

Intergenerational Transmission of Risk Preferences, Entrepreneurship, and Growth*

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November 2011

Abstract

We develop a theory of the intergenerational transmission of risk preferences. Parents can instill either risk tolerance or risk aversion in their children, and face both altruistic and paternalistic motives in this process. Risk-tolerant children are more likely to benefit from profitable but risky opportunities, such as the career choice of being an entrepreneur. However, risk-tolerant children may also engage in other risky choices (such as smoking or riding motorcycles) that the parents disagree with. In our model, the transmission of risk preferences feeds back into the growth rate of the economy, because risk-taking entrepreneurs are essential for endogenous technological innovation. The theory has implications for how the extent and nature of risk in the economic environment affects the transmission of risk preferences, entrepreneurship, and growth.

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1 Introduction

It has long been recognized that entrepreneurship is a key driver of innovation and growth in a modern economy. Likewise, it has been well documented that there is substantial variation in entrepreneurship across countries, regions, and specific social groups within a country. These observations suggest that developing a theory that can account for some of the observed variation in entrepreneurship is an important task for the theory of economic growth and development.¹

The empirical literature on entrepreneurship has identified a number of characteristics of “typical” entrepreneurs. Not surprisingly, one important factor is wealth: entrepreneurship often requires investment, and if collateral is limited *ceteris paribus* wealthy individuals should be more likely to become entrepreneurs. We focus on an additional determinant of entrepreneurship, namely preferences, and in particular risk tolerance. Entrepreneurship is, in its nature, a risk-taking activity: great success can be as likely as bankruptcy, and for every Bill Gates and Steve Jobs there are many others who have failed.² In this light, highly risk tolerant people should be much more likely to select into entrepreneurship, and this is indeed what the literature finds.³ Moreover, it has also been documented that there is substantial variation in risk tolerance across different groups of people.⁴ Explaining variation in risk tolerance is then a key challenge for a theory that aims to account for entrepreneurship.

The objective of this paper is to develop a theory of the intergenerational transmission of risk preferences from parents to children, with the aim of accounting

¹The notion of a distinct entrepreneurial culture goes back at least to Weber’s hypothesis of a “spirit of capitalism” (Weber 1905). While some of Weber’s specific ideas (in particular regarding the role of Protestantism) are contested, the observation that entrepreneurship is concentrated in specific groups is equally relevant today (one example is the considerable economic success of ethnic Chinese immigrants in a number of Asian countries).

²The link between entrepreneurship and risk taking was already pointed out by classical economists and was a major emphasis in the work of Frank Knight, such as Knight (1921). A seminal theoretical contribution on the selection of risk-tolerant individuals into entrepreneurship is due to Kihlstrom and Laffont (1979). For recent theoretical work on risk and entrepreneurship see also Vereshchagina and Hopenhayn (2009).

³See for example van Praag and Cramer (2001), Cramer et al. (2002), and Kan and Tsai (2006).

⁴See, for example, Dohmen et al. (2011) and Bonin et al. (2009); the latter paper focuses on migrant-native differences.

for some of the observed variation in risk tolerance (and ultimately entrepreneurship). We develop a theoretical model in which parents make a conscious effort to form their children's risk preferences. A central feature of the theory is that parents face both altruistic and paternalistic motives when transmitting risk preferences to their children. On the one hand, parents are altruistic in the sense that they would like their children to be able to deal with risk, i.e., to not be overly afraid and to be able to benefit from profitable, but risky, opportunities. On the other hand, we allow for the possibility that parents disagree with children over the proper amount of risk taking. This possibility is highly relevant because risk tolerance is known to decrease over an individual's life, suggesting that parents are usually more risk averse than their adolescent children. Indeed, casual observation suggests routine disagreement between parents and children regarding the proper amount of risk-taking in areas such as driving cars, riding motorcycles, and experimenting with recreational drugs. This disagreement introduces a paternalistic motive, whereby parents attempt to form their children's preferences in order to affect their choices in the direction preferred by the parent.

We show how altruistic and paternalistic motives lead to a mapping from risk in the economic environment to transmitted risk preferences. It is demonstrated that the mapping from risk into preferences is not linear, but depends crucially on the endogeneity of risk, i.e., the extent to which risk is either unavoidable or is a function of a child's future choices. The model of preference transmission is then embedded into a growth model with endogenous innovation, where innovation is a risky activity carried out by entrepreneurs. The model makes predictions for how characteristics of the technology in the economy as well as other dimensions of risk determine risk preferences, entrepreneurship, and growth.

The paper connects to a number of different branches of the literature. Most directly, our research is linked to the recent literature on unified growth theory, which aims to account for economic growth over long time periods, and in particular for the transition from pre-industrial stagnation to modern growth. Within this literature, a number of authors have also considered variations in preferences and culture over time as potential driving forces. The first paper in this line of research is Galor and Moav (2002). The most closely related paper is Galor and

Michalopoulos (2011), which also focuses on the determination of risk tolerance but takes an evolutionary perspective. We also build on our earlier work on the origins of the “spirit of capitalism” (Doepke and Zilibotti 2005, Doepke and Zilibotti 2009). As in the present analysis, these papers build on an explicit model of preference transmission and also focus on the origins of entrepreneurship; however, there is no discussion of risk or risk tolerance. Finally, we build on growth models with endogenous innovation, and in particular on Schumpeterian growth models of the kind developed by Aghion and Howitt (1992), where innovation is a distinct (and risky) economic activity. The role of risk in the long-run growth process has also been discussed by Acemoglu and Zilibotti (1997).

More generally, the paper relates to the recent literature on culture and economics, see for example Tabellini (2010) and the recent surveys by Guiso, Sapienza, and Zingales (2006), Fernández (2008), and Fernández (2011). Within this literature, the paper relates most closely to work that also links cultural differences to conscious socialization efforts on the part of parents. A seminal paper in this literature is Bisin and Verdier (2001); see Fernández-Villaverde, Greenwood, and Guner (2011) for a recent contribution.⁵

One underlying issue that a theory of preference transmission has to confront is the question whether observed preference differences are due to nature or nurture. Our knowledge on this question is far from settled; empirically evaluating theories of preference transmission from parents to children is notoriously difficult due to the lack of available data. Nevertheless, there are at least a number of indications that strongly suggest that nurture has some role to play.⁶ A number of papers demonstrate that personal experience of macroeconomic shocks and other risky events have an impact on measured risk preferences, which shows that there is more to risk preferences than genes (see in particular Guiso and Paiella 2008 and Malmendier and Nagel 2011). Regarding gender differences in risk tolerance, Booth and Nolen (2009) show that there is substantial gap in risk taking between women that have been educated in all-girl schools versus those

⁵Bowles (1998) provide a survey of endogenous preferences in economics.

⁶Of course, genetic variation is likely to also be important. What matters for the theory is not that nurture is the only or main determinant of risk preferences; rather, we only need that the nurture channel is sufficiently strong to make a meaningful contribution to variation in risk tolerance across groups of people.

that went to co-ed institutions, suggesting that socialization is important. Finally, Dohmen et al. (2011) provide a detailed study of risk preferences and risk taking using a panel data set that contains multiple generations. They find strong correlations of risk preferences between parents and children. Moreover, risk preferences are not just correlated in general (which could be due to genes), but the correlations are specific for risk taking in specific situations, such as financial matters, health, career, and car driving. While this evidence is not conclusive, the specificity of the correlation in risk preferences strongly suggest that socialization has an important role to play.

2 A Model of the Intergenerational Transmission of Risk Preferences

This section provides a step-by-step exposition of the proposed model of preference transmission. In the full setup, the production side of the economy features endogenous innovation with an expanding variety of products, where the innovation activity is risky (i.e., innovators may either fail or succeed). However, for brevity and ease of exposition we first describe the core of the theory, namely the model of endogenous preference transmission, combined with a simplified production setup. Below, we indicate how this preference transmission model can be embedded into a model of endogenous innovation.

2.1 The Basic Structure of the Model of Preference Transmission

The model economy is populated by overlapping generations people who live for two periods, adolescence and adulthood.⁷ The mass of the adult population is constant and normalized to one. Everyone gives birth to one child at the beginning of adulthood. A key feature of the model is that parents invest in children's

⁷We label the first period as adolescence, rather than childhood, to emphasize that this is an age at which people already get to make some decisions. One can envision the first period of life as consisting of two sub-periods, childhood and adolescence, where only the second sub-period is explicitly modeled because children do not make any decisions.

risk tolerance. We parameterize risk tolerance by $a \in [\underline{a}, \bar{a}]$ where risk tolerance is increasing in a . adults can choose the risk tolerance parameter a' that they would like to endow their children with. However, parents can affect their children's risk tolerance only with probability $1 - \pi$. With probability π , preference transmission fails and children get the default risk tolerance $\hat{a}$.⁸

The risk tolerance parameter a , once determined by the parent, is fixed over a person's life. Nevertheless, there is still a time profile in actual risk aversion, because adolescents and adults have different period utility functions. Adults' preferences over consumption are ruled by a von Neumann-Morgenstern utility function $u(c|a)$, where u is increasing and concave in c , increasing in a , and risk aversion is decreasing in a . In contrast, adolescents evaluate outcomes with period utility function $u^Y(c|a)$, which satisfies the same assumptions. In line with empirical evidence, we assume that u induces preferences that exhibit higher risk aversion than u^Y . That is, for every individual risk aversion is increasing over the life cycle, but people with a higher a are less risk averse in both periods of life.

During both adolescence and adulthood, people face potentially risky choices. The degree of risk tolerance determines how people feel about risk and, hence, which choices they take. When determining their child's risk tolerance parameter a' , parents have both altruistic and paternalistic motives. To analyze these motives in a tractable way, we assume that altruism and paternalism apply to different periods of a child's life: parents are paternalistic towards their adolescent children, but they are altruistic once the children reach adulthood. Here paternalism means that parents evaluate the children's choices using their own, and not the child's utility function. In contrast, parents evaluate their children's future choices during adulthood using the child's utility function.

While the separation between altruism and paternalism regarding different periods of a child's life is perhaps more stark in the model than in reality, we believe that the overall time profile is realistic. The very term "paternalism" suggest an attitude that is linked to parenting, i.e., the relations between parents and children as long as the children are young. With regards to risk attitudes, it seems

⁸The stochastic nature of preference transmission avoids the possibility of multiple degenerate steady states.

obvious that parents are paternalistic towards their children for at least some time: indeed, a lot of parenting effort goes into preventing children from getting harmed, often against the children's stated will. It is less obvious but still highly plausible that paternalism is also relevant when the children are adolescents, when they can take some decisions for themselves. Adolescents are subject to various risks, and given that risk tolerance declines with age (risk tolerance is particularly high for male adolescents) it seems plausible, and rhymes with conventional wisdom, that their parents may disagree with their choices during this age. In contrast, it should be easier for parents to trust their children to do the right thing later on when the children have reached adulthood themselves.

In this simplified environment, we model decisions and outcomes in the simplest possible way: At each stage of the life cycle, people face a choice between two lotteries, where one is relatively more safe (S) whereas the other is more risky (R). We interpret the choice of lotteries at the adult stage as an occupational choice, where the risky choice corresponds to entrepreneurship, an activity with potentially high rewards but also high risk. In contrast, we envision risk-taking at the juvenile stage as the kind of activity that may lead to disagreement with parents about the correct choice, such as the decisions on whether to smoke, to ride a motorcycle, or to try drugs. Despite these different interpretations, technically the choices are modeled in the same way as choices between different consumption lotteries.

We express the decision problems of adolescents and adults recursively. The individual state variable is given by the risk tolerance parameter a , and the aggregate state vector (which will play a role in the general-equilibrium analysis) is denoted as Ω , with aggregate law of motion $\Omega' = \Gamma(\Omega)$. The value function of an adult with endowed risk tolerance parameter a can be written as:

$$v(a, \Omega) = \max_{a^Y} E_{a'} \left\{ \max \{ Eu(c_{SO}|a), Eu(c_{RO}|a) \} + z \left[(1 - I^Y(a', \Omega)) Eu(c_{SY}|a) + I^Y(a', \Omega) Eu(c_{RY}|a) + \beta v(a', \Gamma(\Omega)) \right] \right\}. \quad (1)$$

Here the choice a^Y is the risk tolerance parameter that the parent tries to assign to their child. The first expectation operator is over the actual realization of the

child's risk tolerance, which is equal to a^Y with probability $1 - \pi$ and equal to $\hat{a}$ with probability π . The remaining term on the first line represents the optimal choice of the parents between the safe and risky adult lotteries c_{SO} and c_{RO} . The second line represents utility derived from the child, where $0 < z < 1$ is the overall weight attached to the welfare of the child. The first terms denote the utility derived from the child's juvenile choice between the safe and risky lotteries c_{SY} and c_{RY} . Notice that these choices are *not* evaluated with the child's utility function, but with the adult's utility function and risk tolerance: the parent is paternalistic towards the juvenile child. As a consequence, adult and child may disagree about the correct choice, so that we cannot simply nest a maximization operator, but have to take the choice of the child as given. Hence, $I^Y(a', \Omega)$ is an indicator function that denotes whether the child takes the risky juvenile action, as a function of her risk tolerance parameter a' . Finally, the parent also derives utility from the child's adult choices. Given that the parent is altruistic towards the child in adulthood, this utility can be represented by the value function $v(a')$, where β is the discount factor between the juvenile and adult periods.

The choice $I^Y(a', \Omega)$ is taken by the adolescent by maximizing her own utility. The adolescent's value function has a similar structure, but the adolescent choice is evaluated using the young-age value function. The value function $v^Y(a', \Omega)$ of the adolescent with risk tolerance parameter a' then satisfies the Bellman equation:

$$v^Y(a', \Omega) = \max \{ Eu^Y(c_{SY}|a'), Eu^Y(c_{RY}|a') \} + \beta v(a', \Gamma(\Omega)). \quad (2)$$

This is similar, but not identical to the second line in (1), because utility during adolescence is evaluated using utility function $u^Y(c|a')$. Given that the adolescent makes her own decisions, this Bellman equation determines the adolescent's choice $I^Y(a', \Omega)$ that enters the parent's value function. This choice is given by:

$$I^Y(a', \Omega) = \operatorname{argmax}_I \{ (1 - I) Eu^Y(c_{SY}|a') + I Eu^Y(c_{RY}|a') \}.$$

We write the choice as a function of the aggregate state Ω also, because in general the aggregate state can affect the lotteries. The maximization problem has a

simple solution, which is given by:

$$I^Y(a', \Omega) = \begin{cases} 1 & \text{if } Eu^Y(c_{RY}|a') > Eu^Y(c_{SY}|a') \\ 0 & \text{if } \quad \quad \quad \text{else.} \end{cases}$$

2.2 Characterization of the Choice Problem

We now move towards characterizing the solution of the choice problem defined in (1) and (2). A special role is played by the level of risk tolerance that makes adolescents just indifferent between taking the safe and risky actions. We hence define:

Definition 1 *Let $\tilde{a}$ to be such that $Eu^Y(c_{RY}|\tilde{a}) = Eu^Y(c_{SY}|\tilde{a})$.*

For the following discussion, we introduce a number of additional assumptions that focus attention on the most interesting cases.

Assumption 1 *For all feasible aggregate states Ω , $Eu(c_{RO}(\Omega)|\tilde{a}) < Eu(c_{SO}(\Omega)|\tilde{a})$.*

This assumption guarantees that it is not possible to induce the child to take entrepreneurship opportunities (i.e., the risky choice during adulthood) but reject the risky choice during adolescence. Hence, from the parent's perspective risk taking during adolescence is a price they have to pay if they would like their child to become an entrepreneur.⁹ Notice that this assumption ultimately depends on the return to entrepreneurship, which in a general-equilibrium setting can be controlled through appropriate technological restrictions (see discussion below).

Assumption 2 *$Eu(c_{RY}|\bar{a}) < Eu(c_{SY}|\bar{a})$.*

⁹We need to impose a specific assumption for this because choices are binary; with continuous choices that are not constrained by corners this would be true more generally.

This assumption guarantees that parents dislike their children taking risk, irrespective of their own risk aversion. Again, this assumption serves to focus attention on the interesting cases in which paternalism is operative, in the sense that parents potentially disagree with their children's choices.

With these assumptions in hand, we can now characterize the optimal choices. Let $U(a^Y, a, \Omega)$ be the function that is maximized on the right-hand side of (1):

$$\begin{aligned} U(a^Y, a, \Omega) \equiv & \max \{Eu(c_{SO}|a), Eu(c_{RO}|a)\} \\ & + (1 - \pi)z [(1 - I^Y(a^Y, \Omega))Eu(c_{SY}|a) + I^Y(a^Y, \Omega)Eu(c_{RY}|a) + \beta v(a^Y, \Gamma(\Omega))] \\ & + \pi z [(1 - I^Y(\hat{a}, \Omega))Eu(c_{SY}|a) + I^Y(\hat{a}, \Omega)Eu(c_{RY}|a) + \beta v(\hat{a}, \Gamma(\Omega))] . \end{aligned}$$

Lemma 1 *Parents choose either $a^Y = \tilde{a}$ or $a^Y = \bar{a}$.*

Proof: U is a piece-wise increasing function of a^Y with a downward discontinuity at $a^Y = \tilde{a}$, since at this point the adolescent starts to choose the risky lottery (which lowers utility because of Assumption 2). Thus, U is maximized either at $a^Y = \tilde{a}$ or at $a^Y = \bar{a}$. $\square$

Intuitively, all else equal parents would like to give their children the largest possible a (namely $\bar{a}$) since utility is increasing in risk tolerance. Strictly in terms of utility, it is good for the child to be unafraid and able to tolerate risk. However, because parents and children evaluate choices during adolescence differently, parents also fear that children will take too much risk (i.e., chose the lottery c_{RY} over c_{SY}). Depending on which of these motives dominates, they may choose either the largest possible a or the highest level of risk tolerance such that children will not get into “trouble” by choosing c_{RY} . Figure 1 illustrates the situation.

Lemma 1 implies that, without loss of generality, we can restrict attention to a distribution of preferences with positive mass at only three points: $\tilde{a}$, $\hat{a}$, and $\bar{a}$. Any other initial distribution would lead to such a distribution after one period.

The next question that arises is which parents assign which risk tolerance to their children. To this end, it can be shown that $U(\bar{a}, a, \Omega) - U(\tilde{a}, a, \Omega)$ is increasing in a . The following lemma then follows.

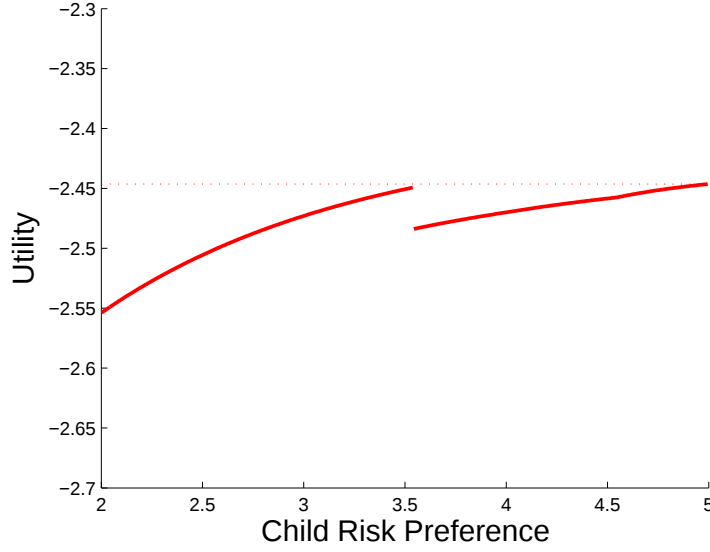


Figure 1: Utility of Parent as Function of Risk Tolerance Transmitted to Child

Lemma 2 Let $a^Y = A(a, \Omega)$ denote the policy function for the choice of the child's preferences.

1. If $\tilde{a} \in A(\bar{a}, \Omega)$, then $\tilde{a} = A(\tilde{a}, \Omega) = A(\hat{a}, \Omega)$. That is, if some parents with $a = \bar{a}$ choose $a^Y = \tilde{a}$, then all parents with $a = \tilde{a}$ and all parents with $a = \hat{a}$ choose $a^Y = \tilde{a}$ as well.
2. If $\bar{a} \in A(\min\{\hat{a}, \tilde{a}\}, \Omega)$, then $\bar{a} = A(\max\{\hat{a}, \tilde{a}\}, \Omega) = A(\bar{a}, \Omega)$. That is, if some parents with $a = \min\{\hat{a}, \tilde{a}\}$ choose $a^Y = \bar{a}$, then all other parents choose $a^Y = \bar{a}$ as well.
3. If both $\bar{a} \in A(\max\{\hat{a}, \tilde{a}\}, \Omega)$ and $\tilde{a} \in A(\max\{\hat{a}, \tilde{a}\}, \Omega)$, then $\bar{a} = A(\bar{a}, \Omega)$ and $\tilde{a} = A(\min\{\hat{a}, \tilde{a}\}, \Omega)$. That is, if parents with $a = \max\{\hat{a}, \tilde{a}\}$ are indifferent between $a^Y = \bar{a}$ and $a^Y = \tilde{a}$, then all parents with $a = \bar{a}$ choose $a^Y = \bar{a}$, whereas all parents with $a = \min\{\hat{a}, \tilde{a}\}$ choose $a^Y = \tilde{a}$.

Proof: It is sufficient to show that:

$$U(\bar{a}, a, \Omega) - U(\tilde{a}, a, \Omega)$$

is strictly increasing in a , that is, parents with high risk tolerance derive relatively higher utility from their children taking the risky choice. Writing out the expression gives:

$$U(\bar{a}, a, \Omega) - U(\tilde{a}, a, \Omega) = (1 - \pi)z [Eu(c_{RY}|a) - Eu(c_{SY}|a) + \beta v(\bar{a}, \Gamma(\Omega)) - v(\tilde{a}, \Gamma(\Omega))].$$

Risk tolerance a only enters the first term, and this difference is increasing in risk tolerance because by assumption c_{RY} is riskier than c_{SY} . $\square$

The lemma establishes the intuitive result that more risk-tolerant parents are more likely to endow their children with a high degree of risk tolerance. Notice that we do not assume that it is cheaper for risk-tolerant parents to invest in risk tolerance (the cost of investment is in fact zero for everyone). Rather, the result obtains because risk-tolerant parents are less afraid of their children taking risky actions during adolescence. Assuming that risk-tolerant parents have a lower cost of investing or assuming some direct preference transmission (say, because of a genetic component of risk taking) would only reinforce this result.

As a final step in the characterization of the choice problem, we discuss how the nature of risk in the economic environment affects the transmission of risk tolerance. As far as risk during adulthood is concerned, this mapping is simple, as parents simply want to maximize the child's utility. This implies, for example, that if the average return to the risky choice increases relative to the safe choice, the parents have an increased desire to endow their children with the high risk tolerance $\bar{a}$ instead of $\tilde{a}$.

The situation is more complicated for the juvenile choices. A key distinction here is between *endogenous* and *exogenous* risk, i.e., the extent to which juvenile risk depends on the choice of the child. To clarify this relationship, we parameterize the juvenile lottery as follows:

$$\begin{aligned} Eu(c_{SY}|a) &= p_{SY}u(c_{SY}(L)|a) + (1 - p_{SY})u(c_{SY}(H)|a) \\ Eu(c_{RY}|a) &= (1 - \lambda^Y)Eu(c_{SY}|a) \\ &\quad + \lambda^Y[p_{RY}u(c_{RY}(L)|a) + (1 - p_{RY})u(c_{RY}(H)|a)]. \end{aligned}$$

Hence, the safe choice is simply a lottery between a low and a high consumption value. The risky lottery reverts to the safe lottery with probability $1 - \lambda^Y$, and with probability λ^Y another, more risky binary lottery is reached. Here λ^Y can be interpreted as the arrival rate of “dangerous” juvenile opportunities. In other words, even an adolescent that would like to take risky choices in principle may not have the opportunity to do so. For example, to experiment with smoking or other drugs one usually first has to come into contact with people who provide access to such opportunities, and that may or may not happen for a given individual.

We can now interpret the risk inherent in lottery c_{SY} as exogenous, or unavoidable, juvenile risk. In contrast, the parameter λ^Y measures the exposure to endogenous juvenile risk, i.e., risk that can be avoided if the adolescent chooses the safe option.

It can now be shown that endogenous and exogenous juvenile risk have opposite effects on risk taking. An increase in exogenous risk induces parents to transmit higher risk tolerance to their children (i.e., transmitting $\bar{a}$ instead of $\tilde{a}$ becomes more attractive). Given that this type of risk cannot be avoided, paternalistic concern about the juveniles’ choices does not play a role, so that parents would like to increase their children’s ability to tolerate this risk. In contrast, an increase in endogenous risk, i.e., the parameter λ^Y , reduces parents’ incentive to transmit high risk tolerance to their children. Parents disagree with the adolescent’s choice of c_{RY} over c_{SY} , and when the risky choice becomes riskier compared to the safer alternative, this paternalistic motive gains in strength. The following proposition summarizes this result.

Proposition 1 *Holding constant the adult lotteries, p_{SY} , and $E(c_{SY})$, the utility difference $U(\bar{a}, a, \Omega) - U(\tilde{a}, a, \Omega)$ is increasing in the variance of c_{SY} (i.e., the difference $c_{SY}(H) - c_{SY}(L)$) and decreasing in λ^Y . Hence, an increase in exogenous juvenile risk increases parents’ incentives for transmitting high risk tolerance, whereas an increase in endogenous risk has the opposite effect.*

Having characterized the effect of juvenile risk on choices, we now move on to adult risk. As mentioned above, we interpret adult risk as being related to the oc-

cupational choice of being a worker or an entrepreneur. To make this connection concrete, we next introduce production and occupations into the model.

2.3 Introducing General Equilibrium

We now move to a general equilibrium setting. We start with a simple setting with a stationary technology, which will be sufficient to illustrate the dynamics of preferences and the returns to entrepreneurship. Below, we also outline how this model can be extended to a full growth model with endogenous innovation.

We assume (similar to Doepke and Zilibotti 2009) that the aggregate production function is a labor-only technology with two inputs, workers and entrepreneurs:

$$Y = F(X_W, X_E).$$

Here F is assumed to feature constant returns to scale and decreasing returns to each input and to satisfy the usual Inada conditions. Each worker supplies one efficiency unit of W -type labor, earning a safe wage w_W . In contrast to workers, entrepreneurs are subject to idiosyncratic, uninsurable shocks. After deciding to be an entrepreneur, an agent supplies $(1 + \sigma)$ efficiency units of E -type labor with probability p_E . In this case, he earns a return $(1 + \sigma) w_E$. With probability $1 - p_E$ he will only be able to supply $\left(1 - \sigma \frac{p_E}{1 - p_E}\right)$ units of labor, and earns $\left(1 - \sigma \frac{p_E}{1 - p_E}\right) w_E$. Note that under these assumptions $X_E = N_E$, where N_E is the number of agents choosing to be entrepreneurs. Likewise, $X_W = 1 - N_E$ (recall that the mass of adult people is normalized to one).

The technology is operated by competitive firms that hire both workers and entrepreneurs. Profit maximization implies that $w_E = F_{X_E}(1 - N_E, N_E)$ and $w_W = F_{X_W}(1 - N_E, N_E)$. The demand for entrepreneurs from firms decreases in the entrepreneurial premium η . More precisely, the inverse demand function is given by:

$$\eta \equiv \frac{w_E}{w_W} = \frac{X_E(1 - N_E, N_E)}{X_W(1 - N_E, N_E)}, \quad (3)$$

where the right hand-side is decreasing in N_E since the numerator is decreasing and the denominator is increasing in N_E .

With an explicit production structure in place, we can now be more specific about the aggregate state vector. Given that the technology is stationary and people only need to know the average wages of workers and entrepreneurs, the entrepreneurial premium η is a sufficient statistic for all consumers' choices. Thus, we set $\Omega = \eta$.¹⁰

We now turn to an analysis of steady states. In a steady state, the skill premium η is constant, $\Gamma(\eta) = \eta$. This implies that the proportion of entrepreneurs, N_E , is also constant. Recall that the support of the steady-state distribution of risk tolerance can be collapsed to three points, $a \in \{\hat{a}, \tilde{a}, \bar{a}\}$, which are independent of the state vector. Two cases are possible: 1.: $\tilde{a} < \hat{a} < \bar{a}$, or 2.: $\hat{a} < \tilde{a} < \bar{a}$. Case 1 appears more natural, and hence we focus on it here (the analysis for Case 2 follows similar lines). Note that in Case 1 only $\tilde{a}$ -type agents will decline the juvenile risk.

The steady-state distribution depends crucially on the optimal choice of parents at $a = \hat{a}$. If $A(\hat{a}, \eta) = \tilde{a}$, then the fraction of type- $\tilde{a}$ agents is $1 - \pi$ in the steady state (recall that the proportion of $\hat{a}$ -type is constant and equal to π). Conversely, if $A(\hat{a}, \eta) = \bar{a}$, the fraction of type- $\tilde{a}$ agents is zero. We will denote by η_{PREF} the (steady-state) threshold entrepreneurial premium such that the $\hat{a}$ type is indifferent between setting $a^Y = \bar{a}$ and setting $a^Y = \tilde{a}$: $U(\bar{a}, \hat{a}, \eta_{PREF}) = U(\tilde{a}, \hat{a}, \eta_{PREF})$. There are two additional important thresholds for the entrepreneurial premium. We denote by $\eta_{\hat{a}}$ the threshold such that the $\hat{a}$ type is indifferent between being a worker and being an entrepreneur, $Eu(c_{RO}(\eta_{\hat{a}}) | \hat{a}) = u(c_{SO}(\eta_{\hat{a}}) | \hat{a})$. Second, we denote by $\eta_{\bar{a}}$ the threshold such that the $\bar{a}$ type is indifferent between being a worker and being an entrepreneur, $Eu(c_{RO}(\eta_{\bar{a}}) | \bar{a}) = u(c_{SO}(\eta_{\bar{a}}) | \bar{a})$. Since $\bar{a} > \hat{a}$, we have $\eta_{\hat{a}} > \eta_{\bar{a}}$. In other words, there exists a range of entrepreneurial premia such that the $\bar{a}$ type become entrepreneurs while the $\hat{a}$ type become workers. The ranking of η_{PREF} depends instead on parameters, and three situations are possible: (i) $\eta_{PREF} < \eta_{\bar{a}} < \eta_{\hat{a}}$, (ii) $\eta_{\bar{a}} < \eta_{PREF} < \eta_{\hat{a}}$, (iii) $\eta_{\bar{a}} < \eta_{\hat{a}} < \eta_{PREF}$. The following lemmas can be established.

¹⁰Note that η and F determine uniquely both w_E and w_W . We will later extend the analysis to a model of endogenous technical change. In that case, $\Omega = \{\eta, N\}$, where N is the state of technical knowledge.

Lemma 3 *If $\eta < \max\{\eta_{PREF}, \eta_{\bar{a}}\}$, then the steady-state supply of entrepreneurs is $N_E = 0$. If $\eta > \max\{\eta_{PREF}, \eta_{\hat{a}}\}$, then the steady-state supply of entrepreneurs is $N_E = 1$.*

If $\eta < \eta_{PREF}$, then the $\hat{a}$ -type agents strictly prefer to endow their children with $\tilde{a}$ preferences. Thus, there is no positive measure of $\hat{a}$ -type agents in the steady state. If $\eta < \eta_{\bar{a}}$, then risk-tolerant ($\bar{a}$ -type) agents strictly prefer to be workers. So will do, *a fortiori*, $\hat{a}$ -type and $\tilde{a}$ -type agents. Thus, there would be no entrepreneurs in the steady state. A converse argument applies to the case $\eta > \eta_{PREF}$.

Lemma 4 (i) *If $\eta \in (\eta_{\hat{a}}, \eta_{PREF})$, the steady-state supply of entrepreneurs is $N_E = \pi$.*
(ii) *If $\eta \in (\eta_{PREF}, \eta_{\bar{a}})$, the steady-state supply of entrepreneurs is $N_E = 1 - \pi$.*

Clearly, the two cases are mutually exclusive, since (i) only arises if $\eta_{\bar{a}} < \eta_{\hat{a}} < \eta_{PREF}$ while (ii) only arises if $\eta_{PREF} < \eta_{\bar{a}} < \eta_{\hat{a}}$. Consider (i) first. In this case, there are no $\bar{a}$ -type agents in the steady state. Yet, the $\hat{a}$ -type agents (who make up measure π of agents in any steady state) strictly prefer to be entrepreneurs. In contrast, the $\tilde{a}$ -type agents (who make up measure $1 - \pi$ in this steady state) prefer to be workers. Next, consider (ii). Here there are no $\tilde{a}$ -type agents in the steady state. The $\hat{a}$ -type agents (who make up measure π) prefer to be workers. In contrast, the $\bar{a}$ -type agents (who make up measure $1 - \pi$ in this steady state) prefer to be entrepreneurs.

Combining these results, we have the following steady-state supply functions. If $\eta_{PREF} < \eta_{\hat{a}}$, we have:

$$N_E \begin{cases} = 0 & \text{if } \eta < \max\{\eta_{PREF}, \eta_{\bar{a}}\} \\ \in [0, 1 - \pi] & \text{if } \eta = \max\{\eta_{PREF}, \eta_{\bar{a}}\} \\ 1 - \pi & \text{if } \eta \in [\max\{\eta_{PREF}, \eta_{\bar{a}}\}, \eta_{\hat{a}}] \\ \in [1 - \pi, 1] & \text{if } \eta = \eta_{\hat{a}} \\ 1 & \text{if } \eta \in [\eta_{\hat{a}}, \eta_{\max}]. \end{cases} \quad (4)$$

If $\eta_{PREF} > \eta_{\hat{a}}$, we have:

$$N_E \begin{cases} = 0 & \text{if } \eta < \eta_{\hat{a}} \\ \in [0, \pi] & \text{if } \eta = \eta_{\hat{a}} \\ \pi & \text{if } \eta \in [\eta_{\hat{a}}, \eta_{PREF}] \\ \in [\pi, 1] & \text{if } \eta = \eta_{PREF} \\ 1 & \text{if } \eta \in [\eta_{PREF}, \eta_{\max}] \end{cases} \quad (5)$$

In both cases there is a monotonic entrepreneurial supply function. Figure 2 illustrate the determination of the steady state as a function of the demand for and supply of entrepreneurship. The upward sloping line is the supply function as given above. The downward sloping curve is the demand function as given in (3). The three horizontal lines denote η_{PREF} , $\eta_{\hat{a}}$, and $\eta_{\bar{a}}$, where in this example we have $\eta_{\bar{a}} < \eta_{PREF} < \eta_{\hat{a}}$.¹¹ Given that supply increases monotonically and demand decreases strictly monotonically with the entrepreneurial premium, the steady state is unique.

We can now analyze how changes in the economic environment affect equilibrium entrepreneurship. For brevity, we focus once again on the effects of changes in young-age risk (the effects of changes to the technology, i.e., the inherent risk and return to entrepreneurs versus workers, are straightforward). Note that any change in young-age risk only affects the threshold η_{PREF} . For example, an increase in endogenous young age risk λ^Y tends to increase η_{PREF} , which, in turn, implies a less risk-tolerant population, fewer entrepreneurs and a higher entrepreneurial risk. In contrast, an increase in unavoidable risk (e.g., parameterized by an increase in the risk associated to c_{SY}) has the opposite effect: parents want to turn their kids more risk tolerant. Thus, unavoidable risk tends to increase entrepreneurship in society.

Proposition 2 *Holding constant p_{SY} and $E(c_{SY})$, the steady-state threshold η_{PREF} is decreasing in the variance of c_{SY} (i.e., the difference $c_{SY}(H) - c_{SY}(L)$) and increasing in*

¹¹The computed example also features a Cobb-Douglas production function and CRRA preferences, where a determines the coefficient of relative risk aversion.

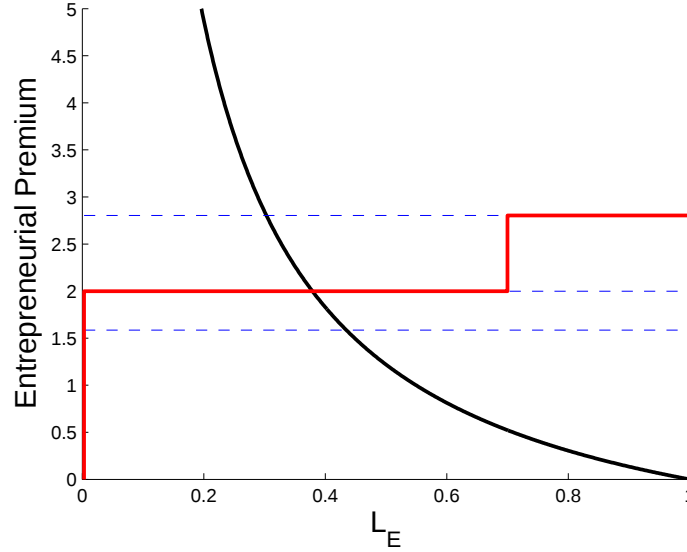


Figure 2: Determination of Steady State as a Function of Entrepreneurial Return and Number of Entrepreneurs

λ^Y . Hence, an increase in exogenous juvenile risk increases entrepreneurship in the long run, whereas an increase in endogenous risk leads to less entrepreneurship.

2.4 Endogenous Innovation

The general-equilibrium setup in the previous subsection describes a stationary environment in which the economy reaches a steady state in which income per capita is constant. Moreover, the entrepreneurs are not truly “entrepreneurial,” in the sense that they are standard employees of a representative firms whose labor endowment happens to be stochastic. Here we briefly outline how the same model of preference transmission can be embedded into a model of endogenous innovation, where the risky entrepreneurial activity is explicitly linked to innovation (as in Schumpeterian models of growth) and where entrepreneurial preferences ultimately affect economic growth.

The model is a variant of a setup with an increasing variety of intermediate inputs, indexed by N_t . In period $t + 1$, final output is produced using production

function:

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

where Q is a fixed factor (land), normalized to unity. To innovate (i.e., create new varieties $N_{t+1} - N_t$, entrepreneurs are required. Worker are needed to produce goods. Old varieties N_t (which were discovered at least one period ago) are sold in competitive markets. We assume that the productivity of both workers and entrepreneurs is indexed by N_t :

$$\begin{aligned} N_t \bar{x} + (N_{t+1} - N_t) x &= N_t X_t^W \Leftrightarrow \bar{x} + (1 + g) x = X^W, \\ \left(\frac{N_{t+1} - N_t}{\xi N_t} \right) &= X_t^E \Leftrightarrow \frac{1 + g}{\xi} = X^E. \end{aligned}$$

The competitive final producer maximize:

$$\frac{1}{\alpha} \left(\int_0^{N_t} \bar{x}(i)^\alpha di + \int_{N_t}^{N_{t+1}} x(i)^\alpha di \right) - \int_0^{N_t} \bar{p}(i) \bar{x}(i) di + \int_{N_t}^{N_{t+1}} p(i) x(i) di.$$

Next, we turn to the problem of the producers of intermediate goods. The old goods are produced competitively, thus:

$$\bar{p}(i) = \frac{w_W}{N} \equiv \omega_W, \quad \bar{x}(i) = \omega_W^{\frac{1}{\alpha-1}}.$$

The producers of new goods (i.e., the entrepreneurs) are monopolists. The profit per variety is $\Pi(i) = p(i) x(i) - \omega_W x(i)$. The maximization of profit subject to the demand constraint yields:

$$p(i) = p = \frac{\omega_W}{\alpha}, \quad x(i) = x = \left(\frac{\omega_W}{\alpha} \right)^{\frac{1}{\alpha-1}}, \quad \Pi(i) = \Pi = (p - \omega_W) x = (1 - \alpha) \left(\frac{\alpha}{\omega_W} \right)^{\frac{\alpha}{1-\alpha}}.$$

We can now solve for ω_W :

$$\begin{aligned} X^W &= \bar{x} + (1 + g) x = \omega_W^{\frac{1}{\alpha-1}} + (1 + g) \left(\frac{\omega_W}{\alpha} \right)^{\frac{1}{\alpha-1}}, \\ \omega_W &= \left(\frac{1 + (1 + g) \alpha^{\frac{1}{1-\alpha}}}{X^W} \right)^{1-\alpha} = \left(\frac{1 + \alpha^{\frac{1}{1-\alpha}} \xi X^E}{X^W} \right)^{1-\alpha}. \end{aligned}$$

Note that $\omega_W \geq 1$. Even in the absence of growth and entrepreneurship, workers earn a wage equal to N .

We can also solve for the entrepreneurial return. Denote by w_E the average entrepreneurial wage, and let $\omega_E \equiv w_E/N$. Then:

$$\omega_E = \xi \Pi = \xi (1 - \alpha) \left(\frac{\alpha}{\omega_W} \right)^{\frac{\alpha}{1-\alpha}} = \xi^{1-\alpha} (1 - \alpha) \left(\frac{\alpha^{\frac{1}{1-\alpha}} \xi X^W}{1 + \alpha^{\frac{1}{1-\alpha}} \xi X^E} \right)^{\alpha}.$$

Note that $\omega_E \in [0, \xi (1 - \alpha) \alpha^{\frac{\alpha}{1-\alpha}}]$. To ensure that the equilibrium entails entrepreneurship, we assume that $\xi > (1 - \alpha)^{-1} \alpha^{-\frac{\alpha}{1-\alpha}}$.

We assume the entrepreneurial return to be risky. In particular, the entrepreneur does not know in advance how successful she will be at inventing new varieties. With probability κ she will be able to run $(1 + \sigma) N$ projects (and, hence, earn $(1 + \sigma) \omega_E$), whereas with probability $1 - \kappa$ she will only be able to run $(1 - \sigma \frac{\kappa}{1-\kappa}) N$ projects (and, hence, earn $(1 - \sigma \frac{\kappa}{1-\kappa}) \omega_E$). We can then define the entrepreneurial premium as:

$$\eta \equiv \frac{w_E}{w_W} = (1 - \alpha) \alpha^{\frac{\alpha}{1-\alpha}} \frac{\xi X^W}{1 + \alpha^{\frac{1}{1-\alpha}} \xi X^E}.$$

By combining this innovation model with our model of preference transmission, we can generate a theory of the evolution of entrepreneurship where entrepreneurship is tightly linked to economic innovation and growth. Results parallel to those shown above for the simple production setup can then be established. In this model, changes in the risk environment have a long-run impact on risk tolerance, entrepreneurship, and growth.

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