CHAPTER ONE

Culture, Entrepreneurship, and Growth

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Abstract

We discuss the two-way link between culture and economic growth. We present a model of endogenous technical change where growth is driven by the innovative activity of entrepreneurs. Entrepreneurship is risky and requires investments that affect the steepness of the lifetime consumption profile. As a consequence, the occupational choice of entrepreneurship hinges on risk tolerance and patience. Parents expecting their children to become entrepreneurs have an incentive to instill these two values in their children. Cultural transmission is Beckerian, i.e. parents are driven by the desire to maximize their children's happiness. We also consider, in an extension, a paternalistic motive for preference transmission. The growth rate of the economy depends on the fraction of the population choosing an entrepreneurial career. How many entrepreneurs there are in a society hinges, in turn, on parental investments in children's patience and risk tolerance. There can be multiple balanced growth paths, where in faster-growing countries more people exhibit an "entrepreneurial spirit." We discuss applications of models of endogenous preferences to the analysis of socio-economic transformations, such as the British Industrial Revolution. We also discuss empirical studies documenting the importance of culture and preference heterogeneity for economic growth.

Keywords

Culture, Entrepreneurship, Innovation, Economic growth, Endogenous preferences, Intergenerational preference transmission

JEL Classification Codes

J24, L26, N30, O10, O32, O33, O43, Z10

1.1. INTRODUCTION

The relationship between economic development and culture—broadly defined as the set of preferences, values, and beliefs that are at least partially learned—has attracted increasing attention in the economic literature over the last decade.

The notion that accounting for cultural heterogeneity is important for explaining individual behavior and economic success was a familiar one to classical economists. For instance, Smith (1776) described members of different social classes of his time as distinct types of human beings driven by different motives: "*A merchant is accustomed to employ his money chiefly in profitable projects; whereas a mere country gentleman is accustomed to employ it*

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chiefly in expense. The one often sees his money go from him and return to him again with a profit: the other, when once he parts with it, very seldom expects to see any more of it" (p. 432).

A century later, Karl Marx postulated that culture is the effect, rather than the cause, of the structure of production relations. In his view, culture, religion, and ideology (the "superstructure") are mere reflections of the material interests of the class that controls the means of production. Marx' materialism was disputed by Max Weber, who argued, that cultural and spiritual factors are independent drivers of socio-economic transformations. For Weber, the emergence of a "spirit of capitalism" with the ensuing emphasis on the virtue of entrepreneurial success was a major engine of the industrial revolution, not just a mere reflection of it. Weber did not fully reverse Marx' perspective, but rather acknowledged that the causation can run both ways.[1] For instance, he held the view that Protestant Asceticism had been an engine of economic transformation, but "was in turn influenced in its development and its character by the totality of social conditions, especially economic" (Weber, 1905, p. 183).

In contrast to the thinking of Smith, Marx, and Weber, the marginalist revolution in economics in the late 19th century sidelined cultural factors. According to the neoclassical paradigm, economics should focus on optimal individual choice and efficient resource allocation, while treating preferences and technology as exogenous primitives. Consistent with this paradigm, until recently economists have regarded preference formation, and culture more broadly, as issues lying outside the realm of economics. Over time, however, as economic imperialism has broken into new territories, exogenous preferences and technology have become straitjackets. The erosion of the neoclassical tenets began from technology. It is by now widely recognized, following the intuition of Schumpeter (1942), that technology cannot be viewed as exogenous if one wants to understand the mechanics of the growth process of industrial as well as developing economies. Rather, the efforts and risk-taking behavior of a particular group of individuals that aims to change the set of technological constraints, namely inventors and entrepreneurs, are the engines of economic growth. This observation motivated the development of the neo-Schumpeterian endogenous technical change paradigm throughout the 1990s (see, e.g. Aghion and Howitt, 1992).

Recently, the paradigm shift has extended to the realm of preferences. The availability of large data sets such as the World Value Survey has revealed that there is a great deal of heterogeneity in values and preferences across both individuals (see, e.g. Guiso and Paiella, 2008; Beauchamp et al. 2011), and world regions (see, e.g. Inglehart et al. 2000). Preference heterogeneity has also become a salient issue in mainstream macroeconomics. For instance, Krusell and Smith (1998), Coen-Pirani (2004), De Nardi (2004), Guvenen (2006), Hendricks (2007), and Cozzi (2011) have argued that individual variation in

[1] "It is, of course, not my aim to substitute for a one-sided materialistic an equally one-sided spiritualistic causal interpretation of culture and of history" (Weber, 1905, p. 183).

preferences is necessary for calibrated macroeconomic models with incomplete markets to reproduce the large wealth inequality observed in the data.

Preference heterogeneity as such is not in conflict with the neoclassical paradigm. Traditionally, extra-economic factors have served as the motivations for error terms in regressions and individual or regional fixed effects. However, treating preferences and culture as exogenous factors in growth and development theory is problematic if, on the one hand, cultural factors respond to changes in the economic and institutional environment (see Alesina and Glaeser, 2004; Alesina and Giuliano, 2009), and, on the other hand, culture and preferences have an important feedback on institutions and economic performance (see Greif, 1994; Grosjean, 2013; Guiso et al. 2006; Gorodnichenko and Gerard, 2010; Tabellini, 2010).

Motivated by these observations, a growing number of studies incorporate endogenous cultural change into economic models.[2] A particularly important link is the one connecting preferences, culture, and innovation (see Mokyr, 2011). In many recent models of endogenous technical change, innovation and economic growth ultimately are determined by policy and preference parameters, such as the time discount rate and risk aversion. Yet, there is a lack of studies of the joint determination of preferences and technology. A key issue is the extent to which different societies differ in terms of the average propensity of their citizens to carry out entrepreneurial or innovative activities. This is the focus of the investigation of this chapter.

To this aim, we present a model of endogenous technical change where growth is driven by the innovative activity of entrepreneurs. The focal point of the analysis is the occupational choice between being a worker and being an entrepreneur in an economy with capital market imperfections. Entrepreneurs face more risk and make investments that force them to defer consumption. As a consequence, the occupational choice hinges on patience and risk tolerance. These preference traits are distributed heterogeneously in the population and subject to the influence of family upbringing. Cultural transmission is driven by the desire of parents to maximize their children's happiness, conditional on the expectations they hold about the children's future occupation. Parents expecting their children to become entrepreneurs have stronger incentives to raise them to be patient and risk tolerant.

At the aggregate level, the growth rate of the economy depends on the fraction of entrepreneurs in the population, since this determines the rate of technological innovation. The theory identifies a self-reinforcing mechanism linking preferences and growth. In a highly entrepreneurial society, a large proportion of the population is patient and risk tolerant. These preferences sustain high human capital investment and risky innovation, leading to a high growth rate and incentives for entrepreneurial preferences to develop

[2] The recent literature in behavioral economics has proposed a psychological foundation for endogenous preferences. Fehr and Hoff (2011) argue that individual preferences are susceptible to institutional, familiar, and social influences due to their intrinsic psychological properties.

in the next generation, too. Societies with identical primitives may end up in different balanced growth paths characterized by different degrees of entrepreneurial culture, innovativeness, and growth. In addition, changes in institutions or policies can feed back into the evolution of culture and preferences, giving rise to potentially long-lasting effects on economic growth and development.

This chapter is organized as follows. Section 1.2 presents a model of endogenous technical change with an occupational choice, where entrepreneurship is the driver of innovation. Sections 1.3 and 1.4 endogenize culture and preference transmission analyzing, respectively, the endogenous accumulation of patience and risk tolerance. While in Sections 1.3 and 1.4 the cultural transmission of preferences hinges on an altruistic Beckerian motive, Section 1.5 considers an alternative model incorporating parental paternalism. Section 1.6 reviews the existing theoretical and empirical literature. Section 1.7 concludes. Proofs of propositions and lemmas are deferred to the mathematical appendix.

1.2. A FRAMEWORK FOR ANALYZING THE INTERACTION OF CULTURAL PREFERENCES, ENTREPRENEURSHIP, AND GROWTH

In this section, we develop a dynamic model where culture and economic growth are jointly determined in equilibrium. The underlying process of technical change is related to the model of Romer (1990), where growth takes the form of an expanding variety of inputs. However, unlike Romer we assume that innovation is driven by a specific group of people, namely entrepreneurs, whose economic lives (for example, in terms of risk and lifetime consumption profiles) are distinct from those of ordinary workers. Cultural preferences determine people's propensity to entrepreneurship, and conversely the return to entrepreneurship affects parents' incentives for forming their children's preferences. In other words, there is a two-way interaction between culture and growth. In this section, we develop the general setup, turning to specific dimensions of endogenous preferences further below.

1.2.1 A Model of Endogenous Innovation

Consider an endogenous growth model where innovation takes the form of an increasing variety of intermediate inputs. New inputs are created by people in a specific occupation, namely entrepreneurs (as in Klasing, 2012). Innovative activity has two key features: it involves investments and deferred rewards (as in Doepke and Zilibotti, 2008), and it may also involve risk (as in Doepke and Zilibotti, 2012 and Klasing, 2012). In addition, financial markets are incomplete: agents can neither borrow to smooth consumption over the life cycle, nor hedge the entrepreneurial risk.[3] Since entrepreneurs and regular workers face

[3] While these assumptions are stark, models with moral hazard typically imply imperfect consumption smoothing or risk sharing. Empirically, we observe that entrepreneurs can neither borrow without

different consumption profiles (across both time and states of nature), the choice between these two occupations hinges on heterogeneous cultural preferences.

The measure of the intermediate input varieties invented before the start of period t is denoted by N_t. Time is discrete. Final output at time t is produced using the production function:

$$Y_t = \frac{1}{\alpha}\left(\int_0^{N_t} \bar{x}_t(i)^\alpha \, di + \int_{N_t}^{N_{t+1}} x_t(i)^\alpha \, di\right) Q^{1-\alpha},$$

where Q is a fixed factor (e.g. land or unskilled labor) that will be normalized to unity; $\bar{x}_t(i)$ is the supply of intermediates i that were invented up until time t; and $x_t(i)$ is the supply of new varieties i invented during period t. Following Matsuyama (1999), we assume that old varieties with $i \in [0, N_t]$ are sold in competitive markets, whereas new varieties $i \in (N_t, N_{t+1}]$ are supplied monopolistically by their inventors. Put differently, inventors enjoy patent protection for only one period.

Innovation (i.e. the introduction of $N_{t+1} - N_t$ new varieties) is carried out by entrepreneurs. The return to entrepreneurial effort is assumed to be stochastic. In particular, entrepreneurs do not know in advance how successful they will be at inventing new varieties. With probability $\kappa > 0$ an entrepreneur will be able to run $(1 + \nu) N_t$ projects, whereas with probability $1-\kappa$ he or she will manage only $\left(1 - \nu\frac{\kappa}{1-\kappa}\right) N_t$ projects, where $\nu \geq 0$. In the aggregate, κ is the fraction of successful entrepreneurs. Intermediate-good production is instead carried out by workers using a linear technology that is not subject to uncertainty.

In order for the equilibrium to feature balanced growth, we assume that a knowledge spillover increases the productivity of both workers and entrepreneurs as knowledge accumulates. More precisely, productivity is indexed by N_t, and thus grows at the equilibrium rate of innovation. Given these assumptions, the labor market-clearing condition at time t is given by:

$$N_t X_t^W = N_t \bar{x}_t + (N_{t+1} - N_t)\, x_t,$$

where the left-hand side is the labor supply by workers in efficiency units, and the right-hand side is the labor demand given the production of intermediates $\bar{x}_t$ and x_t.[4] The corresponding market-clearing condition for entrepreneurs is:

$$N_t X_t^E = \left(\frac{N_{t+1} - N_t}{\xi}\right),$$

where X_t^E is the number of entrepreneurs, and the parameter ξ captures the average productivity per efficiency unit of entrepreneurial input in innovation. Hence, an efficiency unit of the entrepreneurial input produces measure ξ of new varieties. Denoting

constraints to finance their investments, nor separate their personal economic success from the fate of their enterprises. Thus, our stylized model captures some important features of the real world that are well-understood outcomes of models of imperfect information.

[4] Note that the market-clearing expression is written under the assumption that all old varieties $i \in [0, N_t]$ are supplied at the same level, $\bar{x}_t$, and that all new varieties $i \in (N_t, N_{t+1}]$ are supplied at the same level, x_t. We show later that this the case in equilibrium.

the growth rate of technology by $g_t \equiv (N_{t+1} - N_t)/N_t$ allows us to simplify the two market-clearing conditions as follows:

$$X_t^W = \bar{x}_t + g_t x_t, \tag{1.1}$$

$$X_t^E = \frac{g_t}{\xi}. \tag{1.2}$$

We now turn to the goods-market equilibrium. The representative competitive final-good producer maximizes profits by solving:

$$\max_{\bar{x}(i),x(i)} \left\{ \frac{1}{\alpha} \left(\int_0^{N_t} [\bar{x}_t(i)^\alpha - \alpha \bar{p}_t(i)\bar{x}_t(i)]di + \int_{N_t}^{N_{t+1}} [x_t(i)^\alpha - \alpha p_t(i) x_t(i)]di \right) \right\},$$

where $\bar{p}_t(i)$ and $p_t(i)$ are the prices of old and new intermediates, respectively.[5] The first-order conditions for the maximization problem imply:

$$\bar{x}_t(i) = \bar{p}_t(i)^{\frac{1}{\alpha-1}} \quad \text{and} \quad x_t(i) = p_t(i)^{\frac{1}{\alpha-1}}. \tag{1.3}$$

Next, we consider the intermediate-goods producers. Let w_t^W denote the market wage of workers, and let $\omega_t^W = w_t^W / N_t$ denote the wage per efficiency unit of labor. The maximization problem for the competitive producers of old intermediates with $i \in [0, N_t]$ can then be written as:

$$\max_{\bar{x}_t(i)} \left\{ \left(\bar{p}_t(i) - \omega_t^W \right) \bar{x}_t(i) \right\},$$

so that we have $\bar{p}_t(i) = \omega_t^W$ and, hence:

$$\bar{x}_t(i) = \left(\omega_t^W \right)^{\frac{1}{\alpha-1}}. \tag{1.4}$$

The producers of new goods (i.e. the firms run by entrepreneurs) are monopolists that maximize profits subject to the demand function (1.3). More formally, they solve:

$$\max_{x_t(i),p_t(i)} \left\{ \left(p_t(i) - \omega_t^W \right) x_t(i) \right\}$$

subject to (1.3). The solution to this problem yields:

$$p_t(i) = \frac{\omega_t^W}{\alpha} \equiv p_t, \tag{1.5}$$

$$x_t(i) = \left(\frac{\omega_t^W}{\alpha} \right)^{\frac{1}{\alpha-1}} \equiv x_t, \tag{1.6}$$

[5] The fixed factor $Q = 1$ is owned by firms, so that profits correspond to the return to the fixed factor. For simplicity, we assume that firms are held by "capitalist" dynasties that are distinct from the workers and entrepreneurs, although allowing for trade in firm shares would not change our results.

and the realized profit per variety is:

$$\Pi_t = \left(p_t - \omega_t^W\right) x_t = (1-\alpha)\left(\frac{\alpha}{\omega_t^W}\right)^{\frac{\alpha}{1-\alpha}}.$$

We can now solve for the equilibrium return to labor and entrepreneurship as functions of the aggregate supply of regular and entrepreneurial labor. First, combining (1.1), (1.4), and (1.6) yields:

$$X_t^W = \left(\omega_t^W\right)^{\frac{1}{\alpha-1}} + g_t\left(\frac{\omega_t^W}{\alpha}\right)^{\frac{1}{\alpha-1}}.$$

Using (1.2) to eliminate g_t, and rearranging terms, yields the following expression for the workers' normalized wage:

$$\omega_t^W = \left(\frac{1+g_t\alpha^{\frac{1}{1-\alpha}}}{X_t^W}\right)^{1-\alpha} = \left(\frac{1+\alpha^{\frac{1}{1-\alpha}}\xi X_t^E}{X_t^W}\right)^{1-\alpha}.$$

Next, denote by w_t^E the expected profit of entrepreneurs, and let $\omega_t^E = w_t^E/N_t$.[6] Then, the following expression for the return to entrepreneurship obtains:

$$\omega_t^E = \xi\Pi_t = \xi^{1-\alpha}(1-\alpha)\left(\frac{\alpha^{\frac{1}{1-\alpha}}\xi X_t^W}{1+\alpha^{\frac{1}{1-\alpha}}\xi X_t^E}\right)^{\alpha}.$$

Finally, let $\eta_t \equiv w_t^E/w_t^W$ denote the expected entrepreneurial premium. Taking the ratio between the expressions of the two returns obtained above yields:

$$\eta_t = \frac{(1-\alpha)\,\alpha^{\frac{\alpha}{1-\alpha}}\xi X_t^W}{1+\alpha^{\frac{1}{1-\alpha}}\xi X_t^E}. \tag{1.7}$$

Innovation and growth are ultimately pinned down by the share of the population choosing entrepreneurship. The occupational choice, in turn, hinges on both technological variables and the endogenous distribution of individual preferences. We therefore turn, next, to the structure of preferences in the economy.

1.2.2 Demographics and Structure of Preferences

The model economy is populated by overlapping generations of altruistic people who live for two periods. Every person has one child, and a measure one of people is born each period. The lifetime utility V_t of a person born at time t is given by:

$$V_t = \chi U(c_{1,t}) + \beta U(c_{2,t}) + zV_{t+1}, \tag{1.8}$$

[6] Recall that the entrepreneurial return is stochastic. Each entrepreneur earns $(1+\nu)\,w_t^E$ with probability κ and $\left(1-\nu\frac{\kappa}{1-\kappa}\right)w_t^E$ with probability $1-\kappa$.

where $c_{1,t}$ is consumption when young, $c_{2,t}$ is consumption when old, and V_{t+1} is the lifetime utility of the person's child. Preferences are pinned down by the shape of the period utility function $U(\cdot)$ and by the weights χ, β, and z attached to young-age consumption, old-age consumption, and the utility of the child, respectively. Below, we endogenize the determination (via intergenerational transmission) of specific preference parameters. More specifically, we assume that people can shape certain aspects of their children's preferences, but cannot change their own preferences. Economic decisions within a generation are taken therefore for fixed preference parameters. This feature allows us to discuss economic choices and preference transmission separately.

People have one unit of time in each period. When young, they make a career choice between being workers or being entrepreneurs. Workers supply one unit of labor to the labor market in each period. Entrepreneurs supply a fraction ψ of their time to the labor market when young, and use the remainder $1-\psi$ for human capital investment.[7] When old, entrepreneurs use all their time for innovating, with a return to innovation as described in Section 1.2.1.

As generations overlap, at time t labor is supplied by the people born in periods $t-1$ and t. Let λ_t denote the fraction of entrepreneurs in the generation born at time t. Then, aggregate labor supply at time t is given by:

$$X_t^W = 1 - \lambda_t + \lambda_t \psi + 1 - \lambda_{t-1}, \tag{1.9}$$

namely, it is the sum of labor supply by young workers, young entrepreneurs, and old workers. The supply of entrepreneurial input is given by the labor supply of old entrepreneurs:

$$X_t^E = \lambda_{t-1}. \tag{1.10}$$

Equations (1.2) and (1.10) imply that the growth rate of the economy is given by $g_t = \lambda_{t-1}\xi$.

1.2.3 Balanced Growth Path for Fixed Preferences

To establish a benchmark, we first analyze balanced growth paths for the case of fixed preferences. That is, parents do not affect their children's preferences, and the preference parameters χ, β, and z, as well as the $U(\cdot)$ function are fixed. For simplicity, we focus initially on the case where entrepreneurship is not risky, $\nu = 0$. In a balanced growth path, the growth rates of output and consumption are constant, as is the fraction of the population comprised of entrepreneurs. This balanced growth path requires that preferences feature a constant intertemporal elasticity of substitution, so that period utility

[7] Other ways of modeling the cost of becoming an entrepreneur would yield similar results as long as the cost results in lower utility at young age, and therefore has the characteristic of an investment.

is given by:

$$U(c) = \frac{c^{1-\sigma}}{1-\sigma}.$$

We restrict attention to the case $0 \leq \sigma < 1$, because the analysis of the economy with endogenous preferences will require utility to be positive (although this can be generalized, see Doepke and Zilibotti, 2008). We also impose the following restriction:

$$(1+\xi)^{1-\sigma} z < 1,$$

which guarantees that discounted utility is well defined.

Given that with fixed preferences everyone's preferences are the same, the key condition for a balanced growth path with a positive growth rate is that the entrepreneurial premium, η, makes people just indifferent between being workers and being entrepreneurs.[8] The indifference condition for people born at time t can be written as:

$$\chi u\left(w_t^W\right) + \beta u\left(w_{t+1}^W\right) + zV_{t+1} = \chi u\left(\psi w_t^W\right) + \beta u\left(w_{t+1}^E\right) + zV_{t+1},$$

where the left-hand side is the utility of workers and the right-hand side is the utility of entrepreneurs. Note that the utility derived from children is identical for both occupations, and therefore does not feature in the indifference condition. In a balanced growth path, wages and entrepreneurial returns are given by $w_t^W = N_t \omega^W$ and $w_t^E = N_t \omega^E$, respectively, where ω^W and ω^E are constants and N_t grows at the constant rate g. Canceling common terms allows us to rewrite the indifference condition in this form involving only variables that are constant in the balanced growth path:

$$\chi \frac{\left(\omega^W\right)^{1-\sigma}}{1-\sigma} + \beta \frac{((1+g)\omega^W)^{1-\sigma}}{1-\sigma} = \chi \frac{(\psi \omega^W)^{1-\sigma}}{1-\sigma} + \beta \frac{((1+g)\omega^E)^{1-\sigma}}{1-\sigma}. \tag{1.11}$$

Condition (1.11) can be further simplified by dividing both sides of the equality by $(\omega^W)^{1-\sigma}$, and rewriting it in terms of the entrepreneurial premium $\eta = \omega^E/\omega^W$:

$$\chi + \beta(1+g)^{1-\sigma} = \chi(\psi)^{1-\sigma} + \beta((1+g)\eta)^{1-\sigma}. \tag{1.12}$$

Next, consider the expression for the entrepreneurial premium, (1.7). Plugging in the balanced growth levels of X^W and X^E from (1.9) and (1.10), we can express the premium as a function of the fraction of entrepreneurs, λ:

$$\eta = (1-\alpha)\,\alpha^{\frac{\alpha}{1-\alpha}}\xi \frac{2-(2-\psi)\lambda}{1+\alpha^{\frac{1}{1-\alpha}}\xi\lambda}. \tag{1.13}$$

[8] The analysis here applies to interior balanced growth paths where positive proportions of agents choose either occupation, worker, or entrepreneur. More discussion is provided below.

Combining (1.12) and (1.13), recalling that $g = \lambda\xi$, and rearranging terms yields:

$$\chi\left(1 - (\psi)^{1-\sigma}\right) = \beta(1+\lambda\xi)^{1-\sigma}\left(\left((1-\alpha)\,\alpha^{\frac{\alpha}{1-\alpha}}\xi\,\frac{2-(2-\psi)\lambda}{1+\alpha^{\frac{1}{1-\alpha}}\xi\lambda}\right)^{1-\sigma} - 1\right). \quad (1.14)$$

Here the left-hand side is the (normalized) cost of becoming an entrepreneur in terms of forgone utility when young, and the right-hand side is the (normalized) benefit in terms of higher utility when old. Equation (1.14) pins down the equilibrium fraction of entrepreneurs, λ, which in turn determines the entrepreneurial premium and the rate of economic growth.

Depending on parameters, there can be corner solutions with $\lambda = 0$ or $\lambda = 1$, i.e. there aren't any entrepreneurs or all old agents are entrepreneurs. In addition, the balanced growth path need not be unique. The reason is that on the one hand an increase in the fraction of entrepreneurs lowers the entrepreneurial premium (making entrepreneurship less attractive), but on the other hand it also increases the growth rate (making entrepreneurship, where higher rewards occur later in life, relatively more attractive). To provide a sharp contrast with the case of endogenous preferences, we will focus on parameter configurations where the balanced growth path for fixed preferences is both interior and unique.

Assumption 1. The parameters α, ξ, and ψ satisfy:

$$2\,(1-\alpha)\,\alpha^{\frac{\alpha}{1-\alpha}}\xi > 1 > \frac{(1-\alpha)\,\alpha^{\frac{\alpha}{1-\alpha}}\xi\psi}{1+\alpha^{\frac{1}{1-\alpha}}\xi}.$$

Proposition 1. *Under Assumption 1, there exists a* $\bar{\chi}(\alpha,\xi,\psi) > 0$ *such that for all* $\chi < \bar{\chi}(\alpha,\xi,\psi)$ *a unique interior balanced growth equilibrium exists, i.e. there is a unique* $\lambda \in (0,1)$ *that satisfies Equation (1.14).*

1.3. ENDOGENOUS CULTURE I: WEBER AND THE TRANSMISSION OF PATIENCE

The balanced growth analysis in the previous section shows that the growth rate in our economy is determined by both technology parameters (such as the efficiency of the innovation technology ξ) and preference parameters (such as the time discount factor β). Despite this fact, when using similar growth models to address variations in economic growth across time and space, the literature has typically focused on variations in technology as the driving force. Unlike technology, preferences usually are assumed to be exogenous. Deviating from this practice, we now endogenize preferences, and analyze the interaction of preference formation with technology, occupational choice, and ultimately, economic growth.

1.3.1 Endogenizing Patience

We start by focusing on patience, parameterized by the time discount factor β. Since risk is not important for the analysis in this section, we abstract from uncertainty and assume that $\nu = 0$. Adult agents in period t are endowed with a predetermined discount factor, β_t, but they can affect the discount factor of their children, β_{t+1}. For example, in their children's upbringing parents can emphasize the appreciation of future rewards. Given that we assume $\sigma < 1$, a higher β always yields higher utility. However, investing in children's patience is costly, so parents face a tradeoff. More precisely, denoting by l_t the effort a parent of generation t spends on raising her child's patience, the parent's discounted utility is:

$$\chi(l_t)\frac{c_{t,1}^{1-\sigma}}{1-\sigma} + \beta_t \frac{c_{t,2}^{1-\sigma}}{1-\sigma} + zV_{t+1}(\beta_{t+1}(l_t)),$$

where χ is a strictly decreasing, strictly concave, and differentiable function, and effort is bounded by $0 \leq l_t \leq 1$. The structure of preferences is still of the form given in (1.8), although χ and β are now endogenous variables rather than given parameters. The child's patience is given by:

$$\beta_{t+1}(l_t) = (1-\delta)\beta_t + f(l_t), \tag{1.15}$$

where f is an increasing, non-negative, and strictly concave function, and δ satisfies $0 < \delta \leq 1$. Notice that if $\delta < 1$ there is some direct persistence in preferences across generations, which captures children's imitation of their parents and other transmission channels that do not require direct parental effort. In addition to this direct transmission, the function $f(l_t)$ captures the return to parental effort in terms of increasing the child's patience.

1.3.2 Transmission of Patience in the Balanced Growth Path

We now characterize balanced growth paths with endogenous patience. People face a twofold decision problem. First, when young they choose whether to be workers or become entrepreneurs. This decision hinges only on returns within the person's lifetime, and much of the previous analysis for fixed preferences still applies. Second, people choose the investment l_t in instilling patience in their children.

We proceed by analyzing the individual decision problem under the assumption that a balanced growth path has already been reached, so that the entrepreneurial premium is constant, and wages and profits grow at the constant rate g. The decision problem can be analyzed recursively, with the discount factor β serving as the state variable of a dynasty. In principle, the state of technology N_t is a second state variable, because growth in N_t scales up all wages and returns. However, due to the homothetic utility function, in a balanced growth path utility at time t can be expressed as:

$$V_t(\beta_t, N_t) = \left(\frac{N_t w_0^W}{N_0}\right)^{1-\sigma} v(\beta_t),$$

where v is a value function that does not depend on N_t and is scaled so that it gives utility conditional on the worker's wage being equal to one. This value function, in turn, satisfies the following set of Bellman equations:

$$v(\beta) = \max \left\{ v^W(\beta), v^E(\beta) \right\}, \tag{1.16}$$

where:

$$v^W(\beta) = \max_{0 \leq l \leq 1} \left\{ \chi(l) + \beta (1+g)^{1-\sigma} + z (1+g)^{1-\sigma} v(\beta') \right\}, \tag{1.17}$$

$$v^E(\beta) = \max_{0 \leq l \leq 1} \left\{ \chi(l) \psi^{1-\sigma} + \beta ((1+g)\eta)^{1-\sigma} + z (1+g)^{1-\sigma} v(\beta') \right\}. \tag{1.18}$$

The maximization in (1.17) and (1.18) is subject to the law of motion for patience across generations:

$$\beta' = (1-\delta)\beta + f(l). \tag{1.19}$$

The Bellman equations (1.17) and (1.18) represent the utilities conditional on choosing to be a worker or an entrepreneur, respectively, and (1.16) captures the optimal choice between these two careers.

Given our assumptions on f and l, there is a maximum level of patience, $\beta_{\max}$, that can be attained. The decision problem is therefore a dynamic programming problem with a single state variable in the interval $[0, \beta_{\max}]$, and can be analyzed using standard techniques. The following proposition summarizes the properties of the value function and the associated policy functions for investing in patience and for choosing an occupation.

Proposition 2. *The system of Bellman equations* (1.16)–(1.18) *has a unique solution. The value function v is increasing and convex in β. The optimal occupational choice is either to be a worker for any β, or there exists a $\bar{\beta}$ such that impatient people with $\beta < \bar{\beta}$ strictly prefer to be workers, patient people with $\beta > \bar{\beta}$ strictly prefer to be entrepreneurs, and people with $\beta = \bar{\beta}$ are indifferent. The optimal investment in patience $l = l(\beta)$ is non-decreasing in β.*

The proof of the proposition is contained in the mathematical appendix. The convexity of the value function follows from two features of the decision problem: the discount factor enters utility linearly, and there is a complementarity between being patient and being an entrepreneur.

To gain intuition, consider the decision problem without the occupational choice, i.e. assume that all members of a dynasty are forced to be either workers or entrepreneurs regardless of their patience. If we vary the discount factor β of the initial generation, while holding constant the investment choices l of all generations, the utility of the initial generation is a linear increasing function of β. This is because initial utility is a linear function of present and future discount factors, and the initial discount factor, in turn, has a linear effect on future discount factors through the term $1-\delta$ in the law of motion (1.19). In addition, if the occupation of all generations is held constant, it is in fact optimal to choose a constant l for all β, because the marginal return to investing in patience depends only on the choice of occupation, and not on β.

Now consider the full model with a choice between the two occupations. The career with the steeper income profile, namely entrepreneurship, is more attractive when β is high. As we increase β, each time either a current or future member of the dynasty switches from being a worker to being an entrepreneur, the value function also becomes steeper in β. The optimal l increases at each step, because the cost of providing patience declines with the steepness of the income profile, while the marginal benefit increases. Since there are only two possible occupations, the value function is piecewise linear, where the linear segments correspond to ranges of β for which the optimally chosen present and future occupations are constant. At each kink of the value function, some member of the dynasty is indifferent between being a worker and an entrepreneur. Since the choice of l depends on the chosen occupation, there may be multiple optimal choices l at a β where the value function has a kink, whereas in between kinks the optimal choice of l is unique. The following proposition summarizes our results regarding the optimal choice of income profiles and investment in patience.

Proposition 3. *The state space $[0, \beta_{\max}]$ can be subdivided into (at most) countably many closed intervals $[\underline{\beta}, \overline{\beta}]$ such that over the interior of any range $[\underline{\beta}, \overline{\beta}]$, the occupational choice of each member of the dynasty (i.e. parent, child, grandchild, and so on) is constant and unique (though possibly different across generations), and $l(\beta)$ is constant and single-valued. The value function $v(\beta)$ is piecewise linear, where each interval $[\underline{\beta}, \overline{\beta}]$ corresponds to a linear segment. Each kink in the value function corresponds to a switch, from being a worker to being an entrepreneur, by a present or future member of the dynasty. At a kink, the optimal choices of occupation and l corresponding to both adjoining intervals are optimal (thus, the optimal policy functions are not single-valued at a kink).*

The proposition implies that the optimal policy correspondence $l(\beta)$ is a non-decreasing step-function, which takes multiple values only at a step. Proposition 3 allows us to characterize the equilibrium law of motion for patience. Since the policy correspondence $l(\beta)$ is monotone, the dynamics of β are monotone as well and converge to a steady state from any initial condition.

Proposition 4. *The law of motion of β is described by the following difference equation:*

$$\beta' = g(\beta) = (1 - \delta)\,\beta + f\,(l\,(\beta))\,,$$

where $l(\beta)$ is a non-decreasing step-function (as described in Proposition 3). Given an initial condition β_0, patience in the dynasty converges to a constant β where parents and children choose the same profession.

Notice that while the discount factor of a dynasty always converges, the steady state does not have to be unique even for a given β_0. For example, if the initial generation is indifferent between the two occupations, the steady state can depend on which one is chosen.

Given the optimal occupational choices of parents and children, the optimal choice of l has to satisfy first-order conditions. This allows us to characterize more sharply the decisions on patience and their interaction with occupational choices. We have already established that both patience β and occupation converge within a dynasty. Thus, the population ultimately divides into worker dynasties and entrepreneur dynasties, and these two types face different incentives for investing in patience. Consider the case in which the solutions for l are interior. For workers, the first-order condition characterizing the optimal effort l^W for investing in patience is given by:

$$-\chi'(l^W) = \frac{z(1+g)^{2(1-\sigma)} f'(l^W)}{1 - z(1+g)^{1-\sigma}(1-\delta)}. \tag{1.20}$$

The corresponding condition for entrepreneurial dynasties is given by:

$$-\chi'(l^E)\psi^{1-\sigma} = \frac{z(1+g)^{2(1-\sigma)} \eta^{1-\sigma} f'(l^E)}{1 - z(1+g)^{1-\sigma}(1-\delta)}. \tag{1.21}$$

In both equations, the left-hand side is strictly increasing in l, and the right-hand side is strictly decreasing. Moreover, for a given l the left-hand side is smaller for entrepreneurial dynasties, and the right-hand side is larger. Therefore, in the balanced growth path we must have $l^E > l^W$: The returns to being patient are higher for entrepreneurs because of their steeper income profile, inducing them to invest more in patience. In the balanced growth path, we therefore also have $\beta^E > \beta^W$, where:

$$\beta^W = \frac{f(l^W)}{\delta},$$
$$\beta^E = \frac{f(l^E)}{\delta}.$$

These findings line up with Max Weber's (1905) view of entrepreneurs as future-oriented individuals who possess a "spirit of capitalism". However, in our theory, differences in patience are not just a determinant of occupational choice (as in Weber), but also a consequence of it. Entrepreneurial dynasties develop patience because of the complementarity between this preference trait and their occupation. In contrast, Weber focused on religion as a key determinant of values and preferences across social groups.

Figure 1.1 provides an example of the characteristics of the value and policy functions analyzed in Propositions 2 and 3.[9] In the example, the value function has two linear segments. Below the threshold of $\beta = 0.65$, the optimal choice is to become a worker, and investment in patience in this range is such that all subsequent generations are workers too. Thus, investment in patience is constant over this range, as displayed in the lower panel. Above the threshold, the optimal choice for both the current and future generations

[9] The parametrization is as in the balanced growth computations in Section 1.3.3 with the equilibrium fraction of entrepreneurs given by $\lambda = 0.35$.

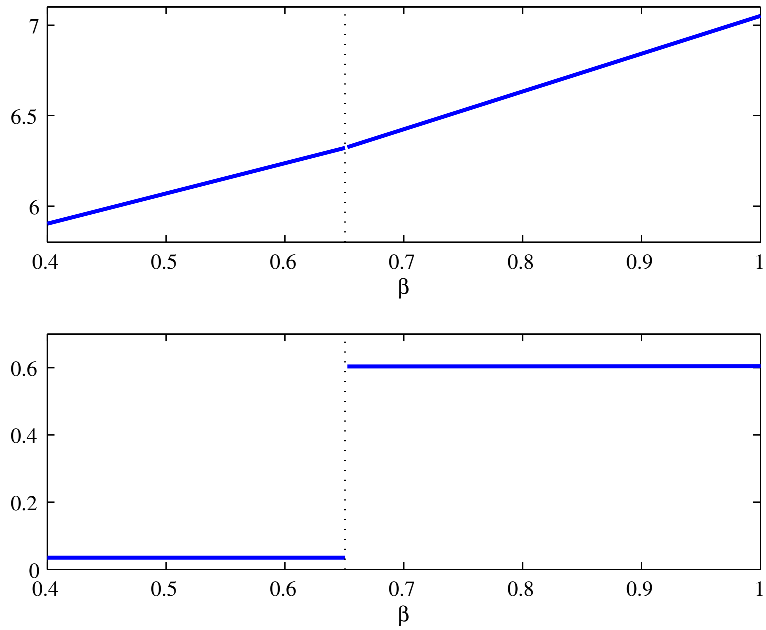

Figure 1.1 Example of value function (upper panel) and policy function for *I* (lower panel).

is to become entrepreneurs. Consequently, investment in patience is constant over this range as well, but considerably higher compared to worker dynasties. The value function has a kink at $\beta = 0.65$ and becomes steeper, because the return to patience is higher for entrepreneurs given their steeper lifetime income profiles. The differential investment results in a substantial gap in patience across occupations in the balanced growth path, with a discount factor $\beta^W = 0.55$ for workers, and $\beta^E = 0.95$ for entrepreneurs.

1.3.3 Multiplicity of Balanced Growth Paths with Endogenous Patience

Given the preceding analysis, it is clear that there is no balanced growth path in which all dynasties have identical preferences, and in which there are positive fractions of both entrepreneurs and workers. The reason is that the entrepreneurs have a steeper income profile, given the need to acquire skills when young and the entrepreneurial return that is received when old. This steeper income profile implies that parents of entrepreneurs have a higher incentive to invest in patience compared to parents of workers. Moreover, in any given period the population will sort such that the more patient individuals become entrepreneurs and the less patient become workers. Finally, because of persistence of patience within dynasties, occupations also will be persistent within dynasties.

Hence, a balanced growth path has the property that the two groups are characterized by different preferences, patient entrepreneurs and impatient workers. Given the patience gap between these groups, at least one of them will strictly prefer their own occupation over the alternative, both for themselves and for their children. In fact, generically there exists a continuum of balanced growth path where both workers and entrepreneurs strictly prefer their own occupation, and where the fraction of entrepreneurs, the entrepreneurial premium, and the equilibrium growth rate vary across growth paths. For given parameters, the balanced growth path that is reached depends on initial conditions. More generally, the multiplicity of balanced growth paths opens up the possibility of history dependence and a persistent impact of policies or institutions on the performance of an economy.

To illustrate these results, we focus on the case where preferences are not persistent, $\delta = 1$. We would like to characterize the set of balanced growth paths in terms of the growth rate g, the entrepreneurial premium η, and the patience levels β^W and β^E of workers and entrepreneurs. From (1.20) and (1.21), we know that the investments in patience l^W and l^E by workers and entrepreneurs have to satisfy:

$$-\chi'(l^W) = z(1+g)^{2(1-\sigma)} f'(l^W),$$
$$-\chi'(l^E)\psi^{1-\sigma} = z(1+g)^{2(1-\sigma)} \eta^{1-\sigma} f'(l^E),$$

and we have $\beta^W = f(l^W)$ and $\beta^E = f(l^E)$. Here, focusing on the $\delta = 1$ case implies that the choice of future patience depends only on today's occupational choice, but not directly on the current patience.

The balanced growth values of the value functions (1.17) and (1.18) are:

$$v^W = \frac{\chi(l^W) + \beta(1+g)^{1-\sigma}}{1 - z(1+g)^{1-\sigma}},$$
$$v^E = \frac{\chi(l^E)\psi^{1-\sigma} + \beta((1+g)\eta)^{1-\sigma}}{1 - z(1+g)^{1-\sigma}}.$$

In the balanced growth path, each group has to prefer their own occupation over the alternative, for the present generation and future descendants. In particular, there are four constraints to consider. The first is that a person with patience β^E prefers entrepreneurship for all members of the dynasty over everyone being a worker:

$$v^E \geq \chi(l^W) + \beta^E(1+g)^{1-\sigma} + z(1+g)^{1-\sigma} v^W. \tag{1.22}$$

The right-hand side has two components, because the first generation still has patience β^E, with all following generations in the deviation would have patience β^W. The second constraint is that entrepreneurship for all generations is preferred to the first generation being an entrepreneur, but all following generations switching to being workers. This constraint can be written as:

$$v^E \geq \chi(l^{EW})\psi^{1-\sigma} + \beta^E((1+g)\eta)^{1-\sigma} + z(1+g)^{1-\sigma}\left(\chi(l^W) + \beta^{EW}(1+g)^{1-\sigma}\right)$$
$$+ z^2(1+g)^{2(1-\sigma)} v^W. \tag{1.23}$$

Here l^{EW} and β^{EW} are the investment and patience level that are optimal given that path of occupational choices, characterized by:

$$-\chi'(l^{EW})\psi^{1-\sigma} = z(1+g)^{2(1-\sigma)}f'(l^{EW}).$$

and $\beta^{EW} = f(l^{EW})$. The parallel constraints for worker dynasties with patience β^{W} are given by:

$$\chi(l^{E})\psi^{1-\sigma} + \beta^{W}((1+g)\eta)^{1-\sigma} + z(1+g)^{1-\sigma}v^{E} \leq v^{w}. \tag{1.24}$$

and:

$$\begin{aligned}\chi(l^{WE}) + \beta^{W}(1+g)^{1-\sigma} + z(1+g)^{1-\sigma}\left(\chi(l^{E})\psi^{1-\sigma} + \beta^{WE}((1+g)\,\eta)^{1-\sigma}\right)\\ +z^{2}(1+g)^{2(1-\sigma)}v^{E} \leq v^{W},\end{aligned} \tag{1.25}$$

where l^{WE} and β^{WE} are characterized by:

$$-\chi'(l^{WE}) = z(1+g)^{2(1-\sigma)}\eta^{1-\sigma}f'(l^{WE}),$$

and $\beta^{WE} = f(l^{WE})$. It can now be shown that a continuum of balanced growth paths exists. Because of the gap in balanced growth preferences, when one occupational group is just indifferent between their occupation and the alternative, the other group strictly prefers their own occupation. It is therefore possible to raise the return of the indifferent group in some range so that both groups strictly prefer to stay in their own occupation. The potentially binding constraints are given by (1.23) and (1.25). The following lemma contains the main result underlying the multiplicity of balanced growth paths.

Lemma 1. *When the entrepreneurial premium η in the balanced growth path is such that* (1.23) *holds as an equality, then* (1.22), (1.24), and (1.25) *hold as strict inequalities.*

Building on this lemma, we can now establish the main result:

Proposition 5. *If there exists a balanced growth with path a fraction of entrepreneurs λ such that* $0 < \lambda < 1$*, there exists a continuum of additional balanced growth paths with different fractions of entrepreneurs and thus different growth rates.*

That is, there are multiple balanced growth paths unless the only feasible balanced growth path features a corner solution with all agents choosing the same profession.

We have focused on the $\delta = 1$ case for analytical convenience. When there is direct persistence in patience across generations ($\delta < 1$), the forces generating multiple balanced growth paths are strengthened even more, and generally a wider range of rates of entrepreneurship and economic growth can be long-run outcomes. Figure 1.2 illustrates this with a computed example. The parameter values used are as follows: $z = 0.5, \sigma = 0.5, \xi = 3, \alpha = 0.3, \psi = 0.5$. The cost function for investing in patience is given by $\chi(l) = 1 - l$, and the law of motion for patience is parameterized as:

$$\beta' = (1-\delta)\beta + \delta\tilde{\beta} + \theta_1 l^{\theta_2},$$

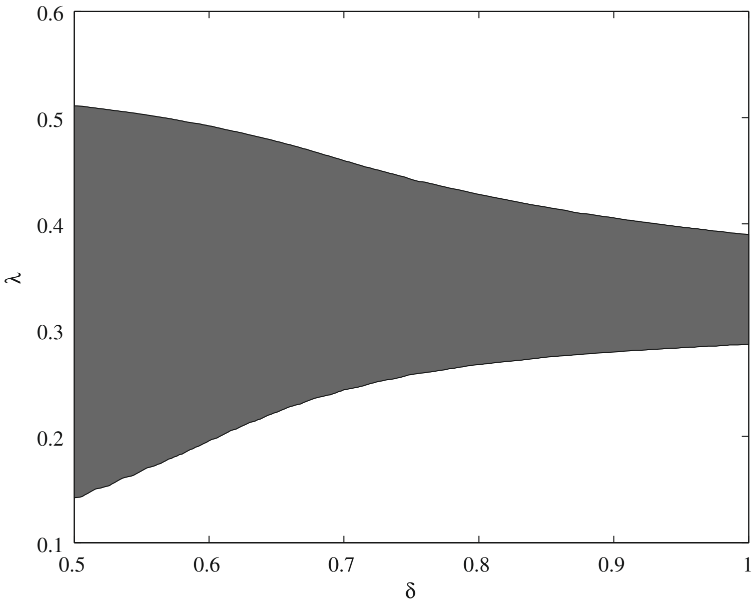

Figure 1.2 Range of balanced growth paths for different δ.

where we set $\tilde{\beta} = 0.5$ and $\theta_2 = 0.8$. We computed outcomes for a variety of values of the persistence parameter δ. For $\delta = 1$, we set $\theta_1 = 1$, and for lower δ the value of θ_1 is adjusted, to hold the impact of investing in patience on utility constant in the balanced growth path (so that changing δ does not lead to a level shift in patience).

For these parameters, Figure 1.2 plots the range for λ (the fraction of entrepreneurs in the population) that can be supported as a balanced growth path. At $\delta = 1$ (no direct persistence in patience across generations), the balanced growth level of λ varies between 0.29 and 0.39, which corresponds to growth rates (per generation) between $g = 0.87$ and $g = 1.27$, or, if a generation is interpreted to last 25 years, between 2.5 and 3.3% per year. As we lower δ and make patience more persistent, the range of balanced growth paths widens. At $\delta = 0.5$, λ can vary between 0.15 and 0.51 in the balanced growth path, which corresponds to annual growth rates between 1.5 and 3.8% per year.

Figure 1.3 demonstrates what the law of motion for patience looks like in the balanced growth path for different values of λ. In all panels, the persistence of patience is set to $\delta = 0.8$. In the top panel, we set $\lambda = 0.26$, which is close to the lowest fraction of entrepreneurs that can be sustained in a balanced growth path. In this growth path, the return to entrepreneurship is high. The law of motion for patience intersects the 45-degree line twice, where the lower intersection corresponds to the long-run patience of workers, and the higher intersection corresponds to entrepreneurs. Given high returns to entrepreneurship, dynasties that start out with patience that is only a little higher

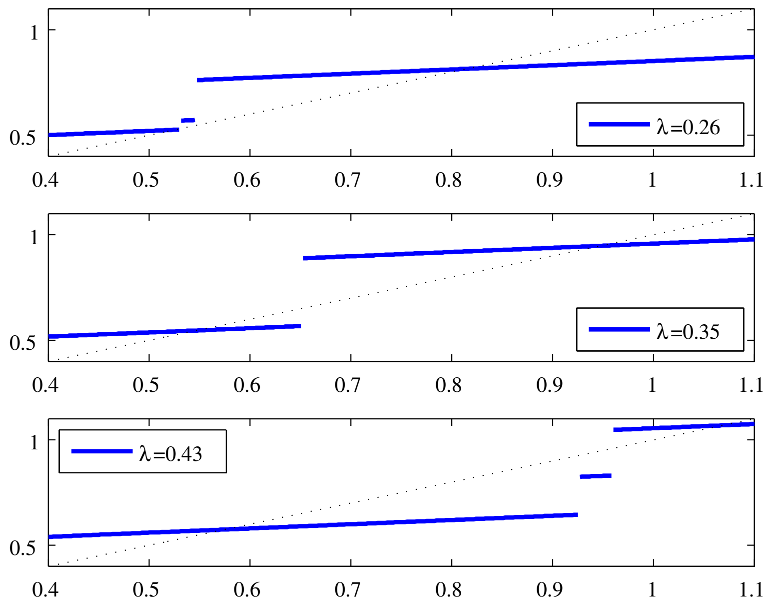

Figure 1.3 Laws of motion for β in balanced growth paths for $\delta = 0.8$ and different values of λ.

than the long-run patience of workers, ultimately converge to entrepreneurship. The law of motion has three linear segments, where the bottom one corresponds to worker dynasties and the top one to entrepreneur dynasties. The (small) middle segment pertains to dynasties where the current generation consists of workers who invest sufficiently in patience for all following generations to switch to entrepreneurship. In the middle panel, we set $\lambda = 0.35$. Here the law of motion has only two segments. All dynasties are either workers or entrepreneurs forever; there are no transitions between the occupations. The bottom panel for $\lambda = 0.43$ corresponds to a low return to entrepreneurship. The law of motion is a mirror image of the top panel. There are three segments, where the middle segment now corresponds to dynasties where the current generation consists of entrepreneurs, but all subsequent ones will be workers. Comparing across the levels of λ, it is apparent that as we move to higher levels of λ the long-run levels of patience (i.e. the intersections with the 45-degree line) increase both for workers and for entrepreneurs. This is because a higher λ implies a higher growth rate, which results in steeper income profiles for both professions, and thus more investment in patience.

1.3.4 Implications of Multiplicity of Balanced Growth Paths

Taken at face value, our finding of multiplicity of balanced growth paths implies that different economies, although characterized by identical technological parameters, can experience permanently different growth rates, driven by cultural differences across their populations. Of course, cultural differences themselves are endogenous in our theory. From this perspective, the theory suggests the possibility of path dependence, that is, a country's success at entrepreneurship and innovation may depend on the cultural and economic makeup of the country at the onset of modern economic growth. This theme is explored in more detail in Doepke and Zilibotti (2008), where we explicitly model the transition of an economy with endogenous preferences from a stagnant, pre-industrial economy to capital-driven growth. In that paper, the distribution of preferences at the onset of modern growth depends on the nature of pre-industrial occupations in terms of lifetime income profiles and the distribution of land ownership. Combining the approach of Doepke and Zilibotti (2008) with the theory outlined here would lead to the prediction that the nature of the pre-industrial economy can have long-term repercussions for economic development.

Another implication of multiplicity of balanced growth paths is that policies or institutions that affect preferences can have a long-term impact on economic growth. Consider a country that imposes high taxes on entrepreneurs or discourages entrepreneurship through other means, as in the centrally planned economies of Eastern Europe during the 20th century. Over time, such policies would shift the culture of the population toward being less future-oriented with a lower propensity for entrepreneurship. Consider now the transition of the economy when the political constraints on entrepreneurship are removed. We would expect to observe a small class of entrepreneurs gaining high returns, but lower rates of entrepreneurship and a lower rate of economic growth compared to a country undergoing a similar transition from more favorable initial cultural conditions.

The model can also be extended to allow for open economies. The simplest case is that of a world economy in which trade across borders is frictionless, so that all goods are traded at the same price, and workers and entrepreneurs get the same returns regardless of where they live. In such an environment, initial cross-country differences would manifest themselves in permanent differences in rates of entrepreneurship and innovation across countries, even though ultimately all countries would benefit from innovation (and experience the same growth rates) because of integrated markets.

1.3.5 The Model with Financial Markets

In the sections above, we showed that workers and entrepreneurs face different incentives for investing in patience, because entrepreneurs face a steeper income profile. However, the difference in the income profile would not matter if people could use financial markets to smooth consumption. A steep income profile directly translates into a steep utility profile only if financial markets are absent or incomplete.

To illustrate this point, consider the opposite extreme of perfect financial markets, i.e. people can borrow and lend at a fixed interest rate R subject to a lifetime budget constraint. For simplicity, we abstract from financial bequests. The only occupations that are chosen in equilibrium are now those that maximize the present value of income,

$\gamma_1 + \gamma_2/R$. Therefore, the lifetime returns of being a worker and being an entrepreneur have to be equalized:

$$\omega^W + \frac{(1+g)\omega^W}{R} = \psi\omega^W + \frac{(1+g)\omega^E}{R},$$

which implies that:

$$\eta = 1 + \frac{(1-\psi)\,R}{1+g} = 1 + \frac{(1-\psi)\,R}{1+\lambda\xi}.$$

The equilibrium condition (1.13) continues to hold, hence:

$$\eta = (1-\alpha)\,\alpha^{\frac{\alpha}{1-\alpha}}\,\xi\,\frac{2-(2-\psi)\lambda}{1+\alpha^{\frac{1}{1-\alpha}}\,\xi\,\lambda}.$$

Combining these equations yields a relationship between the proportion of entrepreneurs, λ(or, alternatively, the growth rate), and the market interest rate:

$$1 + \frac{(1-\psi)\,R}{1+g} = (1-\alpha)\,\alpha^{\frac{\alpha}{1-\alpha}}\,\frac{2\xi-(2-\psi)g}{1+\alpha^{\frac{1}{1-\alpha}}\,g}. \tag{1.26}$$

Since workers and entrepreneurs have the same lifetime income, it is sufficient to consider the individual saving decision of one group, e.g. the workers:

$$\max_s \frac{\left(\omega^W - s\right)^{1-\sigma}}{1-\sigma} + \frac{\beta}{\chi}\frac{\left(Rs + \omega^W\,(1+g)\right)^{1-\sigma}}{1-\sigma}.$$

The solution yields a standard Euler equation:

$$\frac{Rs + \omega^W\,(1+g)}{\omega^W - s} = \left(\frac{\beta}{\chi}R\right)^{\frac{1}{\sigma}}.$$

Hence, denoting by c^Y and c^O the consumption of the young and the old, respectively,

$$c^Y = \omega^W\,\frac{1+g+R}{R+\left(R\frac{\beta}{\chi}\right)^{\frac{1}{\sigma}}},$$

$$c^O = \left(R\frac{\beta}{\chi}\right)^{\frac{1}{\sigma}}\,\omega^W\,\frac{1+g+R}{R+\left(R\frac{\beta}{\chi}\right)^{\frac{1}{\sigma}}}.$$

Given this solution to the saving problem, the optimal investment in patience is given by:

$$l(\beta, g) = \underset{0\leq l\leq 1}{\operatorname{argmax}} \left\{ \left(\omega^W\right)^{1-\sigma} \left(\frac{1+g+R}{R + \left(R\frac{\beta}{\chi(l)}\right)^{\frac{1}{\sigma}}} \right)^{1-\sigma} \right.$$
$$\left. \left(\chi\left(l\right) + \beta \left(\frac{\beta}{\chi\left(l\right)} R \right)^{\frac{1-\sigma}{\sigma}} \right) + z\left(1+g\right)^{1-\sigma} v(\beta') \right\}.$$

The policy function, $l(\beta, g)$ determines the equilibrium law of motion of β, and hence the steady-state value of β. This is a function of g and R.

So far we have found two equilibrium conditions for three endogenous variables, g, β, and R. The model is closed by an asset market-clearing condition that pins down the interest rate. We assume that the young cannot borrow from the old, since the latter cannot obtain repayment within their lifetime. Hence, all borrowing and lending takes place between workers and entrepreneurs of a given cohort. The market-clearing condition then yields $s^W + s^E = 0$, or:

$$\left(R\frac{\beta}{\chi}\right)^{\frac{1}{\sigma}} - (1+g) + \psi \left(R\frac{\beta}{\chi}\right)^{\frac{1}{\sigma}} - \eta\,(1+g) = 0$$
$$\left(R\frac{\beta}{\chi}\right)^{\frac{1}{\sigma}} (1+\psi) = (1+g)\,(1+\eta)\,.$$

This is the third of the conditions that jointly pin down g, β, and R in the balanced growth path.

The next proposition summarizes our main findings for the model with a perfect market for borrowing and lending.

Proposition 6. *When a perfect market exists for borrowing and lending within generations, the only occupations that are chosen in equilibrium are those that maximize the present value of income. The set of optimal occupations is independent of patience β. If both occupations yield the same present value of income, investment in patience l is independent of which occupation is chosen.*

The intuition for this result is simple: with perfect borrowing and lending, every adult will choose the income profile that yields the highest present value of income, regardless of patience.[10] The proposition shows that at least some degree of financial market imperfection is necessary for occupational choice and investments in patience to be interlinked.

[10] In the model of the previous section, general equilibrium forces ensure that there exist equilibria with positive growth where both occupations yield the same present value of income.

A positive implication of this finding is that the degree of discount-factor heterogeneity in a population depends on the development of financial markets. In an economy where financial markets are absent, workers and entrepreneurs face very different incentives for investing in patience, and consequently the gap in patience across occupations is large in the balanced growth path. In contrast, in a modern economy with deeper financial markets we would expect to observe smaller cultural differences across occupations.

1.4. ENDOGENOUS CULTURE II: KNIGHT AND THE TRANSMISSION OF RISK TOLERANCE

In our economic environment, entrepreneurs face not only a steeper income profile than workers; they also face risk, provided that $\nu > 0$. As a result, risk preferences too should be relevant for explaining entrepreneurship, in line with Frank Knight's characterization of risk-taking entrepreneurs (see Knight, 1921, and more recently Kihlstrom and Laffont, 1979; Vereshchagina and Hopenhayn, 2009). In this section, we provide a formal analysis of this possibility.

1.4.1 Endogenizing Risk Preferences

To facilitate our analysis of endogenous risk preferences, we focus on a period utility function with mean-variance preferences. That is, the period utility function evaluating (potentially stochastic) consumption c is given by:

$$U(c) = E(c) - \sigma\sqrt{Var(c)}, \tag{1.27}$$

where $E(c)$ is expected consumption and $Var(c)$ is the variance of consumption, and σ is a measure of risk aversion. The specific functional form is chosen to be consistent with balanced growth.[11] The utility function implies that people are always better off with a lower risk aversion, i.e. a higher risk tolerance. However, as in our analysis of patience, there is a cost of investing in children's preferences. The effort that a parent of generation t spends on raising the child's risk tolerance is denoted by l_t. Total utility is then given by:

$$\chi(l_t)\left(E(c_{t,1}) - \sigma_t\sqrt{Var(c_{t,1})}\right) + \beta\left(E(c_{t,2}) - \sigma_t\sqrt{Var(c_{t,2})}\right) + zV_{t+1}(\sigma_{t+1}(l_t)),$$

where χ is a strictly decreasing, strictly concave, and differentiable function, and effort is bounded by $0 \leq l_t \leq 1$. The child's risk preferences are given by:

$$\sigma_{t+1}(l_t) = (1-\delta)\sigma_t + \delta\sigma_{\max} - f(l_t), \tag{1.28}$$

where f is an increasing and strictly concave function with $f(0) = 0$, and δ satisfies $0 < \delta \leq 1$. Here, $\sigma_{\max}$ denotes the level of risk aversion exhibited by a dynasty that never

[11] While this utility function is not of the expected-utility form, the main results carry over to expected utility as well. For an analysis of the usual CRRA case see Doepke and Zilibotti (2012).

invests in risk tolerance. If $\delta < 1$ there is some direct persistence in preferences across generations.

Let w^W denote the workers' wage, and η the ratio of the expected return of entrepreneurs to this wage. To simplify the analysis, we assume that the risk of entrepreneurship takes the form that with probability κ, the entrepreneur is successful and earns a positive return, whereas with probability $1-\kappa$ the entrepreneur fails and earns zero. That is, in the notation of Section 1.2.1 we have:

$$\nu = \frac{1-\kappa}{\kappa},$$

so that if successful, the earnings are:

$$(1+\nu)\eta w^W = \frac{\eta w^W}{\kappa},$$

whereas with probability $1-\kappa$ entrepreneurial output is zero. The mean return is then ηw^W, and the variance of the return is given by:

$$\begin{aligned} Var(c^E) &= \kappa\left(\frac{\eta w^W}{\kappa} - \eta w^W\right)^2 + (1-\kappa)\left(\eta w^W\right)^2 \\ &= \frac{1-\kappa}{\kappa}\left(\eta w^W\right)^2. \end{aligned}$$

Thus, the old-age felicity of an entrepreneur is given by:

$$E(c^E) - \sigma\sqrt{Var(c^E)} = \eta w^W\left(1 - \sigma\sqrt{\frac{1-\kappa}{\kappa}}\right).$$

1.4.2 Transmission of Risk Preferences in the Balanced Growth Path

We now consider balanced growth paths. People choose both a career, and whether and how much to invest in their child's risk tolerance. We analyze the individual decision problem under the assumption that the economy is in a balanced growth path, so the entrepreneurial premium is constant, and wages and profits grow at the constant rate g. The decision problem admits a recursive representation with the risk aversion parameter, σ, serving as the state variable of the dynasty. As in our analysis of endogenous patience, the state of technology N_t is in principle a second state variable. However, the linear homogeneity of utility in expected consumption allows us to express the value function at time t in a multiplicatively separable form:

$$V_t(\sigma_t, N_t) = \frac{N_t w_0^W}{N_0} v(\sigma_t),$$

where $v(\sigma_t) = V_t(\sigma_t, 1)$ satisfies the following set of Bellman equations:

$$v(\sigma) = \max\left\{v^W(\sigma), v^E(\sigma)\right\}, \tag{1.29}$$

$$v^W(\sigma) = \max_{0\le l\le 1} \left\{ \chi(l) + \beta(1+g) + z(1+g)\,v(\sigma') \right\}, \tag{1.30}$$

$$v^E(\sigma) = \max_{0\le l\le 1} \left\{ \chi(l)\psi + \beta(1+g)\,\eta\left(1 - \sigma\sqrt{\frac{1-\kappa}{\kappa}}\right) + z(1+g)\,v(\sigma') \right\}, \tag{1.31}$$

the maximizations in (1.30) and (1.31) being subject to:

$$\sigma' = (1-\delta)\sigma + \delta\sigma_{\max} - f(l). \tag{1.32}$$

Here, v^W and v^E are the present-value utilities conditional on choosing to be a worker or an entrepreneur, respectively, and v yields the optimal occupational choice.

Since l is bounded and $\delta > 0$, there is a lower bound $\sigma_{\min}$ for feasible levels of risk aversion. Note that, depending on f and $\delta, \sigma_{\min}$ could be negative, corresponding to risk-loving individuals who would choose a risky lottery over a safe one with the same expected return. For a given growth rate g and average return to entrepreneurship η, the decision problem is a standard dynamic programming problem with a single state variable in the interval $[\sigma_{\min}, \sigma_{\max}]$. The following propositions summarize the properties of the value function and the associated optimal policy functions.

Proposition 7. *The system of Bellman equations (1.29)–(1.31) has a unique solution. The value function v is decreasing and convex in σ. The optimal occupational choice is either to be a worker for any σ, or to be an entrepreneur for any σ, or there exists a $\bar{\sigma}$ such that people with high risk aversion, $\sigma > \bar{\sigma}$, strictly prefer to be workers; people with low risk aversion, $\sigma < \bar{\sigma}$, strictly prefer to be entrepreneurs; and people with $\sigma = \bar{\sigma}$ are indifferent. The optimal investment in risk tolerance $l = l(\sigma)$ is non-increasing in σ.*

Proposition 8. *The state space $[\sigma_{\min}, \sigma_{\max}]$ can be subdivided into (at most) countably many closed intervals $[\underline{\sigma}, \overline{\sigma}]$ such that over the interior of any range $[\underline{\sigma}, \overline{\sigma}]$ the occupational choice of each member of the dynasty (i.e. parent, child, grandchild, and so on) is constant and unique (though possibly different across generations), and $l(\sigma)$ is constant and single-valued. The value function $v(\sigma)$ is piecewise linear, where each interval $[\underline{\sigma}, \overline{\sigma}]$ corresponds to a linear segment. Each kink in the value function corresponds to a switch from being a worker to being an entrepreneur by a present or future member of the dynasty. At a kink, the optimal choices of occupation and l corresponding to both adjoining intervals are optimal (thus, the optimal policy functions are not single-valued at a kink). If there is an interval $[\underline{\sigma}, \overline{\sigma}]$ such that over this interval all present and future members of the dynasty are workers, the value function $v(\sigma)$ is constant over this interval, and there is no investment in risk tolerance: $l(\sigma) = 0$.*

The proofs of the propositions (omitted) are analogous to the proofs of Propositions 2 and 3. The final part of Proposition 8 arises because workers do not face any risk, so that in all-worker dynasties utility is independent of risk preferences, and the return on investing in risk tolerance is zero.

The next proposition characterizes the dynamics of risk aversion within dynasties.

Proposition 9. *The law of motion of σ is described by the following difference equation:*

$$\sigma' = g(\sigma) = (1-\delta)\,\sigma + \delta\sigma_{\max} - f\,(l\,(\sigma))\,,$$

where $l\,(\sigma)$ is a non-increasing step-function (as described in Proposition 8). Given an initial condition σ_0, risk aversion in the dynasty converges to a constant σ where parents and children choose the same profession. If the dynasty ends up as a worker dynasty, the limit for risk aversion is given by $\sigma = \sigma_{\max}$.

The proof (omitted) is analogous to the proof of Proposition 4.

We have already established that in worker dynasties the return to investing in risk tolerance is zero, so that these dynasties do not invest in risk tolerance and hence we have $l^W = 0$ and $\sigma^W = \sigma_{\max}$. For entrepreneurs, in contrast, the return to investing in risk tolerance is positive. If their choice of investment is interior, the investment l^E is characterized by a first-order condition:

$$-\chi'(l^E)\psi = \frac{z(1+g)^2\beta\eta\sqrt{\frac{1-\kappa}{\kappa}}f'(l^E)}{1-z(1+g)(1-\delta)}. \tag{1.33}$$

Here, the left-hand side is strictly increasing in l, and the right-hand side is strictly decreasing. The optimal parental investment in risk tolerance is increasing in the entrepreneurial premium η, the growth rate g, and the entrepreneurial risk $1-\kappa$.

Parallel to our analysis of endogenous patience, the gap in risk preferences between workers and entrepreneurs leads to a multiplicity of balanced growth paths. There can be long-run differences in growth rates across countries, where faster-growing countries are characterized by a larger group of entrepreneurial individuals with low risk aversion. As in the discussion of Section 1.3.4, the multiplicity of balanced growth paths can give rise to path dependence, to persistent effects of institutions and policies that affect risk-taking, and (in an open-economy context) to specialization of certain groups or countries in innovative and risk-taking activities. Also, the development of financial markets once again interacts with endogenous culture and growth, as discussed in Section 1.3.5 for the patience case. For example, for a given distribution of preferences, better risk-sharing institutions (e.g. through insurance markets or tax and transfer policies) can make entrepreneurship more attractive to individuals with high risk aversion, and thereby lead to faster economic growth. However, there is also a downside to the provision of more insurance. In the limit with perfect risk sharing there would be no incentive to invest in risk tolerance, and consequently over time the population would end up more risk averse compared to a country where less insurance is available. Consider now the arrival of a new technology that involves some uninsurable idiosyncratic risk. The population in the well-insured country would be less likely to pick up such new opportunities, and thus might fall back over time compared to a less well-insured, but more risk tolerant and innovative country.

1.5. PATERNALISTIC MOTIVES FOR PREFERENCE TRANSMISSION

Up to this point, in our model of preference transmission parents are motivated solely by altruism, i.e. they evaluate the welfare of the children using the same utility function that drives the children's choices. However, preference transmission could be driven also by paternalistic motives. This is the case when there are potential disagreements between parents and children about optimal choices, and parents use preference transmission as a tool to influence their children's choices.

The paternalistic motive is especially salient in the relationship between parents and adolescent children. It is common for parents to desire to control the tendency of adolescents to take risks parents disapprove of, such as reckless driving, the use of drugs or alcohol, or risky sexual behavior.[12]

1.5.1 Allowing for Conflict Between Parents and Children

To analyze how paternalistic motives affect preference transmission, we extend the model by allowing children to make an additional choice at a young age, denoted by x, that depends on risk preferences. For simplicity, we assume this choice to be orthogonal to the adult occupational choice, i.e. x does not affect the relative return of the adult occupations or the child's ability to enter either occupation. The environment is a simplified version of Doepke and Zilibotti (2012), where we propose a general theory of parenting style related to paternalism.

Children choose from a set of feasible lotteries so as to maximize the felicity function $U_y(x, \sigma)$, whereas their parents evaluate the choice with a different felicity function, $U(x, \sigma)$, where σ denotes the adult's risk aversion parameter. As a concrete example, let the choice of the lottery x result in a random consumption process $c(x)$, and consider parental preferences given by:

$$U(x, \sigma) = E(c(x)) - \sigma \sqrt{Var(c(x))},$$

as in (1.27), whereas the child's preferences are given by:

$$U_y(x, \sigma) = E(c(x)) - (\sigma - \xi)\sqrt{Var(c(x))}.$$

That is, children have intrinsically lower risk aversion (which is consistent with empirical evidence), where $\xi > 0$ captures the gap in risk aversion between the young and the old. For a given σ, children would choose riskier lotteries x than what their parents would prefer.

12 There is well-documented evidence that children are especially prone to risk-taking. For instance, in a series of laboratory experiments carried out in New Mexico, Harbaugh et al. (2002) it was found that 70–75% of children in the 5–8 year age group chose fair gambles with varying odds over a certain outcome, while only 43–53% of the adults did.

We denote by $x(\sigma)$ optimal choice from the children's standpoint. This choice is given by:

$$x(\sigma) = \underset{x}{\operatorname{argmax}} \left\{ U_y(x, \sigma) \right\}.$$

This choice is static, because the choice of x does not have dynamic consequences. Assuming the choice set to be continuous and differentiable implies:

$$\partial U_y(x(\sigma), \sigma) / \partial x = 0.$$

We now turn to the parents' decision problem. The utility of adult workers and entrepreneurs can be written as:

$$v^W(\sigma) = \max_{0 \le l \le 1} \left\{ \chi(l) + \beta(1+g) + z(1+g) W(\sigma', \sigma) \right\},$$

$$v^E(\sigma) = \max_{0 \le l \le 1} \left\{ \chi(l)\psi + \beta(1+g)\eta \left(1 - \sigma \sqrt{\frac{1-\kappa}{\kappa}} \right) + z(1+g) W(\sigma', \sigma) \right\},$$

where $W(\sigma', \sigma)$ captures the utility that the parents derive from their children. This function is given by[13]:

$$W\left(\sigma', \sigma\right) = U\left(x(\sigma'), \sigma\right) + \beta \max\left\{ v^W\left(\sigma'\right), v^E\left(\sigma'\right) \right\}.$$

Notice that $x(\sigma')$ is written as a function of σ'. This is because the parent cannot control x directly, but must take as given the child's decision based on the child's preference parameter σ'. The choice σ' is constrained by the law of motion:

$$\sigma' = (1-\delta)\sigma + \delta\sigma_{\max} - f(l).$$

1.5.2 Optimal Preference Transmission with Paternalistic Motives

Consider a parent who anticipates her child to become an entrepreneur, and assume, for simplicity, $\delta = 1$. If the optimal l is interior, the following first-order condition obtains:

$$\chi'\left(l^E\right)\psi = z(1+g) \left(\underbrace{\frac{\partial U(x(\sigma'), \sigma)}{\partial x} \frac{\partial x}{\partial \sigma'}}_{\text{paternalistic motive}} + \beta \frac{\partial v^E}{\partial \sigma} \right) f'\left(l^E\right).$$

Relative to the model of Section 1.4, a new term appears in the first-order condition which captures the paternalistic motive. This terms vanishes whenever there is no disagreement between parents and children, i.e. when $U = U_y$ and $\sigma = \sigma'$, because in

[13] In Doepke and Zilibotti (2012), we consider a formulation with partial paternalism, where the W function takes the form:

$$W(\sigma', \sigma) = qU_y(x(\sigma'), \sigma') + (1-q)U(x(\sigma'), \sigma) + \beta \max\{v^W(\sigma'), v^E(\sigma')\}.$$

this case we have:

$$\frac{\partial U\left(x(\sigma'),\sigma\right)}{\partial x}=0,$$

i.e. the envelope theorem applies. Likewise, the paternalistic motive would also be mute if a fixed choice of x were imposed on the child, because this would imply $\partial x/\partial\sigma' = 0$. In contrast, paternalism does affect the parent's decision problem whenever three conditions are all satisfied: There is disagreement between parent and child regarding the choice of x; the child is free to choose x; and the child's choice depends on the endogenous preference parameter σ'. In this case, it is valuable for the parent to distort the child's preferences in order to induce the child to choose an x that is more to the parent's liking. Alternatively, if the option were available, the parent would impose restrictions on the ability of the child to choose freely. When forming a child's preferences, parents realize that reducing the child's risk tolerance comes at the expense of the child's future utility, implying a tradeoff for the altruistic parents. Thus, in general the parent will strike a compromise, and accept that the child chooses an x that is different from the parents' most preferred option.

The discussion above assumes that the parental choice of σ' (via l) does not affect the child's occupational choice. However, if the paternalistic motive is sufficiently strong, the occupational choice of the child may be affected. More formally, if $\hat{\sigma}$ denotes the risk aversion parameter such that $v^W(\hat{\sigma}) = v^E(\hat{\sigma})$, it is possible that absent the paternalistic motive the parent would choose $\sigma' < \hat{\sigma}$, inducing the child to become an entrepreneur, whereas the paternalistic motive induces a choice $\sigma' > \hat{\sigma}$, implying that the child will choose to be a worker. This scenario is more likely if ξ (i.e. the child's intrinsic risk-loving bias) is large, and if the set of feasible lotteries x among which the child can choose includes choices the parent would strongly disapprove of. In practice, this choice set would depend on various features of the environment in which the adolescent grows up. For instance, adolescents living in areas infested by juvenile gangs are more exposed to risky choices than are children in safe middle-class neighborhoods, where risky choices are limited to more innocuous transgressions. An implication of this analysis, which we explore in more detail in Doepke and Zilibotti (2012), is that families living in areas exposed to acute juvenile risk will emphasize values that are less conducive to an entrepreneurial spirit. When integrated into the general equilibrium model of Section 1.2.1, the theory bears the prediction that countries where juvenile risk is more severe will have a smaller equilibrium proportion of entrepreneurs as well as larger risk premia.

1.6. LITERATURE REVIEW

1.6.1 Cultural Transmission, Human Capital, and Non-cognitive Skills

The theory presented in the previous sections provides a two-way link between the economic environment and preferences. A pioneering contribution to this literature is Becker and Mulligan (1997), which formalizes a model where people choose their own preferences rather than those of their children. In Mulligan (1997), parents choose their own level of altruism toward their children. Along similar lines, in Haaparanta and Puhakka (2004), agents invest in their own patience and in health. Doepke and Zilibotti (2008) (discussed in more detail below) provide the first theory where altruistic parents shape their children's preferences in order to "best prepare" them for the economic environment in which they will operate.

In these studies, as in our model above (except in the extension of Section 1.5), parents evaluate their children's wellbeing using their children's preferences. Namely, parents choose their investments in preference optimally by maximizing their children's utility. There is no explicit desire of parents to preserve their own culture or to instill values that they regard as intrinsically good or moral. In particular, parents may choose to teach their children preferences that differ from their own. In contrast, a number of recent studies postulate that cultural transmission hinges on a form of "imperfect empathy" (see Bisin and Verdier, 2001; Hauk and Saez-Marti, 2002; Gradstein, 2007; Klasing, 2012; Saez-Marti and Sjoegren, 2008; Tabellini, 2008; and Saez-Marti and Zenou, 2011). According to this approach, parents use their own preferences to evaluate the children's utility and are driven by a desire to make the children's values similar to their own. The two approaches and their differences are reviewed in more detail by Saez-Marti and Zilibotti (2008).[14]

In the Beckerian approach, parents transmit traits to their children that are supposed to make them fit for success. Thus, investment in preference transmission resembles a standard human capital investment. From this perspective, preferences are closely related to what the recent labor literature has labeled "non-cognitive skills." These skills determine how well people can focus on long-term tasks, behave in social interactions, and exert self-restraint, and include patience, perseverance, and self-discipline, among others. Recent empirical studies emphasize the importance of such human assets for economic success (see Heckman et al. 2006; Segal, 2013).

Within the realm of non-cognitive skills, we emphasize the role of patience and of the propensity to take risks. The importance of patience for economic success has been documented by experimental studies. A longitudinal study by Mischel et al. (1992) finds that individuals who were more patient as children were subsequently more likely to acquire formal education, to choose market-oriented occupations, and to earn higher income. More recently, Sutter et al. (2013) found that measures of time preferences of young people aged 10–18 elicited through experiments predict saving behavior, smoking and alcohol abuse, BMI, and conduct at school. Reyes-Garcia et al. (2007) study the effect of patience on economic outcomes among the Tsimanes, an Amazonian tribal society that only recently transitioned from self-sufficiency to a market economy. They found

[14] Our analysis in Section 1.5.2 and in Doepke and Zilibotti (2012) provides a bridge between these two approaches. Our analysis proposes an explicit microfoundation of the child-adult preference conflict, whereas in the existing literature imperfect empathy is postulated as a primitive.

that individuals who were already more patient in the pre-market environment (when patience was a latent attribute with no effect on individual success) acquired on average more education and engaged more often in entrepreneurial activity when the society introduced markets.[15]

The importance of the propensity to take risk for entrepreneurship has been emphasized, among others, by Kihlstrom and Laffont (1979). Several studies point to robust evidence that risk tolerant people are more likely to become entrepreneurs; see, e.g. Van Praag and Cramer (2001), Cramer et al. (2002), and Kan and Tsai (2006).

The evidence discussed above leaves open the extent to which patience and risk tolerance hinge on parental effort or on the influence of the environment, as opposed to being genetically inherited. The long-standing debate among anthropologists and population geneticists on the role of nature versus nurture has reached no clear conclusion.[16] Both genes and culture appear to be important, likely in a non-linear interactive fashion. The recent economic literature has explored, in different contexts, both the evolutionary selection and the cultural transmission mechanisms. For instance, recent studies focusing on economic development from a very long-run perspective have emphasized the importance of Darwinian evolution of preferences and of genetic diversity for the process of development (see, e.g. Galor and Michalopoulos, 2012; Ashraf and Galor, 2013). We view the selection and investment in preference approaches to endogenous preference formation as complementary, because they operate on different time horizons.[17]

There is direct evidence that non-cognitive skills are influenced by social factors and family upbringing at a shorter time horizon. Heckman (2000) and Carneiro and Heckman (2003) review the evidence from a large number of programs targeting disadvantaged children. They show that most programs were successful in permanently raising the treated children's non-cognitive skills. These children were more motivated to learn, less likely to engage in crime, and altogether more future-oriented than children of non-treated families. Similar conclusions are reached by studies in child development psychology such as Shonkoff and Philips (2000) and Taylor et al. (2000).

Some studies focus explicitly on preference parameters of economic models. For example, Knowles and Postlewaite (2004) provide evidence of cultural transmission of patience. Using the PSID, they find that parental savings behavior is highly correlated with the education and savings choices of their children's households, after controlling for standard individual characteristics. Moreover, the correlation is stronger between mothers and children than between fathers and children. Since mothers tend to be more actively involved than fathers in the child-rearing process, this observation suggests that there is

15 These results are consistent with other studies on developing countries.

16 See, e.g. Cavalli-Sforza and Feldman (1981), Bowles and Gintis (2002), and Richerson and Boyd (2005).

17 Earlier articles emphasizing the evolutionary selection of preferences include Galor and Moav (2002) and Clark and Hamilton (2006). A recent paper by Baudin (2010) incorporates the interaction of evolutionary forces and cultural transmission in a Beckerian model of endogenous fertility. The interplay between cultural diversity and economic growth is analyzed in Ashraf and Galor (2012).

cultural transmission in patience and propensities to save. In the same vein, Dohmen et al. (2012) document that trust and risk attitudes are strongly correlated between parents and children in the German Socio-Economic Panel. Using the same data set, Zumbuehl et al. (2013) find that parents who invest more in child-rearing efforts are more similar to their children in terms of attitudes toward risk. All these studies concur on the importance of the transmission of non-cognitive skills within families.

1.6.2 Investments in Patience and the Spirit of Capitalism

Doepke and Zilibotti (2008) are closely related to the model discussed in this chapter. The authors propose a dynamic dynastic model rooted in the Beckerian tradition where parents invest in their children's patience and work ethic (modeled as the inverse of the marginal utility of leisure).[18] Preferences are treated as a human-capital-like state variable: parents take their own preferences as given, but can invest in those of their children. The focus of the theory is on the interaction of this accumulation process with the choice of an occupation and savings.

The authors show that the endogenous accumulation of "patience capital" can lead to the stratification of a society into social classes, characterized by different preferences and occupational choices. This occurs even if all individuals initially are identical. In the presence of such endogenous differences in preferences, episodes of technological change can trigger drastic changes in the income distribution, including the leapfrogging of a lower class over the existing elite. The theory is applied to the changes in the distribution of income and wealth that occurred during and after the Industrial Revolution in Britain. Before the onset of industrialization, wealth and political power were associated with the possession of land. Over the 19th century, a new class of entrepreneurs and businessmen and women emerged as the economic elite, replacing the landed elite.

From a theoretical standpoint, the focal point of Doepke and Zilibotti (2008) is an association between occupations and consumption profiles, similar to the model presented in this chapter. In some professions, lifetime earnings are relatively flat, while in others, in particular those requiring the acquisition of skills, high returns are achieved only late in life. These differences affect the incentive of altruistic parents for investing in their children's patience capital: the steeper the consumption profile faced by their children, the stronger the incentive for parents to teach them to be patient. The converse is also true: patient agents have a higher propensity to choose professions entailing steep earnings and consumption profiles.

In the historical application they consider, the pre-industrial middle class had accumulated patience capital, and consequently was better prepared to exploit the new economic opportunities than was the existing elite. The differences in patience, in turn, had their roots in the nature of pre-industrial professions. For centuries, artisans, craftsmen, and

[18] Doepke and Zilibotti (2005) developed a simplified model that focuses only on patience.

merchants were used to sacrificing consumption and leisure in their youth to acquire skills. Consequently, middle-class parents had the strongest incentive to instill into their children a patience and work ethic, that is, a "spirit of capitalism" in Weberian terms. In contrast, the landed elite had accumulated little patience, but a strong appreciation for leisure. The preference profile of the elite arises because the traditional aristocratic sources of income were mostly rents, which neither grew steeply over time, nor hinged on labor effort.

Doepke and Zilibotti (2008) differ from the model presented in this chapter insofar as it abstracts from innovation. In that model, cultural differences that were formed in pre-industrial times explain why different classes responded differently to the new technological opportunities arising at the outset of the Industrial Revolution. However, technology is exogenous, whereas in this chapter cultural transmission is linked explicitly to a theory of endogenous technical change.[19] The theory discussed in this chapter rationalizes why some individuals become entrepreneurs and innovators, and how this affects the speed of technical change and long-run growth.[20]

An implication shared by both Doepke and Zilibotti (2008) and the model presented in this chapter is that cultural transmission makes dynasties facing steeper income profiles more patient. This prediction is consistent with the evidence from a field experiment conducted on Danish households by Harrison et al. (2002). Using monetary rewards, they show that highly educated adults have time discount rates (which are inversely related to the discount factor) as low as two-thirds of those of less educated agents. Since spending time on education typically steepens people's income profile, this finding is in line with the prediction of the theory. A positive correlation between steep income profiles and patience has also been documented at the macro level (see Carroll and Summers, 1991; Becker and Mulligan, 1997). The former documents that in both Japan and the United States consumption-age profiles are steeper when economic growth is high. The latter paper shows that consumption grows faster for richer families and adult consumption grows faster for children of the rich.

1.6.3 Religious Beliefs and Human Capital

Another set of papers studies culture as a system of beliefs affecting people's choices, and ultimately economic development. Significant attention has been paid to religion. Barro and McCleary (2003) show that economic growth is higher in countries with a more widespread belief in hell and heaven. Guiso et al. (2003) come to similar conclusions. Cavalcanti et al. (2007) develop a theoretical model with the possibility of beliefs in

[19] In addition, the model discussed here considers the cultural transmission of risk aversion as well as the possibility of paternalism. Neither feature is covered in Doepke and Zilibotti (2008). Conversely, in that paper we consider the interaction between patience and work ethic, a dimension from which we abstract here.

[20] In this regard, our analysis is related to Klasing (2012) and Klasing and Milionis (2013). However, these papers use a different growth model (related to Acemoglu et al. 2006) and a different cultural transmission mechanism (related to Bisin and Verdier, 2001).

rewards in afterlife. They argue that the model can quantitatively explain cross-country differences in the takeoff from pre-industrial stagnation to growth.

Some influential recent studies point to a close connection between the transmission of religious beliefs and human capital investment. In particular, Botticini and Eckstein (2005, 2006, 2007) examine the cultural roots of the economic success of the Jewish population through a theory of specialization in trade-related activities. They conclude that the key factor was not the system of beliefs of the Jewish religion per se. Rather, it is the extent to which religious beliefs led to human capital accumulation. They document that a religious reform introduced in the second century B.C. caused an increase in literacy rates among Jewish farmers, which, in turn, led to increasing specialization in occupations with a high return to literacy, such as artisanship, trade, and finance. High literacy also led to increased migration into towns, where occupations that reward literacy are concentrated. In a similar vein, Becker and Woessmann (2009) documented that in 19th century Prussia, Protestant counties were more prosperous than Catholic ones, but the effect was entirely due to differences in literacy and education. They conclude that the main channel of the effect of religion on economic performance is human capital.[21]

In the literature discussed so far, religious beliefs are exogenous. In contrast, in Fernández-Villaverde et al. (2010) social norms and beliefs mediated by religious institutions are instead endogenous. They construct a theory where altruistic parents socialize children about sex, instilling a stigma against pre-marital sex in order to reduce the risk of out-of-wedlock births. Religious beliefs and institutions operate as enforcement mechanisms. Similar to Doepke and Zilibotti (2008), cultural transmission responds to changes in the underlying environment. In particular, when modern contraceptives reduce the risk associated with pre-marital sex, they reduce the need for altruistic parents and religious authorities to inculcate sexual mores. The equilibrium effect of technology on culture yields the surprising implication that the number of out-of-wedlock births initially grows significantly in response to new contraceptive technology, due to the higher cultural tolerance for pre-marital sex.

While Doepke and Zilibotti (2008) and Fernández-Villaverde et al. (2010) emphasize the process of cultural transmission, Fernández (2013) and Fogli and Veldkamp (2011) describe culture as a process of Bayesian learning from public and private signals. Those

[21] The finding that the main channel through which Protestantism led to higher economic prosperity was higher literacy and human capital is interpreted by Becker and Woessmann (2009) as evidence against Max Weber's hypothesis that Protestant work ethic had a causal effect of economic success. The distinction is, to some extent, semantic. Their findings are consistent with the broader interpretation of Weber provided by Doepke and Zilibotti (2008) who abstract from religion, but argue that the cultural transmission of patience induces the middle class to undertake human capital investments. In this perspective, one can interpret religious beliefs (e.g. Protestantism) as a complementary driver of patience and work ethic. To the extent to which patience is a constituent of the spirit of capitalism, the evidence of Becker and Woessmann (2009) would be actually consistent with a broad interpretation of Max Weber's theory.

papers explain the sharp increase in female labor supply during the 20th century.[22] Doepke and Tertilt (2009) focus on an earlier period and provide a theory of the expansion of women's rights in the 19th century. The authors argue that rising demand for human capital changed cultural attitudes regarding the proper role of women in society, and ultimately triggered political reform.[23]

1.6.4 Beliefs and Social Norms

Many recent studies link culture and beliefs with the process of development through the effects these have on institutions. For instance, Aghion et al. (2010) and Aghion et al. (2011) argue that trust determines the demand for regulation, especially in labor markets.[24] Heterogeneous beliefs about the effect of redistributive policies are the focus of Piketty (1995). A number of papers also consider the feedback effect from institutions to culture. For instance, Hassler et al. (2005) argue that a generous unemployment benefits system induces low geographic mobility of workers in response to labor market shocks. Low mobility, in turn, increases over time the attachment of workers to their location (modeled as a preference trait), sustaining a high demand of social insurance. A similar argument is developed by Michau (2013), who incorporates his theory in a model of cultural transmission. Lindbeck and Nyberg (2006) argue that public transfers weaken parents' incentives to instill a work ethic in their children. The relationship between trust, efficiency, and size of the welfare state is emphasized by Algan et al. (2013).[25]

Culture, trust, and beliefs have also been argued to have first-order effects on institutional stability and on the ability of societies to foster economic cooperation among its citizens. Rohner et al. (2013) construct a theory where persistent civil conflicts are driven by the endogenous dynamics of inter-ethnic trade and inter-ethnic beliefs about the nature and intentions of other ethnic groups. Inter-ethnic trade hinges on reciprocal trust. The theory predicts that civil wars are persistent (as in Acemoglu et al. 2010), and that societies can plunge into a vicious cycle of recurrent conflicts, low trust, and scant

[22] The learning process can be related to the observation of different family models. Fernández et al. (2004) show that the increase in female labor force participation over time was associated with a growing share of men who grew up in families where mothers worked. They test their hypothesis using differences in mobilization rates of men across states during World War II as a source of variation in female labor supply. They show that higher male mobilization rates led to a higher fraction of women working not only for the generation directly affected by the war, but also for the next generation.

[23] Doepke et al. (2012) provide a more extensive discussion of the relationship between cultural and economic explanations for the historical expansion of women's rights.

[24] For a recent survey of the relationship between trust and economic performance, see Algan and Cahuc (2013).

[25] A related argument is provided by the politico-economic theory of Song et al. (2012) arguing that in countries characterized by inefficient public provision voters are more prone to support high public debt. Although debt crowds out future public expenditure, this is a smaller concern to (young) voters in countries whose governments are inefficient.

inter-ethnic trade (a "war trap") even though there are no fundamental reasons for the lack of cooperation. Long-run outcomes are path dependent: economies with identical fundamentals may end up in either good or bad equilibria depending on the realization of stochastic shocks that cement or undermine cohesion and inter-group cooperation.[26] Rohner et al. (2013) also provide evidence that the onset and incidence of civil wars are affected significantly by a lagged measure of trust from the World Values Survey. There is also evidence of the opposite channel, i.e. exposure to civil conflict affecting preferences and trust. Using data from a field experiment in rural Burundi, Voors et al. (2012) document that exposure to violence encourages risk-taking but reduces patience, hence depressing saving and investments. Rohner et al. (2012) document survey evidence from the civil conflicts in Uganda that war destroys trust, strengthens ethnic identity, and harms future growth in ethnically divided communities.

In the empirical literature, beliefs and social norms are often difficult to disentangle from the effects of the local economic and institutional environment. Studying the behavior of immigrants and expatriates has proven useful to achieve identification. A noteworthy example is Giuliano (2007), which shows that second-generation southern European male immigrants in the United States behave similarly to their counterparts in their country of origin, and live with their parents much longer than young Americans do. Similarly, Fernández and Fogli (2006, 2009) document that the country of origin explains fertility and work behavior of second-generation American women. Fisman and Miguel (2007) finds that diplomats from more corrupted countries tend to incur significantly more parking violations in the United States (diplomats are generally immune, so fines are not enforced). Bruegger et al. (2009) compare unemployment across Swiss communities with different languages (French versus German). The language border separates cultural groups, but not labor markets or political jurisdictions. They find that cultural differences (identified by language differences) can explain differences in unemployment duration of about 20%.

A number of papers have emphasized the persistence of cultural factors. Culture may respond to changes in the institutional environment, but cultural shifts may take time. This is consistent with the view that adults' preferences are by and large fixed, as opposed to those of children, whose beliefs, non-cognitive skills, and preferences can be shaped by cultural transmission and the surrounding environment. Even with these influences, cultural changes can take several generations to reach a new steady state after institutions have changed. Alesina and Fuchs-Schuendeln (2007) focus on the fall of the Berlin Wall. After the end of communism, East Germans became subject to the same institutions as West Germans, but carried with them the cultural heritage of the communist experience. Their study documents that several years after unification, East Germans (compared to

[26] In a related paper, Acemoglu and Wolitzky (2012) propose a theory where mistaken signals can trigger belief-driven conflict between two groups.

West Germans) are more supportive of redistribution and believe that social conditions are a more important determinant of individual success. Voigtlaender and Voth (2012) go much further and document evidence that a particular form of cultural trait, namely anti-Semitism in German local communities, has persisted for more than 600 years.[27]

Finally, exogenous sources of variation for culture can be found in historical data. Using data for European regions, Tabellini (2010) finds evidence that culture has a significant causal effect on economic development. The identification relies on two historical variables, the literacy rate and past political institutions.

1.7. OUTLOOK AND CONCLUSIONS

Explaining the vast variation in rates of economic growth and living standards around the world remains one of the main challenges in economics. Growth-theoretic explanations for these observations have focused on variation in factor endowments, technology, or institutions as explanatory variables, while abstracting from the potential role of differences in culture, values, and preferences. In contrast, in this chapter we have developed a theory in which culture (modeled as endogenous preferences) and economic growth are endogenous and affect each other. Economic growth feeds back into the preference formation and transmission process of families, and conversely the existing distribution of preferences in the population determines the potential for economic growth. The theory predicts that countries can reach different balanced growth paths, in which some countries grow fast and others more slowly. Fast-growing countries are the ones with larger shares of the population exhibiting a "spirit of capitalism" (i.e. preferences conducive to innovative activities). Institutions, the development of financial markets, and government policies affecting risk sharing all feed back into preferences and culture, giving rise to long-term changes in economic development that can long outlast the underlying institutions and policies.

In the past, economists generally have shied away from explaining economic phenomena with variation in culture or preferences. A common concern is that such explanations put little discipline on the data. However, this criticism does not apply to explicit models of intergenerational preference transmission that generate specific testable implications, which is the route that we have taken here. In this sense, this chapter is in the spirit of Stigler and Becker (1977), who also analyzed phenomena that at first sight suggest an important role for variation in preferences (such as addiction; customs and tradition; and fashion and advertising).

Of course, for testable implications to be meaningful, researchers need data allowing them to evaluate the restrictions imposed by the theory in practice. From this perspective, an important change in recent years is the increased availability of data sets that permit

[27] They document that cities where Jews were victims of medieval pogroms during the plague era were also very likely to experience anti-Semitic violence in the 20th century, before and during the Nazi rule.

empirical analyses of the transmission of preference traits from parents to children as well as the mutual interaction between cultural preferences and the economic environment (we review a number of such studies in Section 1.6). We expect that combining these new empirical insights with theoretical analyses of the interaction of culture, entrepreneurship, and growth of the kind developed in this chapter will, over time, greatly enhance our understanding of the development process.

A PROOFS OF PROPOSITIONS AND LEMMAS

Proof of Proposition 1. Given Equation (1.14), the zero growth ($\lambda = 0$) steady state exists, if and only if:

$$\chi\left(1-(\psi)^{1-\sigma}\right) \geq \beta\left(\left(2(1-\alpha)\,\alpha^{\frac{\alpha}{1-\alpha}}\xi\right)^{1-\sigma}-1\right).$$

Conversely, the balanced growth path features $\lambda = 1$, if and only if:

$$\chi\left(1-(\psi)^{1-\sigma}\right) \leq \beta(1+\xi)^{1-\sigma}\left(\left(\frac{(1-\alpha)\,\alpha^{\frac{\alpha}{1-\alpha}}\xi\psi}{1+\alpha^{\frac{1}{1-\alpha}}\xi}\right)^{1-\sigma}-1\right).$$

An interior balanced growth path with positive fractions of workers and entrepreneurs exists if (1.14) is satisfied as an equality for some λ with $0 < \lambda < 1$. A steady state has to exist (either corner or interior) because (1.14) is continuous in λ. The first inequality in Assumption 1 guarantees that the right-hand side of (1.14) is positive for $\lambda = 0$. The second inequality guarantees that the right-hand side of (1.14) reaches zero for a $\tilde{\lambda}$ with $0 < \tilde{\lambda} < 1$. This also implies that the right-hand side of (1.14) is strictly decreasing in λ for $\lambda \leq \tilde{\lambda}$ sufficiently close to $\tilde{\lambda}$. Let $\hat{\lambda}$ denote the lower bound of the monotonic region. The right-hand side of (1.14) is bounded strictly away from zero for $0 \leq \lambda \leq \hat{\lambda}$. By choosing χ sufficiently small, we can guarantee that (1.14) is not satisfied for a λ in this region. This implies that (1.14) is satisfied for a λ that lies in this monotonic region, which then has to be unique, resulting in a unique, interior balanced growth path. □

Proof of Proposition 2. The system of Bellman equations (1.16)–(1.18) defines a mapping T on the space of bounded continuous functions on the interval $[0, \beta_{\max}]$, endowed with the sup norm, where the mapping is given by:

$$\begin{aligned} Tv(\beta) = \max_{I\in\{0,1\},0\leq l\leq 1} &\left\{(1-I)\left[\chi(l)+\beta(1+g)^{1-\sigma}\right]\right. \\ &\left.+I\left[\chi(l)\psi^{1-\sigma}+\beta((1+g)\eta)^{1-\sigma}\right]+z(1+g)^{1-\sigma}v(\beta')\right\}, \end{aligned} \quad (1.34)$$

where the maximization is subject to:

$$\beta' = (1-\delta)\beta + f(l).$$

I is an indicator variable for the occupational choice, and $\beta_{\max} = f(1)/\delta$. Since we imposed assumptions that guarantee $0 < z(1+g)^{1-\sigma} < 1$, this mapping is a contraction by Blackwell's sufficient conditions, and it therefore has a unique fixed point by the Contraction Mapping Theorem. This proves the first part of the proposition.

The proof that the value function is increasing and convex is an application of Corollary 1 to Theorem 3.2 in Stokey and Lucas (1989). Using this result, we can establish the result by establishing that the operator T preserves these properties. To establish that the value function is increasing, let v be a non-decreasing bounded continuous function. We need to show that Tv is a strictly increasing function. To do this, choose $\overline{\beta} > \underline{\beta}$. We now need to establish that $Tv(\overline{\beta}) > Tv(\underline{\beta})$. Since the right-hand side of (1.34) is the maximization of a continuous function over a compact set, the maximum is attained. Let $\underline{l}$ and $\underline{I}$ be choices attaining the maximum for $\underline{B}$. We then have:

$$\begin{aligned}
Tv(\overline{\beta}) \geq{} & (1-\underline{I})\left[\chi(\underline{l}) + \overline{\beta}(1+g)^{1-\sigma}\right] \\
& + \underline{I}\left[\chi(\underline{l})\psi^{1-\sigma} + \overline{\beta}((1+g)\eta)^{1-\sigma}\right] + z(1+g)^{1-\sigma} v((1-\delta)\overline{\beta} \\
& + f(\underline{l})) > (1-\underline{I})\left[\chi(\underline{l}) + \underline{\beta}(1+g)^{1-\sigma}\right] \\
& + \underline{I}\left[\chi(\underline{l})\psi^{1-\sigma}\right. \\
& \left. + \underline{\beta}((1+g)\eta)^{1-\sigma}\right] + z(1+g)^{1-\sigma} v((1-\delta)\underline{\beta} + f(\underline{l})) = Tv(\underline{\beta}),
\end{aligned}$$

which is the desired result. Here the weak inequality follows because the choices $\underline{l}, \underline{I}$ may not be maximizing at $\overline{\beta}$, and the strict inequality follows because v is assumed to be increasing, and we have that $\overline{\beta} > \underline{\beta}$ and $\eta > 0$.

To establish convexity of the value function, let v be a (weakly) convex bounded continuous function. We need to establish that Tv is also a convex function. To show this, choose a number θ such that $0 < \theta < 1$, let $\overline{\beta} > \underline{\beta}$, and let $\beta = \theta\overline{\beta} + (1-\theta)\underline{\beta}$. We now need to show that $\theta Tv(\overline{\beta}) + (1-\theta)Tv(\underline{\beta}) \geq Tv(\beta)$. Let l and I be choices attaining the maximum for β. Since these are feasible, but not necessarily optimal choices at $\overline{\beta}$ and $\underline{\beta}$, we have:

$$\begin{aligned}
Tv(\overline{\beta}) \geq{} & (1-I)\left[\chi(l) + \overline{\beta}(1+g)^{1-\sigma}\right] \\
& + I\left[\chi(l)\psi^{1-\sigma} + \overline{\beta}((1+g)\eta)^{1-\sigma}\right] + z(1+g)^{1-\sigma} v((1-\delta)\overline{\beta} + f(l)), \\
Tv(\underline{\beta}) \geq{} & (1-I)\left[\chi(l) + \underline{\beta}(1+g)^{1-\sigma}\right] \\
& + I\left[\chi(l)\psi^{1-\sigma} + \underline{\beta}((1+g)\eta)^{1-\sigma}\right] + z(1+g)^{1-\sigma} v((1-\delta)\underline{\beta} + f(l)).
\end{aligned}$$

Working toward the desired condition, we therefore have:

$$\begin{aligned}
&\theta Tv(\overline{\beta}) + (1-\theta) Tv(\underline{\beta}) \\
&\quad \geq (1-I)\left[\chi(l) + \beta(1+g)^{1-\sigma}\right] + I\left[\chi(l)\psi^{1-\sigma} + \beta((1+g)\eta)^{1-\sigma}\right] \\
&\qquad + z(1+g)^{1-\sigma}\left[\theta v((1-\delta)\overline{\beta} + f(l)) + (1-\theta)v((1-\delta)\underline{\beta} + f(l))\right] \\
&\quad \geq (1-I)\left[\chi(l) + \beta(1+g)^{1-\sigma}\right] + I\left[\chi(l)\psi^{1-\sigma} + \beta((1+g)\eta)^{1-\sigma}\right] \\
&\qquad + z(1+g)^{1-\sigma} v((1-\delta)\beta + f(l)) = Tv(\beta),
\end{aligned}$$

which is the required condition. Here, the last inequality follows from the assumed convexity of v. The operator T therefore preserves convexity, and thus the fixed point must also be convex. Notice that linearity is key to this result: the discount factor enters utility linearly, and the parental discount factor has a linear effect on the discount factor of the child.

Regarding the optimal occupational choice, the difference between the utility of being a worker and an entrepreneur for given β and l is given by:

$$\chi(l)\left(1-\psi^{1-\sigma}\right) - \beta(1+g)^{1-\sigma}\left(\eta^{1-\sigma}-1\right),$$

where the first term is always positive, and the second term is negative as long as $\eta > 1$. Given that the second term is weighted by β, it follows that being a worker is always optimal for β sufficiently close to zero. Since the utility derived from entrepreneurship relative to being a worker is strictly increasing in β, there is either a cutoff $\bar{\beta}$ such that entrepreneurship is chosen for $\beta \geq \bar{\beta}$, or being a worker is always the preferred choice (when the required cutoff would be larger than $\beta_{\max}$).

As the last step, we would like to show that the optimal investment in patience $l = l(\beta)$ is non-decreasing in β. Fix two discount factors $\underline{\beta} < \overline{\beta}$. Let $\underline{u}_1 = 1$ if at $\underline{\beta}$ the optimal choice is to be a worker, and $\underline{u}_1 = \psi^{1-\sigma}$ otherwise. Similarly, for the second period we define $\underline{u}_2 = (1+g)^{1-\sigma}$ for workers and $\underline{u}_2 = ((1+g)\eta)^{1-\sigma}$ for entrepreneurs. $\overline{u}_1$ and $\overline{u}_2$ are defined in the same way. Now let $\underline{l}$ and $\bar{l}$ denote the optimal investments in patience at $\underline{\beta}$ and $\overline{\beta}$. The optimal choice of l the implies the following inequalities:

$$\begin{aligned}
&\chi(\underline{l})\underline{u}_1 + \underline{\beta}\underline{u}_2 + z(1+g)^{1-\sigma} v((1-\delta)\underline{\beta} + f(\underline{l})) \\
&\quad \geq \chi(\bar{l})\underline{u}_1 + \underline{\beta}\underline{u}_2 + z(1+g)^{1-\sigma} v((1-\delta)\underline{\beta} + f(\bar{l})) \\
&\chi(\underline{l})\overline{u}_1 + \overline{\beta}\overline{u}_2 + z(1+g)^{1-\sigma} v((1-\delta)\overline{\beta} + f(\underline{l})) \\
&\quad \leq \chi(\bar{l})\overline{u}_1 + \overline{\beta}\overline{u}_2 + z(1+g)^{1-\sigma} v((1-\delta)\overline{\beta} + f(\bar{l})).
\end{aligned}$$

Subtracting the two inequalities yields:

$$\begin{aligned}
&\chi(\underline{l})\left(\underline{u}_1 - \overline{u}_1\right) + z(1+g)^{1-\sigma}\left(v((1-\delta)\overline{\beta} + f(\bar{l})) - v((1-\delta)\underline{\beta} + f(\bar{l}))\right) \\
&\quad \geq \chi(\bar{l})\left(\underline{u}_1 - \overline{u}_1\right) + z(1+g)^{1-\sigma}\left(v((1-\delta)\overline{\beta} + f(\underline{l})) - v((1-\delta)\underline{\beta} + f(\underline{l}))\right).
\end{aligned}$$

Now there are two possibilities. If the optimal occupational choices at $\underline{\beta}$ and $\overline{\beta}$ are the same, we have $\underline{u}_1 = \overline{u}_1$ and the inequality reads:

$$\begin{aligned} &v((1-\delta)\overline{\beta} + f(\bar{l})) - v((1-\delta)\underline{\beta} + f(\bar{l})) \\ &\quad \geq v((1-\delta)\overline{\beta} + f(\underline{l})) - v((1-\delta)\underline{\beta} + f(\underline{l})). \end{aligned}$$

Since we have already shown that v is convex, this implies $\bar{l} \geq \underline{l}$. The second possibility is that at $\underline{\beta}$ it is optimal to be a worker, and at $\overline{\beta}$ it is optimal to be an entrepreneur, so that we have $\underline{u}_1 - \overline{u}_1 > 0$. Rearranging the expression gives:

$$\begin{aligned} \left(\chi(\underline{l}) - \chi(\bar{l})\right)\left(\underline{u}_1 - \bar{u}_1\right) \geq z(1+g)^{1-\sigma} \Big[& v((1-\delta)\bar{\beta} + f(\underline{l})) - v((1-\delta)\underline{\beta} + f(\underline{l})) \\ & - \Big(v((1-\delta)\bar{\beta} + f(\bar{l})) - v((1-\delta)\underline{\beta} + f(\bar{l}))\Big)\Big]. \end{aligned}$$

Due to the convexity of v, if we have $\underline{l} > \bar{l}$, the left-hand side would be negative and the right-hand side positive; we therefore must have $\underline{l} \leq \bar{l}$, which completes the proof. □

Proof of Proposition 3. In Proposition 2, we can subdivide the state space $[0, \beta_{\max}]$ into (at most) two closed intervals (they are closed because of our continuity assumptions), where each interval corresponds to the choice of a given occupation (worker or entrepreneur). The agent is just indifferent between the occupations at the boundary between the intervals, and strictly prefers a given occupation in the interior of an interval. The intervals can be further subdivided according to the occupational choice of the child. Since $l(\beta)$ may not be single-valued, there may be multiple optimal β' corresponding to a given β today. Nevertheless, since the β' are strictly increasing in β (because of Proposition 3 and $\delta < 1$) and given that there are only two occupations, we can once again subdivide today's state space into at most two closed intervals, each one corresponding to a specific occupational choice of the child. Continuing this way, the state space $[0, \beta_{\max}]$ can be divided into a countable number of closed intervals (there are two possible occupations in each of the countably many future generations), where each interval corresponds to a specific occupational choice of each generation. Let $[\underline{\beta}, \overline{\beta}]$ be such an interval. We want to establish that the value function is linear over this interval, and that the optimal choice of patience $l(\beta)$ is single-valued and constant over the interior of this interval.

It is useful to consider the sequential formulation of the decision problem. Taking the present and future occupational choices as given and writing the resulting first and second period utilities net of cost of investing in patience as $u_{1,t}$ and $u_{2,t}$, we can substitute for β_t and write the remaining decision problem over the l_t on the interval $[\underline{\beta}, \overline{\beta}]$ as:

$$v(\beta) = \max \Big\{ \chi(l_0) u_{1,0} + \beta u_{2,0} + \sum_{t=1}^{\infty} z^t \left[\chi(l_t) u_{1,t} + \left((1-\delta)^t \beta + \sum_{s=0}^{t-1} (1-\delta)^{t-s-1} f(l_s) \right) u_{2,t} \right] \Big\}. \quad (1.35)$$

For given current and future occupations, (1.35) is strictly concave in l_t for all t, since χ is concave and f is strictly concave. Moreover, the discount factor β and all expressions involving l_t appear in separate terms in the sum. Therefore, it follows that, given the optimal income profiles, for all t the optimal l_t is unique, and independent of β. Since on the interior of $[\underline{\beta}, \overline{\beta}]$, the current and future optimal occupations are unique, the optimal policy correspondence $l(\beta)$ is single-valued. By construction of the intervals, at the boundary between the two intervals both occupations are optimal choices for at least one generation, hence $l(\beta)$ may take on more than one optimal value, one corresponding to each optimal set of income profiles.

The optimal value function v over the interval $[\underline{\beta}, \overline{\beta}]$ is given by (1.35) with occupations and investment in patience l_t fixed at their optimal (and constant) values. Equation (1.35) is linear in β; it therefore follows that the value function is piecewise linear, with each kink corresponding to the boundary between two of the intervals. □

Proof of Proposition 4. Since f is an increasing function and we assume that $\delta < 1$, the law of motion is strictly increasing in β. Notice that $l(\beta)$ may not be single-valued for all β. Strictly increasing here means that $\overline{\beta} < \underline{\beta}$ implies $\overline{\beta}' < \underline{\beta}'$ for all optimal $\overline{\beta}' \in g(\overline{\beta})$ and $\underline{\beta}' \in g(\underline{\beta})$, even if $g(\overline{\beta})$ or $g(\underline{\beta})$ is a set. For a given β_0, the law of motion g defines (potentially multiple) optimal sequences of discount factors $\{\beta_t\}_{t=0}^{\infty}$. Any such sequence is a monotone sequence on the compact set $[0, \beta_{\max}]$, and must therefore converge. Notice, however, that since $l(\beta)$ is not single-valued everywhere, different steady states can be reached even from the same initial β_0. □

Proof of Lemma 1. Assume that (1.23) holds with equality:

$$v^E = \chi(l^{EW})\psi^{1-\sigma} + \beta^E ((1+g)\eta)^{1-\sigma} + z(1+g)^{1-\sigma}\left(\chi(l^W) + \beta^{EW}(1+g)^{1-\sigma}\right) + z^2(1+g)^{2(1-\sigma)} v^W. \quad (1.36)$$

Now replacing l^{EW} and β^{EW} on the right-hand side with l^E and β^E lowers utility, because these are not the optimal choices given the chosen occupations. We therefore have:

$$\chi(l^E)\psi^{1-\sigma} + \beta^E ((1+g)\eta)^{1-\sigma} + z(1+g)^{1-\sigma} v^E$$
$$> \chi(l^E)\psi^{1-\sigma} + \beta^E ((1+g)\eta)^{1-\sigma} + z(1+g)^{1-\sigma}\left(\chi(l^W) + \beta^E (1+g)^{1-\sigma}\right) + z^2(1+g)^{2(1-\sigma)} v^W,$$

where we also rewrote the left-hand side to explicitly show the first-generation utility. Now subtracting the (identical) first-generation terms on both sides and dividing by $z(1+g)^{1-\sigma}$ we get:

$$v^E > \left(\chi(l^W) + \beta^E (1+g)^{1-\sigma}\right) + z(1+g)^{1-\sigma} v^W,$$

which is (1.22) as a strict inequality.

Moving on, replacing the β^E of the initial generation on both sides of (1.36) with β^W leaves the equality intact, because the discount factor enters both sides in the same way:

$$\begin{aligned}&\chi(l^E)\psi^{1-\sigma} + \beta^W ((1+g)\,\eta)^{1-\sigma} + z(1+g)^{1-\sigma} v^E \\ &\quad = \chi(l^{EW})\psi^{1-\sigma} + \beta^W ((1+g)\,\eta)^{1-\sigma} + z(1+g)^{1-\sigma}\left(\chi(l^W) + \beta^{EW}(1+g)^{1-\sigma}\right) \\ &\qquad + z^2(1+g)^{2(1-\sigma)} v^W. \end{aligned} \tag{1.37}$$

Now switching the first-generation occupational choice from entrepreneurship to work yields the following strict inequality:

$$\begin{aligned}&\chi(l^{WE}) + \beta^W (1+g)^{1-\sigma} + z(1+g)^{1-\sigma}\left(\chi(l^E)\psi^{1-\sigma} + \beta^{WE}((1+g)\,\eta)^{1-\sigma}\right) \\ &\quad + z^2(1+g)^{2(1-\sigma)} v^E < v^W.\end{aligned}$$

The strict inequality arises because $l^{EW} < l^E$, implying that the increase in the first-period utility from being a worker is larger on the right-hand side. This still applies after investment in patience is reoptimized (to l^{WE} on the left-hand side and l^W on the right-hand side) due to the envelope theorem. The resulting inequality is a strict version of (1.25).

Finally, again starting with (1.37), replacing the initial investment in patience with l^{EW} (and plugging in the corresponding discount factor in the next generation) lowers utility on the left-hand side, so that we have:

$$\begin{aligned}&\chi(l^{EW})\psi^{1-\sigma} + \beta^W ((1+g)\,\eta)^{1-\sigma} + z(1+g)^{1-\sigma}\left(\chi(l^E)\psi^{1-\sigma} + \beta^{EW}((1+g)\,\eta)^{1-\sigma}\right) \\ &\quad + z^2(1+g)^{2(1-\sigma)} v^E \\ &< \chi(l^{EW})\psi^{1-\sigma} + \beta^W ((1+g)\,\eta)^{1-\sigma} + z(1+g)^{1-\sigma}\left(\chi(l^W) + \beta^{EW}(1+g)^{1-\sigma}\right) \\ &\quad + z^2(1+g)^{2(1-\sigma)} v^W.\end{aligned}$$

Subtracting the identical first-generation terms and dividing by $z(1+g)^{1-\sigma}$ yields:

$$\begin{aligned}&\chi(l^E)\psi^{1-\sigma} + \beta^{EW}((1+g)\eta)^{1-\sigma} + z(1+g)^{1-\sigma} v^E \\ &\quad < \chi(l^W) + \beta^{EW}(1+g)^{1-\sigma} + z(1+g)^{1-\sigma} v^W.\end{aligned}$$

Now changing the initial discount factor from β^{EW} to $\beta^{W} < \beta^{EW}$ lowers the left-hand side yet again more than the right-hand side (because $\eta > 1$), so that the inequality stays intact:

$$\chi(l^E)\psi^{1-\sigma} + \beta^W((1+g)\eta)^{1-\sigma} + z(1+g)^{1-\sigma}v^E < v^W,$$

which is a strict version of (1.24). □

Proof of Proposition 5. The fraction of entrepreneurs λ in the balanced growth path can be mapped into an entrepreneurial premium η and a growth rate g given the analysis in Section 1.2.3 above. The entrepreneurial premium is continuous in λ. Hence, if there exists a fraction of entrepreneurs λ that satisfies $0 < \lambda < 1$ and such that conditions (1.22)–(1.25) hold as strict inequalities, there has to be a range of λ and associated η and g such that the conditions continue to hold. If at the initial λ condition (1.23) holds with equality, then given Lemma 1 we know that the remaining constraints hold as strict inequalities. Given continuity it is then possible to raise η (by changing λ) within some range and have all conditions hold as strict inequalities, implying that a continuum of balanced growth paths exists. The same argument can be applied reversely to the point where (1.25) holds as an equality. The highest entrepreneurial return that is consistent with balanced growth is characterized by (1.25) holding as an equality. □

Proof of Proposition 6. Since the financial market allows for an arbitrary allocation of consumption across the two periods, an occupation that is dominated in terms of the present value of income is also dominated in terms of consumption, and therefore is never chosen. Hence, the set of optimal occupations is independent of patience β, because the present value of income in the two occupations does not depend on β. When both occupations yield the same present value of income, they also lead to the same consumption profile. The cost of investing in patience depends only on first-period consumption, which therefore does not depend on the chosen occupation. Likewise, the return to investing in patience is independent of the occupation of the current generation. Investment in patience therefore does not depend on which occupation is chosen. □

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