g. As shown in Proposition 1, the payoff of agent l (h) is monotonically decreasing (increasing) in q. The left panel represents scenario 1: $g < \underline{g} < 1$. In this case resources are relatively more abundant in the first period and, as discussed above, the interest rate is very low. This is beneficial to the impatient borrower to the point of making her always – i.e., for all q – better off than the patient lender. On the contrary, when $g > \bar{g} > 1$ (scenario 2, right panel), resources in old age are relatively more abundant, the interest rate is very high, and patient lenders are always happier than impatient borrowers. Finally, when g ranges between the lower and the upper thresholds, (scenario 3, intermediate panel), there exists $\bar{q} \in (0, 1)$ such that the payoffs of agents l and h are equal. In this scenario, the impatient agent is better off if the fraction of the impatient agents in the population is relatively low ($q < \bar{q}$), so that also the interest rate is relatively low.

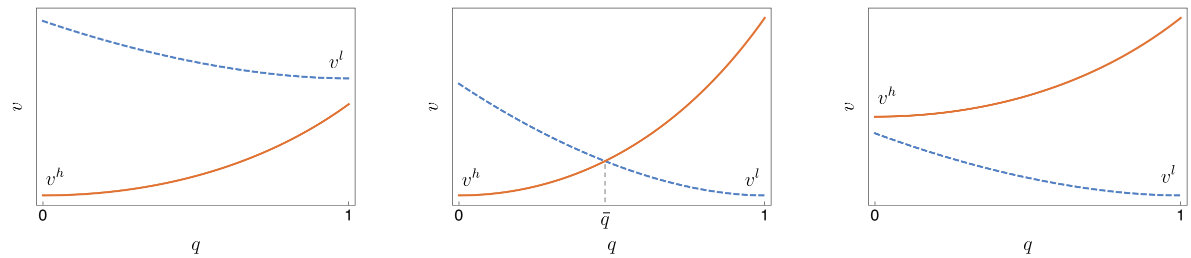

Figure 1: Material payoff of agents of type l (dashed line) and type h (continuous line) as function of q for different levels of g. **Left**: Low growth. **Center**: Mild growth. **Right**: High growth.

In this section we have investigated the material payoff functions of the two types of agents within one generation, so q is fixed. In the next section we study the interaction between market outcomes and social dynamics.

2.2 Intergenerational transmission of patience

We model the dynamics of types as a process of intergenerational transmission of traits *à la* Bisin-Verdier. As mentioned earlier, in each period $t \in \mathbb{N}$, each adult reproduces asexually and gives birth to one child. In the same period children are socialized to one of the cultural traits in the population. The set of possible traits coincides with the set of types $I = \{l, h\}$, defined in the previous section. For each $i \in I$ at time t, let the fraction of individuals with trait i be q_t^i. Using the notation previously introduced, $q_t^l = q_t$ and $q_t^h = 1 - q_t$.

Socialization follows the standard Bisin-Verdier technology, with parent i exerting a *vertical socialization* effort $\tau_t^i \in [0, 1]$ to instill her own trait in the offspring. Socialization can also be oblique. *Oblique socialization* occurs when vertical socialization fails and the child picks the trait of a role model randomly chosen in the population.
We define two transition probabilities. The probability at time t that a parent of trait i has a child of trait i, denoted with P_t^{ii}, is given by

$$P_t^{ii} = \tau_t^i + (1 - \tau_t^i) q_t^i. \tag{15}$$

The first addendum in the right hand side of equation (15) can be interpreted as the probability of success of the vertical socialization process. If vertical socialization is not successful, with probability $1 - \tau_t^i$, the oblique socialization process drives the child to randomly take a trait from her own parent's generation. Thus, q_t^i is the probability that oblique socialization drives the child to pick the parent's own trait. The probability P_t^{ij} that a parent of trait i

has a child of trait j, where $j \in I \setminus \{i\}$ is given by

$$P_t^{ij} = (1 - \tau_t^i)(1 - q_t^i) = 1 - P_t^{ii}. \tag{16}$$

In the previous section, we anticipated that each parent derives utility from the child's wellbeing (see equation (2)). We define the expected utility that a parent of type i, who exerts effort τ_t^i, derives at time t from the material payoff of the child (born in t) when she will be adult, i.e., in $t+1$, as follows:

$$\mathbb{E}^i_{\tau_t^i}[v_{t+1}^{ch^i}] = P_t^{ii}\mathbb{E}^i[v_{t+1}^i] + P_t^{ij}\mathbb{E}^i[v_{t+1}^j] - \frac{1}{2}(\tau_t^i)^2, \tag{17}$$

where $\mathbb{E}^i[v_{t+1}^i]$ is the expected child's payoff if the child's type is the same as the parent's, $\mathbb{E}^i[v_{t+1}^j]$ is the expected child's payoff if the child's type is the opposite of the parent's, and $\frac{1}{2}(\tau_t^i)^2$ is the psychological cost of the socialization effort.

For each $i \in I$, recalling the definition of the transition probabilities in equations (15) and (16), equation (17) now reads

$$\mathbb{E}^i_{\tau_t^i}[v_{t+1}^{ch^i}] = \left[\tau_t^i(1 - q_t^i) + q_t^i\right]\mathbb{E}^i[v_{t+1}^i] + (1 - \tau_t^i)(1 - q_t^i)\mathbb{E}^i[v_{t+1}^j] - \frac{1}{2}(\tau^i)^2. \tag{18}$$

The optimal effort crucially depends on parents' expectations about children's future payoffs. For simplicity we assume *adaptive conjectures formation*:

Assumption **2.** *For every $i \in I$, and for every $t \in \mathbb{N}$, $\mathbb{E}^i[q_{t+1}] = q_t$.*

Assumption 2 greatly simplifies the analysis of the model, but, as argued in Section 2.3 below, assuming perfect foresight of children's future utility does not change the main implications of the model. From Assumption 2 it follows that, for each $i \in I$, $\mathbb{E}^i[v_{t+1}^i] = v^i(q_t, \beta^l, \beta^h) = v_t^i$. Substituting in equation (18), we get

$$\mathbb{E}^i_{\tau_t^i}[v_{t+1}^{ch^i}] = \left[\tau_t^i(1 - q_t^i) + q_t^i\right]v_t^i + (1 - \tau_t^i)(1 - q_t^i)v_t^j - \frac{1}{2}(\tau^i)^2. \tag{19}$$

For a generic $x \in \mathbb{R}$, let $[x]^+ := \max\{0, x\}$. Solving the problem of maximizing equation (19) with respect to τ_t^i, for each $i \in I$, we get

$$\tau_t^{i*} = [\min[1, (1 - q_t^i)(v_t^i - v_t^j)]]^+, \tag{20}$$

where $q_t^l = q_t$ and $q_t^h = 1 - q_t$. Therefore, we can write

$$\tau_t^{l*} = [\min[1, (1 - q_t)(v_t^l - v_t^h)]]^+,$$
$$\tau_t^{h*} = [\min[1, q_t(v_t^h - v_t^l)]]^+.$$

At this point, using Proposition 2, we characterize the optimal socialization efforts of parents in Proposition 3.

PROPOSITION **3.** *Given $g > 0$ and $q_t \in [0, 1]$,*

1. *if $g < \underline{g}$ then, $\tau_t^{h*} = 0$ and $\tau_t^{l*} = \min[1, (1 - q_t)(v_t^l - v_t^h)]$;*
2. *if $g \in [\underline{g}, \bar{g}]$ and*
   - *if $q_t < \bar{q}$, then $\tau_t^{h*} = 0$ and $\tau_t^{l*} = \min[1, (1 - q_t)(v_t^l - v_t^h)]$;*
   - *if $q_t = \bar{q}$, then $\tau_t^{h*} = \tau_t^{l*} = 0$;*
   - *if $q_t > \bar{q}$, then $\tau_t^{l*} = 0$ and $\tau_t^{h*} = \min[1, q_t(v_t^h - v_t^l)]$;*
3. *if $g > \bar{g}$, then $\tau_t^{l*} = 0$ and $\tau_t^{h*} = \min[1, q_t(v_t^h - v_t^l)]$.*

Proof. Immediate from inspection of definitions of τ_t^{i*} and v_t^i. □

This proposition characterizes the effort levels of parents of different types, depending on the state of the economy. In the presence of a sizable economic decline, i.e., when $g < \underline{g}$, the interest rate is very low and the material payoff of the child if she happens to be impatient when adult will always be larger than her payoff if she turns out to be patient. This implies that the effort of the patient parent to transmit her own trait h is always null, whereas the impatient parent exerts a positive level of effort to transmit trait l, as long as $q_t < 1$ (and a null effort when $q_t = 1$, i.e., when all the agents are impatient).

When there is strong economic growth, i.e., when $g > \bar{g}$, just the opposite occurs: the interest rate is very high and the material payoff of the child if she happens to be impatient when adult will always be smaller than her payoff if patient. In this case, parental effort of type l is always null, whereas a parent of type h exerts a positive level of effort as long as $1 - q_t < 1$ (and a null effort when $q_t = 0$, i.e., when the entire population consists of patient agents). For intermediate levels of g (a mild recession or a weak expansion), i.e., when $g \in [\underline{g}, \bar{g}]$, parents of type l exert some vertical socialization effort as long as $q_t < \bar{q}$, that is, as long as the interest rate is relatively low and the payoff of a child of type l is larger than that of a child of type h (while parental effort of type h is null). On the contrary, when

$q_t > \bar{q}$, that is, as long as the interest rate is relatively high and the payoff of a child of type h is larger than that of a child of type l, parents of type h exert some effort in transmitting their trait, while parents of type l will exert no effort. When $q_t = \bar{q}$ the payoffs of different types are equal, so parental efforts of both types are null.[3] Given the discussion above, the dynamics of the shares of different types is given by

$$\begin{aligned} q_{t+1}^i &= P_t^{ii} q_t^i + P_t^{ji}(1 - q_t^i) \\ &= q_t^i[1 + (\tau_t^{i*} - \tau_t^{j*})(1 - q_t^i)] \\ &= q_t^i + q_t^i(\tau_t^{i*} - \tau_t^{j*}) - (q_t^i)^2(\tau_t^{i*} - \tau_t^{j*}). \end{aligned} \tag{21}$$

Notice that $\tau^{l*} > \tau^{h*}$ if and only if $v^l > v^h$. Since v^l and v^h are endogenous, the direction of the dynamics is fully determined by the ordering of the equilibrium payoffs at each point in time, characterized in Proposition 2. Proposition 4 characterizes the steady values of q and their stability properties, given the values of g, β^l and β^h.

Proposition 4. *Consider the dynamics in (21). For every triplet (g, β^l, β^h),*

- *if $g \leq \underline{g}$, $q = 0$ and $q = 1$ are the unique steady states, and $q = 1$ is globally stable;*
- *if $g \geq \overline{g}$, $q = 0$ and $q = 1$ are the unique steady states, and $q = 0$ is globally stable;*
- *if $g \in (\underline{g}, \overline{g})$, $q = \{0, \bar{q}, 1\}$ is the set of steady states, with $q = \bar{q}$ globally stable;*

Proof. See Appendix A.3. □

In this framework, different economic environments induce different incentives to socialize children to the two types so that in the steady state the population could be characterized either by cultural heterogeneity – i.e., the co-existence of patient and impatient types – or homogeneity. Cultural homogeneity occurs if the material payoff of one type is always greater than that of the other, independently of the initial composition of the population. If the economy grows or declines strongly, then patient or impatient agents are favored, respectively, and parents make their best to induce those traits in their own children. For intermediate levels of g, interest rates play a crucial role, and act as a balancing mechanism. Indeed, if there are "too few" patient agents, then their utility is high (since they can lend at a high interest rate) and this provides an incentive for parents to instill patience in their children. The opposite holds when impatient agents are too few. Thus, the credit market

[3] Note that, had we considered also paternalistic motivations, there would be a range of g in which both groups exert a positive effort. However, the basic message of our results would not change.

shapes socialization incentives and leads to cultural heterogeneity. In our framework the credit market and the growth rate play the roles of cultural substitution and paternalism in the standard Bisin-Verdier setting.

2.3 Discussion and comparative statics

According to Proposition 2, when the economy is in scenario 1 – i.e., a situation of economic decline characterized by $g \leq \underline{g}$ – the (equilibrium material) payoff of the impatient agent is always (i.e., for any value of $q \in [0, 1]$) greater than that of the patient one. In this scenario, as shown by Proposition 3, patient parents always exert a zero level of (vertical socialization) effort, because they do not want their children to be of their own type. On the contrary, impatient parents exert a positive effort to induce the impatient trait in their children for any value of $q \in [0, 1)$. When $q = 1$, also impatient parents exert zero effort, because the oblique socialization process will necessarily lead children to take on the impatient trait, the population of parents consisting only of impatient agents. Proposition 4 shows that, in this scenario, $q = 1$ is the unique globally stable equilibrium. Summing up: in a period of economic decline, the cultural transmission mechanism leads to a homogeneous long-run equilibrium in which the whole population has the impatient trait.

When there is strong economic growth – i.e., in scenario 2 characterized by $g \geq \bar{g}$ – from Propositions 2–4 we infer that population dynamics follow a symmetrical pattern. In this case, in fact, the payoff of the patient type is always greater than that of the impatient one and the economy converges to a culturally homogeneous long-run equilibrium in which the whole population has the patient trait.

In the intermediate case (scenario 3, characterized by $\underline{g} < g < \bar{g}$), Proposition 2 shows that the ranking of payoffs of the two types and the vertical socialization efforts of the parents depend on the composition of the population. Proposition 3 states that patient parents exert a positive effort only when $q > \bar{q}$, i.e., when there are (relatively) many impatients, the interest rate is (relatively) high and therefore the patient type is better off than the impatient one. Symmetrically, impatient parents exert a positive effort only when $q < \bar{q}$, i.e., when there are (relatively) few impatients, the interest rate is (relatively) low and therefore the impatient type is better off than the patient one. Both types of parents exert zero effort when $q = \bar{q}$, i.e., when the material payoff of the patient and impatient agent are equalized. Finally, Proposition 4 shows that in this case $q = \bar{q}$ is the unique globally stable equilibrium. Thus, for intermediate levels of growth, the cultural transmission mechanism leads to a long-run equilibrium in which heterogeneous time preferences coexist. The "average" discount factor will be $\bar{\beta} = \bar{q}\beta^l + (1 - \bar{q})\beta^h$.

The main feature of the economy under scrutiny is the *dependence of patience on growth*. Propositions 2–4 in fact show that the state of the economy influences the outcome of the cultural transmission of patience because it affects the parents' socialization effort and the composition of the population in terms of patient and impatient agents.

In order to identify testable implications to assess the empirical validity of our model of endogenous evolution of patience, we perform a comparative statics exercise to analyze the consequences of a sudden, permanent increase of the growth rate g. In our setting this shock translates into an increase of the agents' endowment when old. It is easy to show that this shock boosts the equilibrium material payoff of both types for every value of q. However, the magnitude of this positive effect is not uniform across types. The payoff of type h, in fact, increases more than that of type l:

$$\frac{\partial(v^h - v^l)}{\partial g} = \frac{\beta^h - \beta^l}{g} > 0 \ .$$

Given that $\partial(\tau^h - \tau^l)/\partial g = \partial(v^h - v^l)/\partial g$, our model implies that parental effort to transmit patience should increase after an increase in growth. Importantly, Appendix B shows that this theoretical prediction also holds if we relax Assumption 1 and allow for (empirically plausible) endogenous growth. Moreover, Appendix C shows that parental effort increases after an increase of growth also if we relax Assumption 2 and suppose that parents have perfect foresight of children's future utility. The intuition for the result derived above is as follows. Given the pre-shock interest rate, the immediate effect of an increase in g is an increase in consumption when adult for both types (see equation (4)). This is the wealth effect of the shock. Both types, in fact, want to increase consumption in the first period of their life in order to smooth consumption across periods. In order to increase consumption in adulthood patient agents must reduce lending and impatient agents must increase borrowing. Lower supply and higher demand for loans lead to an increase of the equilibrium interest rate. The higher interest rate induces a substitution effect, which exactly offsets the wealth effect. In fact, substituting the equilibrium interest rate defined by equation (8) into the first period consumption decision defined by equation (4), it is easy to see that consumption in adulthood does not depend on g. Thus, in equilibrium, consumption (and saving) *in adulthood* does not change for both types of agents. On the contrary, due to the increase of g, agents of both types will be richer when old and therefore will increase their consumption. The increase of the interest rate, however, reverberates differently on consumption of the old depending on the type. The patient old will benefit from an increase of interest payments but the impatient old will face higher debt commitments. The overall effect of g on c_{t+1}^{i*}

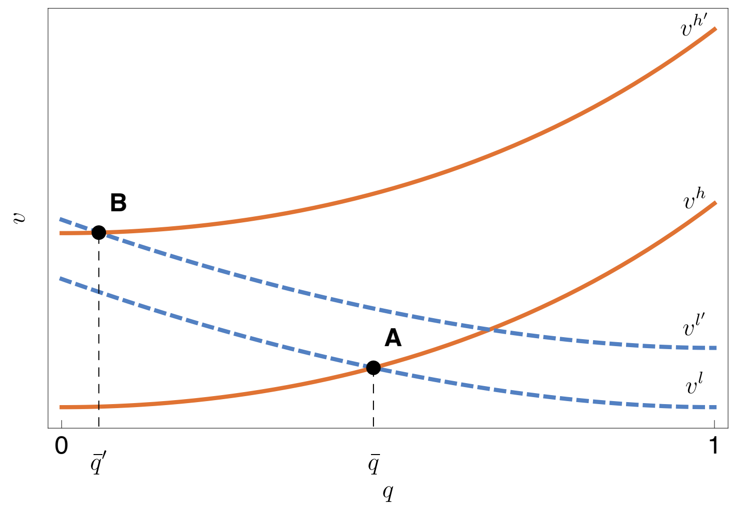

Figure 2: Impact of higher growth g on parental efforts and steady state share $\bar{q}$.

is positive for both agents – i.e., $\partial c_{t+1}^{i*}/\partial g > 0$ – but consumption in the old age is higher for patient lenders than for impatient borrowers. Therefore, the lifetime material payoff of patient agents, v^h, increases more than that of impatient agents, v^l. By affecting differently the payoffs of different types in $t+1$, an increase in g will have an impact on parents' behavior: due to the positive change in the state of the economy, patient parents will make an additional effort to educate their children to become patient.

Let us describe the transmission mechanism of the shock in detail. Figure 2 depicts the equilibrium material payoffs v^l and v^h as functions of q. Suppose that, for a given growth rate $\underline{g} < g_0 < \bar{g}$ (scenario 3), the system is in steady state at point A and the initial composition of the population given by $q_0 := \bar{q} = \bar{q}(g_0)$. In a given period T, an exogenous positive shock to g occurs, $g_1 > g_0$, causing both payoff functions to shift up respectively to $v^{l'}$ and $v^{h'}$. The new long run equilibrium is in point B, characterized by $\bar{q}' = \bar{q}(g_1)$ with $\bar{q}' < \bar{q}$. As pointed out above, after a positive shock to growth, the payoff of the patient agent increases more than that of the impatient one. Hence a positive gap will open between the two: $v^{h'} - v^{l'} > 0$. This gap induces the patient parents to try and socialize their children to their own trait. Therefore, in period $T+1$ we will observe that $\bar{q}' < q_{T+1} < \bar{q}$. From Proposition 2, we know that as long as q is greater than the steady state value, the payoff of patient agents is greater than that of impatient agents, i.e., $v^{l'} < v^{h'}$. From Proposition 3, we know that in this case we will have that $\tau^{h*} = q[v^{h'} - v^{l'}] > 0$, while $\tau^{l*} = 0$. Hence the fraction of impatient agents in the population decreases until the new steady state $\bar{q}'$ is reached in point B.

The model has a clear empirically testable implication. *A positive shock to economic growth should result in a higher parental effort in educating children to patience.* In the next section, we take this implication to the data.

3 Empirical validation

Our model predicts a positive correlation between economic growth and parental effort to transmit patience. To measure the effort to transmit patience we use data from the World Values Survey (WVS). The WVS is a project studying the change of human beliefs and values across countries and in time. It started in 1981 and it arrived at its 7th wave in 2022 (Inglehart et al., 2014). The WVS consists of national representative surveys containing questions on social values, political issues and demography.[4] Among other questions, subjects are asked to answer to the following: *"Here is a list of qualities that children can be encouraged to learn at home. Which, if any, do you consider to be especially important?"*. Respondents can choose up to 5 answers among the following options: 1. Independence; 2. Hard work; 3. Feeling of responsibility; 4. Imagination; 5. Tolerance and respect for other people; 6. Thrift, saving money and things; 7. Determination, perseverance; 8. Religious faith; 9. Unselfishness; 10. Obedience and 11. Self-expression. We interpret choosing *"thrift saving money and things"* as a positive effort in educating children to patience.

In order to identify the causal impact of economic growth on parental effort to transmit patience we exploit variation in per capita income growth in US local labor markets due to the Great Recession (GR) shock. Following the literature on labor market adjustments to trade shocks (see e.g., Autor et al., 2013; Acemoglu et al., 2016, among others), we use commuting zones (CZs) as a measure of local labor markets (Tolbert and Sizer, 1996). We focus on the US because the 7th wave of the WVS contains geolocations data of US respondents, which can then be mapped into CZs.[5] In order to project the Great Recession onto CZs, we use a Bartik shift-share variable (Bartik, 1991) that combines economic composition at the CZ level with shifts at the aggregate level. In particular, we specify the annualized GR shock in shift-share form as

$$z_n = \frac{100}{3} \times \sum_j \frac{L_{n,j,t-\ell}}{L_{n,t-\ell}} \left(\log L^{-n}_{j,t+h} - \log L^{-n}_{j,t}\right) , \tag{22}$$

where $L_{n,j,t-\ell}/L_{n,t-\ell}$ is the lagged initial share of industry j in employment of CZ n, while $\log L^{-n}_{j,t+h} - \log L^{-n}_{j,t}$ is the log change in national employment in industry j over the time span h, outside of the state in which the specific CZ n is located. Using lagged shares helps

[4] A full description of the survey can be found at http://www.worldvaluessurvey.org/

[5] Crosswalks are provided by Autor et al. (2022).

mitigating both the effect of simultaneity and the influence of measurement error, while using national industry employment growth rates outside of CZ n helps alleviating concerns due to the potential effect of the level of patience in CZ n on both parental effort and economic outcomes in CZ n.[6] We set $\ell = 6$ and $h = 3$, so that changes in national employment in the Great Recession period ranging from 2006 to 2009 in industry j, are imputed to CZ n according to its share of industry j employment in year 2000.[7] In what follows we use the dataset provided by Autor et al. (2022) to evaluate the impact of the Great Recession shock on CZ-level growth rates. First, we remark that the mean value of the shock is -2.17 percentage points, meaning that, on average, CZs faced a strong contraction during the period 2006-2009. Second, we assess the relevance of the Bartik instrument by estimating the following equations

$$\Delta y_{n,t+s} = \alpha + \beta z_n + \mathbf{X}'_{n,t-\ell}\gamma + \epsilon_{n,t+s} \ , \tag{23}$$

where $\Delta y_{n,t+s}$ is the change in log-income per capita in CZ n between years $t+s$ and t, with $t = 2006$ and $s = -5, \dots, 11$, and $\mathbf{X}'_{n,t-\ell}$ contains US Census Divisions fixed effects as well as CZ-level demographic and labor force controls in year 2000.[8] We thus estimate a regression for each time span between 2001-2006 and 2017-2006. We focus on this specific time frame because the 7th wave of the WVS in the US was completed in 2017. Periods prior to the beginning of the shock allow us to check for pre-trends in outcomes, while the successively longer time differences allow us to evaluate the longer-run impact of the GR shock. Figure 3 reports the estimated impacts β with 90% confidence intervals.[9]

Overall, the effect of the GR shock is long lasting. In fact, we observe a hump-shaped response to the shock, with impact coefficients reaching a peak for the 2011-2006 period and adverse effects persisting out to 2017. For the 2017-2006 period, CZs more exposed to contracting industries during the Great Recession still display a net decline in per capita income.[10] Finally, we do not detect any significant pre-trend.

After having assessed the relevance of the Bartik instrument, we now perform a reduced

[6] Correlation between the level of patience and parental effort could be introduced in our model by considering e.g., paternalism.

[7] The choice of ℓ and h follows from Autor et al. (2022), who use year 2006 as a starting period for the GR shock because US housing markets started contracting in that year (Charles et al., 2016).

[8] Controls include the fraction of foreign-born, non-whites, and the college educated in the population, the fraction of employed working-age women and the population shares of residents in age ranges 0-17, 18-39, and 40-64.

[9] Results are robust to clustered standard errors at the state level.

[10] For example, a CZ hit by the mean GR shock would have experienced a 1.74 (-2.17×0.8) percentage point decline in income per capita between years 2017 and 2006.

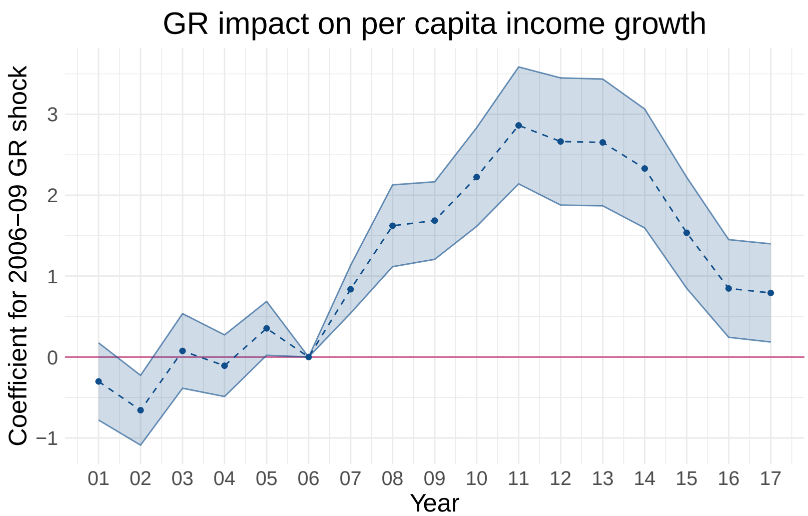

Figure 3: Estimates for coefficients β in Eq. (23) with 90% confidence intervals.

form regression analysis to estimate the probability of choosing thrift in response to the GR shock. Before proceeding, we briefly discuss the basis for identification in our shift-share setup. Recent literature points out that identification in shift-share analyses requires either i) industry shifts to be exogenous taking industry shares as given (Borusyak et al., 2021), or ii) industry employment shares to be exogenous taking industry shifts as given (Goldsmith-Pinkham et al., 2020). Our setting is more consistent with assuming shift exogeneity rather than share exogeneity. In fact, industrial composition in a given CZ may be endogenous to the dynamics of patience transmission. We thus focus on shift exogeneity, arguing that shifts in aggregate employment during the Great Recession, outside the state where a given CZ is located, are exogenous to shocks that may affect parental effort of individuals in the given CZ.

We now proceed with the evaluation of the causal impact of economic growth on parental effort to transmit patience using individual data from the WVS. Let us define Y_i as a binary variable indicating whether respondent i chose thrift among the qualities that children should learn at home. We then use a linear probability model[11] to estimate the probability that $Y_i = 1$

$$\Pr(Y_i = 1|\mathbf{X}_i) = \mathbf{X}_i'\beta \ , \tag{24}$$

which we interpret as a proxy for the individual effort to teach patience. Our explanatory

[11]Using a logit model yields qualitatively similar results.

variables include a constant, the Bartik instrument in Eq. (22), US Census Divisions fixed effects, the same set of CZ-level controls used in the specification described in Eq. (23), and a set of individual controls. In particular, individual characteristics include gender, age, age squared and a set of dummies describing the cultural and social status of the respondent: religiosity, which indicates whether religion is important or not;[12] education, which we divide in three classes, namely primary and lower, high school and university; saving, which describes the savings of respondent's family in the previous year;[13] children, indicating whether the respondent has no children, or one or more child; income, which describes the respondent's self-reported decile in income distribution. Regression results are shown in Table 1, with standard errors clustered at the CZ level.[14]

	Dependent variable: Choosing thrift		
	(1)	(2)	(3)
Bartik GR shock	0.064***	0.058**	0.091***
Census Division FE	YES	YES	YES
Individual-Level Controls	NO	YES	YES
CZ-Level Controls	NO	NO	YES
n.obs	1105	1047	1047

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 1: Individual estimation results. Individual Controls: age, age squared, gender, education, religiosity, saving, children and income. CZ-Level Controls: fraction of foreign-born, non-whites, and the college educated in the population, fraction of employed working-age women and the population shares of residents in age ranges 0-17, 18-39, and 40-64. Standard errors clustered at the CZ level.

Our empirical results suggest a strong and positive correlation between parental effort to teach patience to children and our instrument for the growth rate of income per capita. This is in line with the prediction of our model, i.e., that a lower effort in teaching patience should be observed after a negative growth shock. In particular, a 1% increase in the severity of the shock (i.e., a decrease in the Bartik shift-share variable) decreases the probability of choosing thrift by 9% (ceteris paribus) in the specification including both individual and CZ-level controls. Parents in CZ that experienced a stronger economic contraction attribute less importance to educating children to thrift. Overall, the empirical analysis confirms the

[12] Religiosity is based on the answer to the question "For each of the following, indicate how important it is in your life. Would you say religion is: Very Important, Rather Important, Not Very Important, Not At All Important". We classify a respondent as religious if she chooses one of the first two answers.

[13] Saving is based on the answer to the question: "During the past year, did your family: Saved money, Just got by, Spent some savings and borrowed money, Spent savings and borrowed money".

[14] Results are robust to clustered standard errors at the state level.

predictions of the model developed in Section 2: educational effort to transmit patience is influenced by economic conditions, and it is procyclical.

4 Conclusions

The causal relationship that goes from patience to growth is well established both theoretically and empirically. Traditionally, patience has been considered as a deep exogenous parameter leading to different levels of economic success. The idea that patience may itself be evolving endogenously has been investigated only by few recent contributions. Our contribution to this literature is twofold. First, we describe a theoretical model where the evolution of patience over time is influenced by economic growth through intergenerational cultural transmission. The choice of parents to educate children to patience is aimed at maximizing their offspring's expected welfare. According to our model, the welfare of agents with different levels of patience depends on aggregate economic performance. In particular, when the economy grows faster, patient agents enjoy higher welfare. Therefore, in economies characterized by higher growth, the incentive to educate children to patience is higher. Second, we empirically validate this theoretical mechanism using WVS data. We detect a causal relationship between relatively recent economic performance and parental effort to teach patience. This finding suggests that the level of patience in an economy is not constant but it evolves over time as a result of a cultural transmission process.

Appendix

A Proofs

A.1 Proof of Proposition 1

Consider the following derivatives

$$\frac{\partial v^l(q,g)}{\partial q} = \frac{(q-1)(1+\beta^l)(\beta^l-\beta^h)^2}{(1+\beta^l(1-q)+q\beta^h)(q\beta^l+(1-q)\beta^h+\beta^l\beta^h)}, \tag{25}$$

$$\frac{\partial v^h(q,g)}{\partial q} = \frac{q(1+\beta^h)(\beta^l-\beta^h)^2}{(1+\beta^l(1-q)+q\beta^h)(q\beta^l+(1-q)\beta^h+\beta^l\beta^h)}. \tag{26}$$

It is straightforward to see that, for every $q \in [0,1]$, the denominator of (25)–(26) is always positive. On the other hand, the numerator of (25) is always negative for $q \in [0,1)$ and equal to zero for $q = 1$, while the numerator of (26) is always positive for $q \in (0,1]$ and equal to zero for $q = 0$.

A.2 Proof of Proposition 2

Given monotonicity of $v^l(q,g)$ and $v^h(q,g)$, we have that $v^l(q,g) = v^h(q,g)$ if and only if $v^h(0,g) \leq v^l(0,g)$ and $v^h(1,g) \geq v^l(1,g)$. In what follows we assume that $\beta^l < \beta^h$, i.e., type l is impatient when compared to type h. The first inequality implies that

$$\begin{aligned}
v^h(0,g) &\leq v^l(0,g), \\
\beta^h \log(g) &\leq \log\left(\frac{1+\beta^h}{1+\beta^l}\right) + \beta^l \log\left(g\frac{\beta^l(1+\beta^h)}{\beta^h(1+\beta^l)}\right), \\
(\beta^h-\beta^l)\log(g) &\leq (1+\beta^l)\log\left(\frac{1+\beta^h}{1+\beta^l}\right) + \beta^l \log\left(\frac{\beta^l}{\beta^h}\right), \\
g &\leq \exp\left(\frac{(1+\beta^l)\log\left(\frac{1+\beta^h}{1+\beta^l}\right)+\beta^l\log\left(\frac{\beta^l}{\beta^h}\right)}{\beta^h-\beta^l}\right).
\end{aligned} \tag{27}$$

Denoting the RHS of the inequality above as $\bar{g}$ we can rewrite the first condition as $g \leq \bar{g}$. The second inequality implies that

$$
\begin{aligned}
v^l(1,g) &\leq v^h(1,g), \\
\beta^l \log(g) &\leq \log\left(\frac{1+\beta^l}{1+\beta^h}\right) + \beta^h \log\left(g\frac{\beta^h(1+\beta^l)}{\beta^l(1+\beta^h)}\right), \\
(\beta^l - \beta^h)\log(g) &\leq -(1+\beta^h)\log\left(\frac{1+\beta^h}{1+\beta^l}\right) - \beta^h \log\left(\frac{\beta^l}{\beta^h}\right), \\
g &\geq \exp\left(\frac{(1+\beta^h)\log\left(\frac{1+\beta^h}{1+\beta^l}\right) + \beta^h \log\left(\frac{\beta^l}{\beta^h}\right)}{\beta^h - \beta^l}\right).
\end{aligned} \tag{28}
$$

Denoting the RHS of the inequality above as $\underline{g}$ we can rewrite the first condition as $g \geq \underline{g}$. It is trivial to verify that, when $\beta^l < \beta^h$, we have that $\underline{g} < \bar{g}$. Denoting $\bar{q}$ as the q such that $v^l(q,g) = v^h(q,g)$, equations (25)–(26) imply that $v^l(q,g) > v^h(q,g)$ if and only if $q < \bar{q}$. Moreover, if $g < \underline{g}$ we have that $v^l(1,g) > v^h(1,g)$ and thus $v^l(q,g) > v^h(q,g)$ for all q, while if $g > \bar{g}$ we have that $v^l(0,g) < v^h(0,g)$ and thus $v^l(q,g) < v^h(q,g)$ for all q.

A.3 Proof of Proposition 4

Dynamics of the share of impatient agents in the economy are described by

$$q_{t+1} = q_t + q_t(\tau_t^{l*} - \tau_t^{h*}) - (q_t)^2(\tau_t^{l*} - \tau_t^{h*}).$$

When $g \leq \underline{g}$, the system has two steady states, namely $q = \{0, 1\}$. In fact, from Proposition 3 we know that τ_t^{l*} is always larger that τ_t^{h*} and therefore dynamics converge to $q = 1$, which is globally stable.

When $g \geq \bar{g}$, the system has two steady states, namely $q = \{0, 1\}$. In fact, from Proposition 3 we know that τ_t^{h*} is always larger that τ_t^{l*} and therefore dynamics converge to $q = 0$, which is globally stable.

When $g \in [\underline{g}, \bar{g}]$, the system has three steady states, namely $q = \{0, \bar{q}, 1\}$, where $\bar{q}$ is the steady state level that equates parental efforts of the two types. From Proposition 3 we know that $\tau_t^{l*} = \tau_t^{h*}$ when $v_t^l = v_t^h$, i.e., when $q = \bar{q}$ as defined in equation 14. Moreover, since τ_t^{l*} is larger (smaller) than τ_t^{h*} whenever q is below (above) $\bar{q}$, we have that dynamics converge to $\bar{q}$, which is globally stable.

More formally, consider the map

$$f(q) = q + q(\tau^l - \tau^h) - q^2(\tau^l - \tau^h),$$

and notice that

$$\tau^l - \tau^h = \begin{cases} [\min[1, (1-q)(v^l - v^h)]]^+ > 0 & \text{for } q < \bar{q} \\ 0 & \text{for } q = \bar{q} \\ -[\min[1, q(v^h - v^l)]]^+ < 0 & \text{for } q > \bar{q} \end{cases}$$

To prove global stability of $\bar{q}$, we need to show that f cuts the 45-degree line from above in $\bar{q}$. Given that

$$f'(q) = (1 + \tau^l - \tau^h) + q\frac{\partial(\tau^l - \tau^h)}{\partial q} - 2q(\tau^l - \tau^h) - q^2\frac{\partial(\tau^l - \tau^h)}{\partial q},$$

in a neighborhood of $\bar{q}$,[15] we have that the right and left derivatives of f at $\bar{q}$ are respectively given by

$$f'_+(\bar{q}) = 1 + \bar{q}^2(1-\bar{q})\left(\frac{-(\beta^h - \beta^l)^2}{\bar{q}\beta^l + (1-\bar{q})\beta^h + \beta^l\beta^h}\right)$$
$$f'_-(\bar{q}) = 1 + \bar{q}(1-\bar{q})^2\left(\frac{-(\beta^h - \beta^l)^2}{\bar{q}\beta^l + (1-\bar{q})\beta^h + \beta^l\beta^h}\right).$$

Consider for example $f'_+(\bar{q})$. Given that

$$\frac{-(\beta^h - \beta^l)^2}{\bar{q}\beta^l + (1-\bar{q})\beta^h + \beta^l\beta^h} < 0,$$

for map f to cut the 45-degree line from above in $\bar{q}$, condition

$$\bar{q}^2(1-\bar{q})\left(\frac{-(\beta^h - \beta^l)^2}{\bar{q}\beta^l + (1-\bar{q})\beta^h + \beta^l\beta^h}\right) > -1$$

must hold. Since $0 < \beta^l < \beta^h < 1$ and $0 < \bar{q} < 1$, the condition above is always satisfied.

[15] When $q < \bar{q}$ is such that $(1-q)(v^l - v^h) > 1$, we have that $f'(q) = 2 - 2q$. On the other hand, when $q > \bar{q}$ is such that $q(v^h - v^l) > 1$, we have that $f'(q) = 2q$.

This can be proved by contradiction. In fact, suppose that

$$
\begin{aligned}
\bar{q}^2(1-\bar{q})\left(\frac{-(\beta^h-\beta^l)^2}{\bar{q}\beta^l+(1-\bar{q})\beta^h+\beta^l\beta^h}\right) &< -1 \\
\bar{q}^2(1-\bar{q})(\beta^h-\beta^l)^2 &> \bar{q}\beta^l+(1-\bar{q})\beta^h+\beta^l\beta^h \\
(\bar{q}\beta^h)^2+(\bar{q}\beta^l)^2 &> \bar{q}\beta^l+(1-\bar{q})\beta^h+\beta^l\beta^h+2\bar{q}^2\beta^h\beta^l+\bar{q}^3(\beta^h-\beta^l)^2 \\
(\bar{q}\beta^h)^2+(\bar{q}\beta^l)^2 &> \bar{q}\beta^l+(1-\bar{q})\beta^h+\beta^l\beta^h+\bar{q}^3(\beta^h)^2+\bar{q}^3(\beta^l)^2 \\
(\bar{q}\beta^h)^2+(\bar{q}\beta^l)^2 &> \bar{q}\beta^l+(1-\bar{q})\beta^h+(\beta^l)^2+\bar{q}^3(\beta^h)^2+\bar{q}^3(\beta^l)^2 \\
(\bar{q}\beta^h)^2 &> \bar{q}\beta^l+(1-\bar{q})\beta^h+\bar{q}^3(\beta^h)^2+\bar{q}^3(\beta^l)^2 \\
(\bar{q}\beta^h)^2 &> (1-\bar{q})\beta^h+\bar{q}^3(\beta^h)^2 \\
\bar{q}^2\beta^h+\bar{q}-\bar{q}^3\beta^h &> 1,
\end{aligned}
$$

where the fourth inequality follows from the fact that $\bar{q}^3(\beta^h-\beta^l)^2=\bar{q}^3(\beta^h)^2+\bar{q}^3(\beta^l)^2-2\bar{q}^3\beta^h\beta^l$ and that $2\bar{q}^2\beta^h\beta^l-2\bar{q}^3\beta^h\beta^l>0$, the fifth inequality follows from $(\beta^l)^2<\beta^h\beta^l$, the sixth inequality follows from $(\beta^l)^2-(\bar{q}\beta^l)^2>0$, and the seventh inequality follows from $\bar{q}\beta^l+\bar{q}^3(\beta^l)^2>0$. Given that

$$\bar{q}^2\beta^h+\bar{q}-\bar{q}^3\beta^h<\bar{q}^2+\bar{q}-\bar{q}^3,$$

and that $\bar{q}^2+\bar{q}-\bar{q}^3<1$ for $0<\bar{q}<1$, it follows that $0<f'_+(\bar{q})<1$ since $\beta^h<1$ by assumption. A similar reasoning applies to $f'_-(\bar{q})$. Therefore we conclude that $\bar{q}$ is globally stable. Figure 4 displays map f for different values of growth rate g.

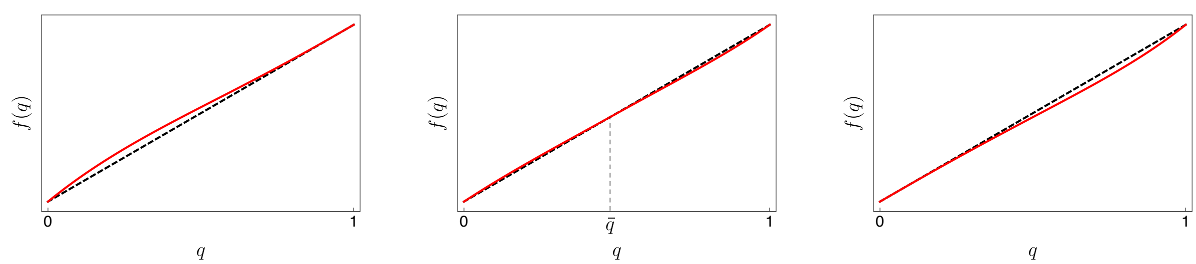

Figure 4: Map f for different levels of g. **Left**: Low growth ($g=0.55$). **Center**: Mild growth ($g=1$). **Right**: High growth ($g=1.45$).

B Endogenous growth

Consider now the case in which growth is endogenous and it depends on q, i.e. on the average level of patience in the economy. We can postulate a negative reduced form relationship between g and q on the grounds that higher patience leads to more savings, more investments and ultimately to higher growth, so that $g := g(q)$ with $g' \leq 0$. We thus have equilibrium utilities given by

$$v^l = v^l(q; \beta^l, \beta^h) = \log\left[\frac{1+\beta^h}{1+q\beta^h+(1-q)\beta^l}\right] + \beta^l \log\left[\frac{\beta^l(1+\beta^h)}{\beta^l\beta^h+q\beta^l+(1-q)\beta^h}\cdot g(q)\right],$$

$$v^h = v^h(q; \beta^l, \beta^h) = \log\left[\frac{1+\beta^l}{1+q\beta^h+(1-q)\beta^l}\right] + \beta^h \log\left[\frac{\beta^h(1+\beta^l)}{\beta^l\beta^h+q\beta^l+(1-q)\beta^h}\cdot g(q)\right].$$

The derivatives of the utilities of the two types of agents with respect to q are given by

$$\frac{dv^l}{dq} = \frac{(q-1)(\beta^h-\beta^l)^2(1+\beta^l)}{(1+q(\beta^h-\beta^l)+\beta^l)(q\beta^l+\beta^h(1-q+\beta^l))} + \frac{\beta^l g'(q)}{g(q)} \tag{29}$$

$$\frac{dv^h}{dq} = \frac{q(\beta^h-\beta^l)^2(1+\beta^h)}{(1+q(\beta^h-\beta^l)+\beta^l)(q\beta^l+\beta^h(1-q+\beta^l))} + \frac{\beta^h g'(q)}{g(q)}\,. \tag{30}$$

The first terms in equations (29) and (30) capture the impact on equilibrium utilities of a change in q through the interest rate channel. These terms are respectively negative and positive in equations (29) and (30). In fact, an increase in q leads to higher credit demand and consequently to a higher interest rate. This has a negative impact on the utility of type l agents and a positive impact on the utility of type h agents. The second terms in equations (29) and (30) capture the impact on equilibrium utilities of a change in q through the growth channel. These terms depend on the sensitivity of growth with respects to q, i.e., $g'(q)$, which measures how growth changes as average patience changes. Given that a positive change in growth has a positive impact on the utility of both types, and that an increase of q represents a decrease of patience, we have that both terms are negative. Therefore, the sign of the derivative in Eq. (29) is negative for all values of q, as in the simplified model described in the main text. The sign of the derivative in Eq. (30) instead, depends on the relative size of the first term (positive) and the second term (negative).

In general, whenever the interest rate channel dominates the growth channel in Eq. (30), dynamic properties are qualitatively similar to the ones presented in the main text. In what follows we specify a functional form for $g(q)$ based on empirical evidence and study the model dynamics. Table 2 shows the estimated relation between average growth and patience, using the data from Sunde et al. (2021). Once the additional controls are included in the estimation, the quadratic term is not significant, suggesting that the relation between growth and patience is well approximated by a linear relationship. Based on this empirical evidence we postulate a linear relation between growth and patience:

$$g(q) = a - b \times q, \tag{31}$$

with $b > 0$. In this case we thus have that $g'(q) = -b$.

	Dependent variable: Annual growth rate in GDP p/c (in %) since...					
	1950			1975		
	(1)	(2)	(3)	(4)	(5)	(6)
Patience	1.46***	1.33***	1.35***	1.45**	1.73***	2.11***
	(0.41)	(0.43)	(0.34)	(0.63)	(0.51)	(0.52)
Patience × Patience	-1.84***	-1.31***	-0.41	-2.07**	-1.00	-0.54
	(0.58)	(0.40)	(0.46)	(0.92)	(0.61)	(0.72)
Log [GDP p/c base year]		-0.76***	-1.16***		-1.02***	-1.63***
		(0.21)	(0.20)		(0.18)	(0.27)
Continent FE	No	Yes	Yes	No	Yes	Yes
Additionals controls	No	No	Yes	No	No	Yes
Observations	62	62	62	68	68	67
R^2	0.16	0.57	0.81	0.09	0.58	0.75

Table 2: Estimations using data from Sunde et al. (2021), downloaded from the Zenodo repository at https://doi.org/10.5281/zenodo.5589052. This table reproduces the estimation of Table D.3 in the online appendix of Sunde et al. (2021), with the addition of quadratic patience to test for non-linearities. Additional controls include geographical, population variables and average trust. The geographical variables include distance to equator, longitude, percentage of arable land, land suitability for agricolture, average precipitation, average temperature, % living in (sub-) tropical zones and % at risk of malaria. The population variables include predicted genetic diversity and squared predicted genetic diversity.

Given that there is only one value of q such that $v^h = v^l$ (see derivation of $\bar{q}$ with endogenous growth in Appendix D.4), we can characterize the dynamic behavior of the model with endogenous growth as follows.

We start by analyzing the case in which $g < \bar{g}$. From Appendix A.2 we know that if $g < \bar{g}$, then $v^h(0) < v^l(0)$. Given (31), we have that $g(0) < \bar{g}$ when $a < \bar{g}$. In this case we may have two situations, depending on the relative values of a and b.

First, the unique $\bar{q}$ is outside the interval $(0, 1)$. This happens when $v^h(1) \leq v^l(1)$, i.e., when $g(1) \leq \underline{g}$ (see Appendix A.2). Using equation (31), the latter condition rewrites as

$b \geq a - \underline{g}$. In this case, $v^h(q) < v^l(q)$ for any $q \in (0,1)$ and the model behaves as the model with exogenous growth with $g \leq \underline{g}$, i.e., it converges to a stable equilibrium in $q = 1$ (see upper-left panel of Figure 5).

Second, the unique $\bar{q}$ is inside the interval $(0,1)$. This happens when $v^h(1) > v^l(1)$, that is when $b < a - \underline{g}$. In this case, the model behaves as the model with exogenous growth with $\underline{g} < g < \bar{g}$, i.e., it converges to the unique stable equilibrium $\bar{q} \in (0,1)$ (see upper-right panel of Figure 5).

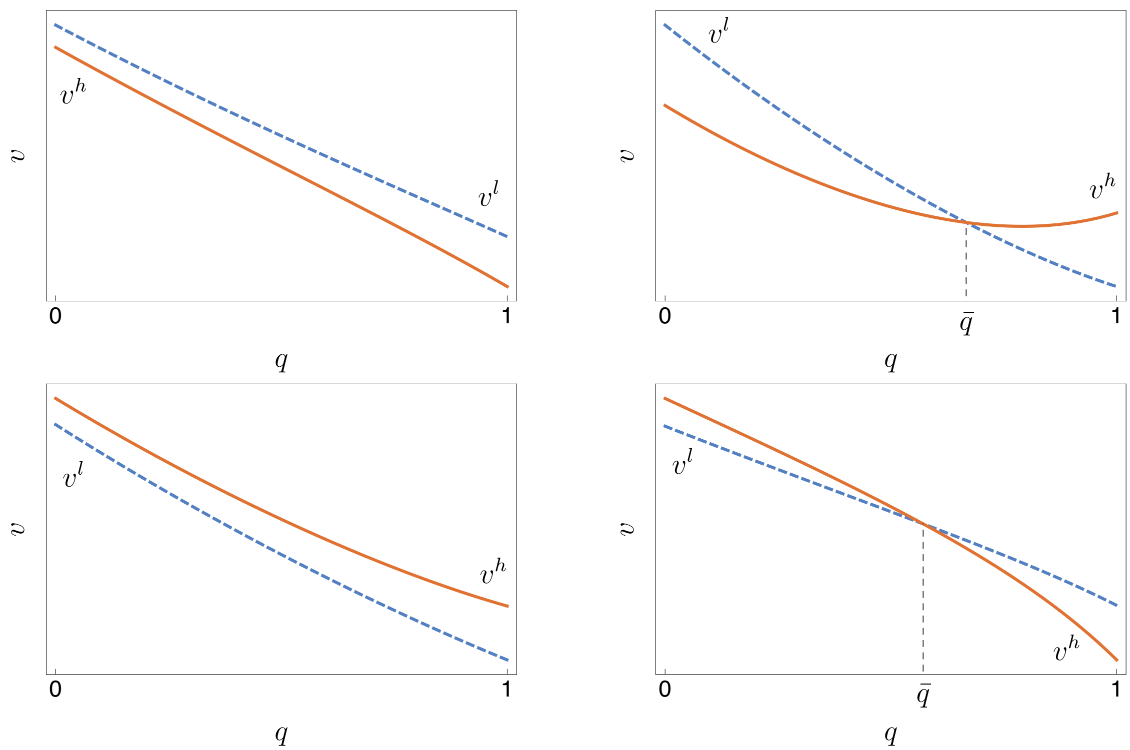

Figure 5: The behavior of utility of types h and l with linear endogenous growth, $g(q) = a - bq$. **Upper left**: $a < \bar{g}$ and $b \geq a - \underline{g}$. **Upper right**: $a < \bar{g}$ and $b < a - \underline{g}$. **Lower left**: $a > \bar{g}$ and $b \leq a - \underline{g}$. **Lower right**: $a > \bar{g}$ and $b > a - \underline{g}$

We now complete the analysis by considering the case in which $g > \bar{g}$. From Appendix A.2 we know that if $g > \bar{g}$ then $v^h(0) > v^l(0)$. Given (31), we have that $g(0) > \bar{g}$ when $a > \bar{g}$. Also in this case we have two possible situations depending on the relative values of a and b.

First, the unique $\bar{q}$ is outside the interval $(0,1)$. This happens when $v^h(1) \geq v^l(1)$, i.e., when $b \leq a - \underline{g}$. In this case, $v^h(q) > v^l(q)$ for any $q \in (0,1)$ and the model behaves as the model with exogenous growth with $g \geq \bar{g}$, i.e., it converges to a stable equilibrium in $q = 0$ (see lower-left panel of Figure 5).

Second, the unique $\bar{q}$ is inside the interval $(0,1)$. This happens when $v^h(1) < v^l(1)$, i.e., when $b > a - \underline{g}$. In this case, $\bar{q} \in (0,1)$ and it is an unstable equilibrium. This is the only situation in which the model with endogenous growth behaves differently from the model with exogenous growth: the dynamics can converge either to $q = 0$ or to $q = 1$ depending on initial conditions (see lower-right panel of Figure 5).

The latter scenario only occurs when growth is extremely sensible to changes in average patience, i.e. in q. For this reason, we maintain that the assumption of exogenous growth represents only a minor loss of generality, which allows nevertheless for a much clearer investigation of the impact that economic growth has on patience. Finally, we remark that the theoretical implication of the model described in Section 2.3 and tested empirically in Section 3 also holds in the model with endogenous growth. In fact, in the empirically plausible case of equation (31), we have that, for a given q, a positive growth shock may be due to an increase in a or to a decrease in b. In the first case we have that $\partial(v^h - v^l)/\partial a = (\beta^h - \beta^l)/(a - bq) > 0$, while in the second case we have that $\partial(v^h - v^l)/\partial b = q(-\beta^h + \beta^l)/(a - bq) < 0$. Thus, our general result that links positively growth to the effort of educating children to patience is valid also in the case of (linear) endogenous growth.

C Perfect Foresight

Consider now the case in which parents have perfect foresight of children's future utility. As before, the optimization problem of parent of type i is given by

$$\max_{\tau_t^i} \mathbb{E}^i_{\tau_t^i}[v_{t+1}^{ch^i}] = \left[\tau_t^i(1 - q_t^i) + q_t^i\right] \mathbb{E}^i[v_{t+1}^i] + (1 - \tau_t^i)(1 - q_t^i)\mathbb{E}^i[v_{t+1}^j] - \frac{1}{2}(\tau_t^i)^2.$$

Notice that $v_{t+1}^{ch^i}$ depends on q_{t+1} via the equilibrium interest rate, and that q_{t+1} is a deterministic function of q_t, τ_t^l and τ_t^h given by

$$q_{t+1}^i = q_t^i[1 + (\tau_t^i - \tau_t^j)(1 - q_t^i)] \; .$$

The first order condition of the optimization problem thus reads

$$\begin{aligned}\tau_t^i &= (1-q_t^i)\left(v_{t+1}^i - v_{t+1}^j\right)\\ &\quad + \left[\tau_t^i(1-q_t^i)+q_t^i\right]\frac{\partial v_{t+1}^i}{\partial q_{t+1}^i}\frac{\partial q_{t+1}^i}{\partial \tau_t^i}\\ &\quad + (1-\tau_t^i)(1-q_t^i)\frac{\partial v_{t+1}^j}{\partial q_{t+1}^i}\frac{\partial q_{t+1}^i}{\partial \tau_t^i}.\end{aligned}$$

Considering q_t as given at the time of the optimization, and noting that both $\frac{\partial v_{t+1}^i}{\partial q_{t+1}^i}\frac{\partial q_{t+1}^i}{\partial \tau_t^i}$ and $\frac{\partial v_{t+1}^j}{\partial q_{t+1}^i}\frac{\partial q_{t+1}^i}{\partial \tau_t^i}$ do not depend on g, we have that totally differentiating condition above yields

$$\begin{aligned}\frac{\partial \tau_t^i}{\partial g} &= (1-q_t^i)\frac{\partial(v_{t+i}^i - v_{t+i}^j)}{\partial g} + \frac{\partial \tau_t^i}{\partial g}(1-q_t^i)\frac{\partial v_{t+1}^i}{\partial q_{t+1}^i}\frac{\partial q_{t+1}^i}{\partial \tau_t^i} - \frac{\partial \tau_t^i}{\partial g}(1-q_t^i)\frac{\partial v_{t+1}^j}{\partial q_{t+1}^i}\frac{\partial q_{t+1}^i}{\partial \tau_t^i}\\ &= \frac{(1-q_t^i)\frac{\partial(v_{t+i}^i - v_{t+i}^j)}{\partial g}}{1-(1-q_t^i)\frac{\partial q_{t+1}^i}{\partial \tau_t^i}\left(\frac{\partial v_{t+1}^i}{\partial q_{t+1}^i} - \frac{\partial v_{t+1}^j}{\partial q_{t+1}^i}\right)}.\end{aligned}$$

In particular, we have that

$$\frac{\partial \tau_t^l}{\partial g} = \frac{(1-q_t)\frac{-(\beta^h-\beta^l)}{g}}{1-(1-q_t)^2 q_t \frac{-(\beta^h-\beta^l)^2}{q_{t+1}\beta^l+\beta^h(1-q_{t+1}+\beta^l)}} < 0,$$

while

$$\frac{\partial \tau_t^h}{\partial g} = \frac{q_t\frac{(\beta^h-\beta^l)}{g}}{1-q_t^2(-1+q_t)\frac{(\beta^h-\beta^l)^2}{q_{t+1}\beta^l+\beta^h(1-q_{t+1}+\beta^l)}} > 0.$$

These results show that, after a positive growth shock, parental effort to transmit their cultural trait increases (decreases) for patient (impatient) agents. This in turn implies that, after an increase in the growth rate of the economy, the share of impatient agents declines, that is

$$\frac{\partial q_{t+1}}{\partial g} = q_t(1-q_t)\left(\frac{\partial \tau^l}{\partial g} - \frac{\partial \tau^h}{\partial g}\right) < 0.$$

D Other derivations

D.1 Optimal Consumption

The households' maximization problem can be solved by maximizing the following Lagrangian (where the i index is dropped for notation simplicity):

$$\mathcal{L} = \log(c_t) + \beta \log(c_{t+1}) + \lambda \left[(R+g)y_t - Rc_t - c_{t+1})\right],$$

where we have used Assumption 1 to substitute y_{t+1} with gy_t. The first order conditions are:

$$\frac{1}{c_t} - \lambda R = 0 \tag{32}$$

$$\frac{\beta}{c_{t+1}} - \lambda = 0 \tag{33}$$

$$(R+g)y_t - Rc_t - c_{t+1} = 0. \tag{34}$$

Substitute equation (33) in equation (32), to obtain

$$\frac{1}{c_t} - \frac{\beta}{c_{t+1}} R = 0, \tag{35}$$

from which

$$c_{t+1} = \beta c_t R. \tag{36}$$

Equation (36) can be substituted in equation (34) to get

$$(R+g)y_t - Rc_t - \beta c_t R = 0,$$

from which the optimal consumption in t can be written as

$$c_t = \frac{(R+g)y_t}{(1+\beta)R},$$

which is equation (4) in the main text. Savings in t are given by $s_t = y_t - c_t$, while consumption in $t+1$ is $c_{t+1} = Rs_t + y_{t+1}$.

D.2 Equilibrium interest rate

The equilibrium interest rate is derived using the market clearing condition

$$-qs_t^l = (1-q)s_t^h.$$

Substituting the optimal saving decision of the different agents in the equation above we obtain

$$\begin{aligned}
-q\left(y_t - \frac{(1+r)y_t + y_{t+1}}{(1+r)(1+\beta^l)}\right) &= (1-q)\left(y_t - \frac{(1+r)y_t + y_{t+1}}{(1+r)(1+\beta^h)}\right) \\
-q\left(\frac{(1+r)(1+\beta^l)y_t - (1+r)y_t - y_{t+1}}{(1+r)(1+\beta^l)}\right) &= (1-q)\left(\frac{y_t(1+r)(1+\beta^h) - (1+r)y_t - y_{t+1}}{(1+r)(1+\beta^h)}\right) \\
-q\left(\frac{(1+r)(1+\beta^l)y_t - (1+r)y_t - y_{t+1}}{1+\beta^l}\right) &= (1-q)\left(\frac{y_t(1+r)(1+\beta^h) - (1+r)y_t - y_{t+1}}{1+\beta^h}\right) \\
-q(1+r)\frac{\beta^l y_t}{1+\beta^l} + q\frac{y_{t+1}}{1+\beta^l} &= (1-q)(1+r)\frac{y_t\beta^h}{1+\beta^h} - (1-q)\frac{y_{t+1}}{1+\beta^h}.
\end{aligned}$$

Denoting $R \equiv (1+r)$ and rearranging we get

$$\begin{aligned}
qR\frac{\beta^l y_t}{1+\beta^l} + (1-q)R\frac{y_t\beta^h}{1+\beta^h} &= (1-q)\frac{y_{t+1}}{1+\beta^h} + q\frac{y_{t+1}}{1+\beta^l} \\
R\left(q\frac{\beta^l y_t}{1+\beta^l} + (1-q)\frac{y_t\beta^h}{1+\beta^h}\right) &= (1-q)\frac{y_{t+1}}{1+\beta^h} + q\frac{y_{t+1}}{1+\beta^l}.
\end{aligned}$$

The equilibrium interest rate is thus given by

$$R = \frac{(1-q)\frac{y_{t+1}}{1+\beta^h} + q\frac{y_{t+1}}{1+\beta^l}}{q\frac{\beta^l y_t}{1+\beta^l} + (1-q)\frac{y_t\beta^h}{1+\beta^h}} = \frac{(1-q)y_{t+1}(1+\beta^l) + qy_{t+1}(1+\beta^h)}{q\beta^l y_t(1+\beta^h) + (1-q)y_t\beta^h(1+\beta^l)}.$$

Using Assumption 1 and substituting y_{t+1} with gy_t we obtain equation 8 in the main text.

D.3 Steady state $\bar{q}$

Start from the utility functions of the two agents written as a function of q and g, in Eqs. (10) and (11).

$$
\begin{aligned}
v^l &= \log\left[\frac{1+\beta^h}{1+q\beta^h+(1-q)\beta^l}\right] + \beta^l \log\left[\frac{\beta^l(1+\beta^h)}{\beta^l\beta^h+q\beta^l+(1-q)\beta^h}\cdot g\right] \\
v^h &= \log\left[\frac{1+\beta^l}{1+q\beta^h+(1-q)\beta^l}\right] + \beta^h \log\left[\frac{\beta^h(1+\beta^l)}{\beta^l\beta^h+q\beta^l+(1-q)\beta^h}\cdot g\right] \; .
\end{aligned}
$$

Imposing the equality between v^l and $= v^h$ we get

$$
\begin{aligned}
&\log[1+\beta^h] - \log[1+q\beta^h+(1-q)\beta^l] + \beta^l \log[\beta^l(1+\beta^h) - \beta^l \log[\beta^l\beta^h+q\beta^l+(1-q)\beta^h] + \beta^l \log[g] = \\
&\log[1+\beta^l] - \log[1+q\beta^h+(1-q)\beta^l] + \beta^h \log[\beta^h(1+\beta^l) - \beta^h \log[\beta^l\beta^h+q\beta^l+(1-q)\beta^h] + \beta^h \log[g] \; ,
\end{aligned}
$$

where the first line is v^l and the second line is v^h. Since the second term in both sides of the equation is the same, we can rewrite the latter as

$$
\begin{aligned}
&\log[1+\beta^h] + \beta^l \log[\beta^l(1+\beta^h)] - \beta^l \log[\beta^l\beta^h+q\beta^l+(1-q)\beta^h] + \beta^l \log[g] = \\
&\log[1+\beta^l] + \beta^h \log[\beta^h(1+\beta^l)] - \beta^h \log[\beta^l\beta^h+q\beta^l+(1-q)\beta^h] + \beta^h \log[g] \; .
\end{aligned}
$$

Further rearranging the equation above to collect terms in q on the left side of the equality yields

$$
\begin{aligned}
&\log[\beta^l\beta^h+q\beta^l+(1-q)\beta^h] = \\
&\frac{1}{(\beta^h-\beta^l)}(\log[1+\beta^l] - \log[1+\beta^h] + \beta^h \log[\beta^h(1+\beta^l)] - \beta^l \log[\beta^l(1+\beta^h)]) + \log[g] \; .
\end{aligned}
$$

Taking the exponential of both sides we get

$$
\begin{aligned}
&\beta^l\beta^h+q\beta^l+(1-q)\beta^h = \\
&g\left((1+\beta^l)\frac{1}{1+\beta^h}(\beta^h(1+\beta^l))^{\beta^h}\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}\right)^{\frac{1}{(\beta^h-\beta^l)}} \; .
\end{aligned}
$$

From the equation above we can solve for q that equalizes the utility of the two types of agents:

$$(1+\beta^l)\beta^h + q(\beta^l - \beta^h) =$$
$$g\left((1+\beta^l)\frac{1}{1+\beta^h}(\beta^h(1+\beta^l))^{\beta^h}\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}\right)^{\frac{1}{(\beta^h-\beta^l)}},$$

from which

$$q = \frac{(1+\beta^l)\beta^h - g\left((1+\beta^l)\frac{1}{1+\beta^h}(\beta^h(1+\beta^l))^{\beta^h}\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}\right)^{\frac{1}{(\beta^h-\beta^l)}}}{\beta^h - \beta^l}.$$

To find the expression in Eq. (14), multiply and divide by β^l the terms within brackets of the second term of the numerator

$$\bar{q} = \frac{(1+\beta^l)\beta^h - g\left(\beta^l(1+\beta^l)\frac{1}{\beta^l(1+\beta^h)}(\beta^h(1+\beta^l))^{\beta^h}\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}\right)^{\frac{1}{(\beta^h-\beta^l)}}}{\beta^h - \beta^l}$$

and rearrange. This equation shows that there is only one value of q such that equalizes the utilities of the two types.

D.4 Steady state $\bar{q}$ with endogenous growth

Consider the case in which $g(q) = a - bq$ and substitute the function $g(q)$ in the value of $\bar{q}$ derived in Appendix D.3:

$$q = \frac{(1+\beta^l)\beta^h - (a-bq)\left(\beta^l(1+\beta^l)\frac{1}{\beta^l(1+\beta^h)}(\beta^h(1+\beta^l))^{\beta^h}\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}\right)^{\frac{1}{(\beta^h-\beta^l)}}}{\beta^h - \beta^l}.$$

Rearrange terms to collect q on the left side:

$$q\left(1-\frac{b\left(\beta^l(1+\beta^l)^{\frac{1}{\beta^l(1+\beta^h)}}(\beta^h(1+\beta^l))^{\beta^h\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}}\right)^{\frac{1}{(\beta^h-\beta^l)}}}{\beta^h-\beta^l}\right)=$$

$$\frac{(1+\beta^l)\beta^h-a\left(\beta^l(1+\beta^l)^{\frac{1}{\beta^l(1+\beta^h)}}(\beta^h(1+\beta^l))^{\beta^h\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}}\right)^{\frac{1}{(\beta^h-\beta^l)}}}{\beta^h-\beta^l},$$

from which we get

$$q\left(\frac{\beta^h-\beta^l-b\left(\beta^l(1+\beta^l)^{\frac{1}{\beta^l(1+\beta^h)}}(\beta^h(1+\beta^l))^{\beta^h\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}}\right)^{\frac{1}{(\beta^h-\beta^l)}}}{\beta^h-\beta^l}\right)=$$

$$\frac{(1+\beta^l)\beta^h-a\left(\beta^l(1+\beta^l)^{\frac{1}{\beta^l(1+\beta^h)}}(\beta^h(1+\beta^l))^{\beta^h\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}}\right)^{\frac{1}{(\beta^h-\beta^l)}}}{\beta^h-\beta^l}.$$

Finally, multiply both sides by $\beta^h-\beta^l$ and write $\bar{q}$ as

$$\bar{q}=\frac{(1+\beta^l)\beta^h-a\left(\beta^l(1+\beta^l)^{\frac{1}{\beta^l(1+\beta^h)}}(\beta^h(1+\beta^l))^{\beta^h\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}}\right)^{\frac{1}{(\beta^h-\beta^l)}}}{\beta^h-\beta^l-b\left(\beta^l(1+\beta^l)^{\frac{1}{\beta^l(1+\beta^h)}}(\beta^h(1+\beta^l))^{\beta^h\frac{1}{(\beta^l(1+\beta^h))^{\beta^l}}}\right)^{\frac{1}{(\beta^h-\beta^l)}}}.$$

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