Aspirations, risk preferences, and investments in agricultural technologies ☆

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ABSTRACT

We investigate the relationship between aspirations, risk preferences, and investment in agricultural technologies using data collected among cacao farmers in Ecuador. We first find that an inverted U-shaped relationship between the income aspirations gap and investments exists when considering relatively *long-term* investments (e.g., farm renovations) but not when considering relatively *short-term* investments (e.g., fertilizer use). Next, using lab-in-the-field experiments and survey instruments designed to elicit risk preferences, we show that the observed inverted U-shaped relationship is robust to the inclusion of risk preference parameters in our regression specification—a potentially important omitted variable in previous studies. Our empirical results are consistent with existing theory suggesting that aspirations that are ahead, but not too far ahead, of current levels provide the best incentives for investments in the future, and suggest the presence of psychological constraints to investments in agricultural technology.

1. Introduction

Agricultural and economic development rely on investment in agricultural technologies (Goldstein and Udry, 2008). Such investments are associated with considerable risk and, especially in low- and middle-income countries, missing or limited insurance markets make risk a critical constraint on investment in agricultural technologies (Feder et al., 1985; Besley and Case, 1993; Liu, 2013; Magruder, 2018). A growing literature also finds that aspirations may partially explain investment decisions (Fruttero et al., 2021). Specifically, existing empirical results demonstrate that aspirations can be either "too low" or "too high" to inspire risky yet productive investments (Janzen et al., 2017; Ross, 2019; Bloem, 2021; McKenzie et al., 2022) and imply the existence of an inverted U-shaped relationship between the aspirations gap (e.g., the distance between and individual's current and aspired levels) and investment choices (Genicot and Ray, 2017). Such a relationship suggests that psychological traits exert an influence on the allocation of resources towards agricultural technologies, and carries implications for the design of policies and programs that aim to inspire agricultural technology adoption.

In this paper, we study the relationship between aspirations and investment in relatively long-term or relatively short-term agricultural technologies while accounting for the influence of risk-taking behavior. To do so, we use data collected among cacao farmers in Ecuador and implement lab-in-the-field experiments to elicit risk preference parameters. We test the theoretical predictions implied in the work of Genicot and Ray (2017), which demonstrate the possibility of an

inverted U-shape relationship between the income aspirations gap and investments. Cacao production in Ecuador presents an appropriate setting to study aspirations, risk preferences, and agricultural investment choices. About 90 percent of Ecuador's cacao bean production is produced by small farmers cultivating one to five hectares (USDA FAS, 2015), and many of these small-scale cacao farms experience relatively low levels of productivity (Villacis et al., 2022b). This low productivity is associated with the use of old plantation trees (i.e., with ages of 60 or more years), less productive varieties, and the scant use of agricultural inputs.[1]

Investing in farm renovations and the use of agricultural inputs – such as fertilizers – can generate positive expected future payoffs among local farmers. However, by nature investing in these agricultural technologies is risky, as, for example, weather phenomena have severely affected local plantations in the past.[2] In addition, investing in a specific agricultural technology might be influenced by its time horizon, i.e., farm renovations using high-yielding cacao tree varieties requires much more time for payoffs to materialize than the seasonal use of agricultural inputs—such as fertilizer. These intricacies of the agricultural production process naturally raises the question as to whether risk preferences and/or time horizons are confounding factors in the relationship between aspirations and investments. Therefore, an investigation into how income aspirations and risk-taking behavior influence investment in different agricultural technologies fits well in the context of cacao cultivation in Ecuador.

We find two key results. In our first key result, we find an inverted U-shaped relationship exists when considering expenditures in farm renovations—an investment with a relatively long-term payoff schedule. We do not, however, find evidence of an inverted U-shaped relationship when considering expenditures on fertilizer—an investment with a relatively short-term payoff schedule. This is an important finding because although several studies test for an inverted U-shaped relationship or behavior consistent with "aspirations frustration" (Janzen et al., 2017; Ross, 2019; Bloem, 2021; McKenzie et al., 2022), none of these studies differentiate between relatively long-term vs. relatively short-term investments. Our results suggest that the time horizon of the investment can be an important dimension of heterogeneity.

Why might the time horizon on the investment be a potentially important dimension of heterogeneity in the inverted U-shaped relationship between the aspirations gap and investments? Aspirations are sufficiently future-oriented and are not about short-term goals or immediate gratification. As discussed by Bernard and Taffesse (2014), a person may exert effort to satisfy immediate hunger, or in contrast, a person may exert effort with a goal of becoming food secure in the future. The former does not count as an aspiration while the latter does. While this distinction may be clear conceptually, the empirical difference between sufficiently long-term investments and other short-term investments remains an open question.

In our second key result, we show that the observed inverted U-shaped relationship is robust to the inclusion of experimentally-elicited risk preference parameters in our regression specifications. This is an important finding because although risk preferences are an important factor for understanding agricultural investment behavior (Liu, 2013), the existing literature investigating the inverted U-shaped relationship with observational data has yet to directly account for variation associated with risk preferences in formal regression analysis.[3] Therefore,

risk preferences are a potentially important omitted variable in these previous studies.

In the model developed by Genicot and Ray (2017), which we summarize in Section 2 of this paper, if an individual's aspiration is achieved, then there is a positive relationship between the aspirations gap and investments. At the point at which an individual's aspirations is not achieved there is a sudden decrease in investments. When we assess the relationship between the aspirations gap and investments using observational data, it might be that the point at which aspirations are not achieved is correlated with a level of investment that a sufficiently risk averse (or loss averse) individual is no longer comfortable. If this is the case, then the observed inverted U-shaped relationship may, in part, be explained by underlying risk preferences rather than a true inverted U-shaped relationship between measured values of an individual's aspirations gap and investments.

Our paper contributes to the literature investigating how aspirations inspire future-oriented behavior (Lybbert and Wydick, 2018; Bernard et al., 2018; McKenzie et al., 2022). In particular, our analysis is most closely related to a sub-set of these studies that test for an inverted U-shaped relationship between the aspirations gap and future-oriented behavior (Janzen et al., 2017; Ross, 2019; Bloem, 2021).[4] Our work differs from previous studies and contributes to our understanding of the role of aspirations in the process of agricultural development in two particular ways.

First, we specifically contribute to the literature investigating the existence of an inverted U-shaped relationship between the aspirations gap and future-oriented behavior with observational data (Janzen et al., 2017; Ross, 2019; Bloem, 2021) in three important areas. Most fundamentally, we differentiate between investments with long-term vs. short-term payoffs, which is a yet-to-be explored source of heterogeneity in any existing empirical study. Next, we study investments in agricultural technologies, which have yet to be formally linked with the aspirations gap. Finally, with survey instruments and experimentally elicited measures of risk preferences, we are able to account for a potentially important omitted variable in the previous studies using observational data, and that plays an important role in the context of adoption of new agricultural technologies.

Second, we contribute to the classic literature on the adoption of high-yielding agricultural technologies in low- and middle-income countries (Feder et al., 1985; Besley and Case, 1993; Sunding and Zilberman, 2001; Conley and Udry, 2010; Foster and Rosenzweig, 2010; Magruder, 2018). We specifically link the study of the role of aspirations in inspiring investment behavior to the seemingly puzzling observation of farmers refraining from investing in welfare-improving agricultural technologies (Mobarak and Saldanha, 2022). Although a number of explanations that draw from the psychology or behavioral literature help explain the farmer's technology adoption decision – such as self-control or commitment problems (Duflo et al., 2011) – other than the recent insights of Knapp et al. (2021), our understanding of how aspirations relate to investment in agricultural technologies remains limited.

The remainder of this paper is organized as follows. In the next section, we briefly summarize the conceptual framework characterizing the theoretical relationship between the aspirations gap and investments. In Section 3, we briefly introduce the study setting and discuss how we measure key variables. In Section 4 we discuss our empirical strategy for estimating the relationship between the aspirations gap and investments in agricultural technologies. In Section 5 we present our main results and discuss a variety of robustness checks. Finally, Section 6 concludes and discuss policy implications.

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[2] El Niño phenomenon of 1998 decimated cacao production in Ecuador (Villacis et al., 2022a).

[3] It is important to note that many of these existing studies control for variables that are known to be correlated with risk preferences, and therefore partially account for variation representing risk preferences. This highlights that while accounting for individual risk preferences is a valid concern, it has yet to be directly accounted for in previous studies.

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[4] Our analysis also intersects with the recent work of Knapp et al. (2021), who integrate measures of risk preferences, personality traits, and aspirations in regressions predicting farmers' farm management choices.

2. Conceptual framework

Recent work by Genicot and Ray (2017) developed a model whereby aspirations that are ahead, but not too far ahead, of current levels provide the best incentive for investment choices. This theoretical model provides an empirically testable prediction of an inverted U-shaped relationship between the income aspirations gap and investments with possible positive returns in future income.

In the model developed by Genicot and Ray (2017), which is further summarized by Janzen et al. (2017), aspirations are modeled as an inter-temporal utility function with a reference point (Kahneman and Tversky, 1979). Importantly, aspiration achievement leads the individual to realize some level of "bonus" utility. This "bonus" utility leads to a piece-wise benefits function. In this benefits function, the net benefit in terms of utility is defined as the discounted net present value of consumption for income levels below some level of aspiration. For income levels above some level of aspiration, the individual realizes this discounted net present value plus the "bonus" utility.

If the aspiration is achieved or "satisfied" then there is a positive relationship between the aspiration gap and investment. However, if the aspiration is not achieved or "frustrated" then there is a sudden decrease in the level of investment. The point at which aspirations switch from being "satisfied" to being "frustrated" represents and individual's turning point in their relationship between their aspirations gap and their investment choices. If every individual held the same turning point value in their income aspiration gap relative to some investment choice, then we would see an upward-sloping relationship between the aspirations gap and investment with a discontinuous drop at this unanimous turning point value. Given the heterogeneity in the location of each individual's turning point, however, an inverted U-shaped relationship will form between the income aspirations gap and investment choices within a population of individuals.

Implicit in the model developed by Genicot and Ray (2017) is the inter-temporal nature of the utility function and the investment activity. This implies that the model of Genicot and Ray (2017) most appropriately applies to long-term investments that involve some distinctively future-oriented investment. We investigate this idea by testing for the inverted U-shaped relationship and distinguishing between long-term and short-term investments, using data from cacao farmers in Ecuador.

3. Data collection and measurement

Fieldwork for the data collection effort of this study was conducted between August and December 2021 in five coastal provinces of Ecuador (i.e., Esmeraldas, Guayas, Los Ríos, Manabí, and Santo Domingo de los Tsáchilas—see Figure A1 in the Supplemental Appendix) in partnership with the Ecuadorian Institute of Agricultural Research (INIAP). These provinces represent 80 percent of the total cacao area planted in the country (CFN, 2018). In a random subset of 25 villages, we conducted a household survey and lab-in-the-field experiments designed to elicit individual risk preferences. In total, our data include 523 cacao farmers from the 25 randomly selected villages in the five coastal provinces of Ecuador mentioned above. Over the course of the past decade, most of these villages were part of a nationwide INIAP extension program that promoted the adoption of pruning practices to rehabilitate older and non-productive cacao plantations. The household survey and the experimental sessions lasted about two hours for each farmer. Before the meetings, INIAP contacted village leaders by phone and asked them for cooperation and help in recruiting subjects. Village leaders were instructed to inform community members about the data collection visit logistics as well as any benefits or risks associated with participation in the study.

Summary statistics for each of the main variables that we use in this paper are shown in Table 1. Fertilizer expenditures are measured as the average expenses on fertilizer (including labor and inputs) during the

Table 1
Summary statistics.

	(1) Mean	(2) Std. Dev.	(3) Min.	(4) Max.	(5) Obs.
Panel A: Key variables					
Income aspiration gap	0.543	0.122	0.15	0.84	523
Farm renovation expenditures (USD)	194.67	563.20	0	5000	523
Fertilizer expenditures (USD)	256.03	835.29	0	16,200	523
DOSPERT investing index	11.44	3.74	3	21	523
PT risk aversion (σ)	0.621	0.452	0.05	1.5	523
PT probability distortion (α)	0.779	0,354	0.05	1.45	523
PT loss aversion (λ)	5.55	4.33	0.12	11.79	523
Panel B: Sample characteristics					
Age	49.47	15.63	17	87	523
Gender (female = 1)	0.268	0.443	0	1	523
Household size	4.08	1.72	1	10	523
Year of education	10.37	4.13	0	17	523
Area of cacao cultivation (hectares)	2.56	2.58	0.1	30	523
Cacao farming experience (years)	19.86	15.53	1	70	523
Annual income (USD)	8915.68	9133.60	800	72,000	523
Plantation age (years)	18.25	16.84	1	80	523

Notes: These summary statistics describe each of the key variables in our analysis along with other relevant variables that describe the composition of our sample of cacao farmers.

last five years. Likewise, farm renovations expenditures are measured as the average expenses on farm renovation (including labor and inputs) during the last five years. We use a time horizon of five years due to cacao trees normally require five years after planted to bear fruits and be harvested (Amores et al., 2011).[5]

3.1. Aspirations

We measure the aspirations gap by first asking participants to assess their current monthly income from farming activities. Next, we follow Bernard and Taffesse (2014) and ask participants the level of monthly income they would like to achieve in their life. Following Ray (2006), we define the aspirations gap as the difference between these two answers divided by the income aspiration, as follows:

$$\text{Income aspirations gap } = \frac{\text{income aspiration } - \text{ current income}}{\text{income aspiration}}. \quad (1)$$

Comparisons across individuals with different income levels is facilitated by the use of the aspirations gap presented in Eq. (1), as by definition, it is positive and bounded between zero and one (Janzen et al., 2017).[6] Panel A in Fig. 1 shows a histogram with the distribution of the income aspirations gap. In our data, none of our respondents report an aspirations gap at the extreme values of zero (i.e., representing current income equaling income aspiration) or one (i.e., representing zero current income). Panel B of Fig. 1 illustrates the relationship between current income and the income aspirations gap and shows that the income aspirations gap tends to be higher for households at the lower end of the income distribution. Finally, panel C of Fig. 1 shows that, on average, income aspirations are higher than households' level of income.

3.2. Risk preferences

We measure risk preferences in two ways: First, we use the Domain-Specific Risk-Taking (DOSPERT) scale (Blais and Weber, 2006; Weber et al., 2002). Second, using lab-in-the-field experiments we elicit

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[5] For the interested reader, Figures A2 and A3 in the Supplemental Appendix report the relationships between the aspirations gap with the main indicators and continuous variables used in this study.

[6] This method for constructing the aspirations gap is useful in that it allows for more meaningful comparisons of the aspirations gap across heterogeneous individuals.
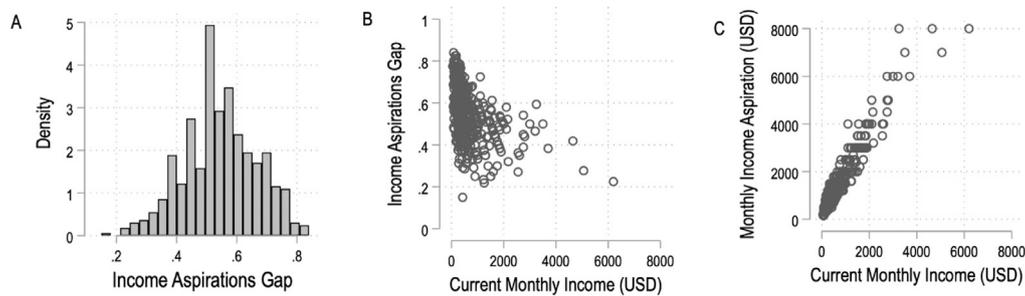
Fig. 1. Income aspirations and the income aspirations gap. *Note*: This figure illustrates the distribution of the income aspirations gap and its relationship with monthly income.

prospect theory risk preference parameters (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) using incentivized lottery games.

Given risk-taking is often domain-specific, the DOSPERT scale assesses risk-taking in six domains: gambling, investing, ethical choices, and behaviors relating to health/safety, social interaction, and recreation (Blais and Weber, 2006; Weber et al., 2002). Thus, our first measure of risk preferences is the DOSPERT investing sub-scale to evaluate participants' risk-taking behavior. The DOSPERT questions from the investing sub-scale prompted participants to rate the risk associated with activities such as investing 10 percent of their annual income in a new business venture. The scale in each question ranges from one (not at all risky) to seven (extremely risky).[7] We sum the items in the DOSPERT investing sub-scale to obtain a single score. As shown in Table 1, out of 21 possible points, the mean DOSPERT investing sub-scale value across individual farmers is 11.44 with a standard deviation of 3.74.

Our second measure of risk preferences are prospect theory risk preference parameters. Previous studies use prospect theory and test its role in a variety of different agricultural settings (Tanaka et al., 2010; Liu, 2013; Bocquého et al., 2014; Villacis et al., 2021). We use prospect theory as a key conceptual basis linking farmer's risk preferences to investment decisions for two main reasons. First, and in contrast to expected utility theory, prospect theory provides a more comprehensive conceptualization of risk preferences as it helps account for loss aversion and the presence of status quo bias (Starmer, 2000). This is important because status quo bias in technology adoption could potentially explain why farmers do not renovate plantations and adopt high-yielding varieties (Liu, 2013; Mullainathan, 2007). Second, in the theoretical model of aspirations and investment choices, Genicot and Ray (2017) model aspirations as reference points in a utility function that draws heavily on insights from prospect theory (Kahneman and Tversky, 1979).

To elicit and measure prospect theory risk parameters, we use a lottery game based on the experimental design of Tanaka et al. (2010) and customized for agricultural settings by Villacis et al. (2021). This adaptation of the experimental design seeks to ease the understanding of highly complex lottery games for participants and has previously been implemented in Ecuador. Probabilities and payoffs are shown to participants by illustrating a farm composed of 10 equally sized lots. The lot's particular payoffs from using two types of technologies, either Seed A or Seed B, accompany the illustration (See Figures A4, A5, and A6 in the Supplemental Appendix).

As in Villacis et al. (2021), participants were told that at the end of each year only one random lot out of the ten would survive. Thus, they need to decide at which year they would "switch" from Seed A to Seed B. Participants received $5 USD for showing up to the experimental sessions and received a bonus that ranged from -$4 to $4 USD based on their actual choices during play. The average earning for participating

in the games was $7.50 USD, roughly the wage of a one-half working day for cacao harvesting activities. Illiterate farmers were not allowed to join the experiment.[8]

Results of the estimation of the prospect theory risk preference parameters are aligned with previous empirical findings (Tanaka et al., 2010; Liebenehm and Waibel, 2014; Villacis et al., 2021). The average of the risk aversion parameter (σ) is 0.62, indicating that the average participant is relatively risk-averse. The average of the probability distortion parameter (α) is 0.78, suggesting that on average, people tend to overweight low probabilities. The average of the loss aversion parameter (λ) is 5.55, indicating that people are more sensitive to losses than to gains, at a magnitude of roughly five to one. Fig. 2 shows the distributions of the parameters σ, α, and λ. The mean values of α and λ are significantly different from one, providing us further evidence to reject an expected utility framework in favor of the prospect theory framework. There is, however, some clustering of values within the distribution of these prospect theory risk preference parameters, and this might indicate systematic rounding or approximation by survey respondents. As such, we present alternative results that defines these risk preference parameters as dummy variables based on the breaks in the distributions illustrated in Fig. 2. We discuss these results in Section 5.3.

Table A1 in the Supplemental Appendix reports the raw correlation between each of our risk preference parameters. These results show that there is a low correlation between the DOSPERT investing sub-scale index and each of the prospect theory risk preference parameters.

4. Estimation strategy

Credibly estimating the relationship between the aspirations gap and investment choices presents an empirical challenge. In particular, socially determined aspirations along with investment choices may both be influenced by, and are therefore endogenous to, a host of both observable and unobservable factors. Thus, designing and implementing an experimental study that exogenously influences an individual's aspirations may seem like a natural avenue for research. As discussed by McKenzie et al. (2022), however, ethical issues complicate the feasibility of such an empirical approach. Given the existing theoretical (Genicot and Ray, 2017) and empirical evidence – using both experimental (McKenzie et al., 2022) and observational data (Janzen et al., 2017; Ross, 2019; Bloem, 2021) – documenting that raising aspirations could have a negative effect on psychological and economic well-being, the ethical feasibility of an experimental study that exogenously increases aspirations is questionable. Therefore, the best way forward to understand the relationship between the aspirations gap and investment choices may be carefully using and interpreting econometric methods with observational data, despite the associated limitations. Given this challenge, it is important to note that we do not intend to show or claim that aspirations that are ahead, but not too far

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[7] The DOSPERT identification of different degrees of risk taking in its six domains has been replicated in a wide range of populations and real-world settings (Figner and Weber, 2011).

[8] See the Supplemental Appendix and Villacis et al. (2021) for more details on the experimental procedures and the incentivized payments.
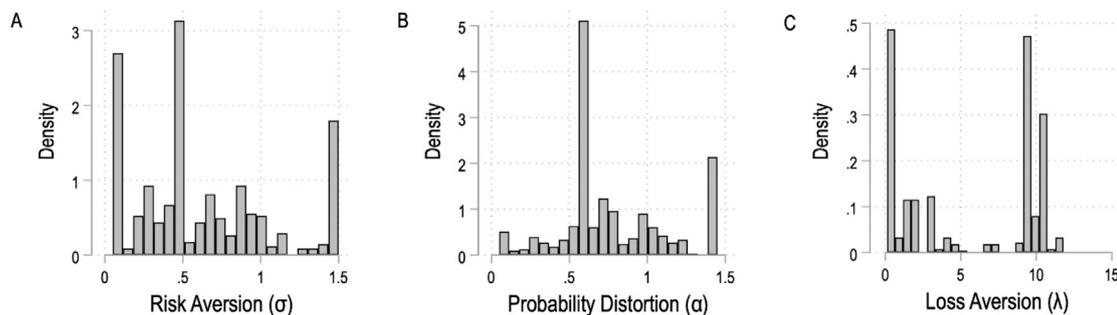
Fig. 2. Distribution of prospect theory risk preference parameters. *Note*: This figure illustrates the distribution of the risk preference parameters elicited using prospect theory.

ahead, *cause* investments in the future. Instead, our aim in this paper is to test if the inverted U-shaped relationship persists among various types of investments in a new context while accounting for various sources of unobserved heterogeneity.[9] Other sources of unobserved heterogeneity that we are not able to account for (e.g., grit, self-control, or perseverance) may persist even after we implement our econometric approach.

Our estimation approach builds on that used in previous studies testing for an inverted U-shape relationship between the income aspirations gap and investment choices with observational data. We specifically estimate two regression specifications. One that imposes a quadratic functional form on the aspirations gap variable and another that allows the aspirations gap variable to enter into the regression specification non-parametrically. The first method estimates the following equation:

$$y_{ie} = \beta_0 + \beta_1 g_{ie} + \beta_2 g_{ie}^2 + \beta_3 r_{ie} + \mathbf{X'_{ie}\Gamma} + \theta_e + \epsilon_{ie} \quad (2)$$

In this equation, y_{ie} is the outcome variable of interest for farmer i in canton (e.g., geographic location) e and represents a farmer's expenditure on either farm renovations or fertilizer. The g_{ie} variable represents the income aspirations gap and g_{ie}^2 represents the squared income aspirations gap. The variable, r_{ie}, controls for the farmer's risk preferences using either the DOSPERT investing index or prospect theory risk parameters (e.g., risk aversion, probability distortion, and loss aversion). The vector $\mathbf{X_{ie}}$ represents a set of control variables. These control variables include respondent age, age squared, household size, whether or not the respondent has a child, respondent gender, whether or not the farmer is a member of a farmer's association, education level, total area of cacao cultivation, area of cacao cultivation squared, years of experience as a cacao farmer, age of the farm, and current level of income.[10] Finally, θ_e are canton fixed effects and ϵ_{ie} is the error term. The standard errors are clustered at the canton level. An inverted U-shape relationship exists if, given an interval of values of $g \in [g_l, g_h]$, $\beta_1 + 2\beta_2 g_l > 0$ and $\beta_1 + 2\beta_2 g_h < 0$ (Lind and Mehlum, 2010).

The second method estimates a semi-parametric regression specification as follows:

$$y_{ie} = \delta_0 + f(g_{ie}) + \delta_1 r_{ie} + \mathbf{X'_{ie}\Xi} + \rho_e + v_{ie} \quad (3)$$

This estimation equation is nearly identical to Eq. (2) except that the g_{ie} variable enters into the equation non-parametrically. This allows

for a more flexible relationship between g_{ie} and y_{ie}, rather than one that imposes a specific quadratic functional form as in Eq. (2). Again r_{ie} represents the farmer's risk preferences, $\mathbf{X_{ie}}$ is the same vector of control variables, ρ_e are canton fixed effects, v_{ie} is the error term, and the standard errors are clustered at the canton level. We estimate this semi-parametric regression using the double residual semi-parametric approach developed by Robinson (1988). This estimator first partials out the non-parametric part of the regression by removing conditional expectations of the parametric part of the regression. In the next step, a local polynomial smoothing function characterizes the residualized non-parametric relationship between g_{ie} and y_{ie}.

Although we account for important and previously omitted variation associated with individual-level risk preferences, the estimates generated by Eqs. (2) and (3) may still be biased from unobserved heterogeneity. For example, remaining unobserved heterogeneity could be of the form of hope, self-efficacy, and locus of control (Bloem et al., 2018; Lybbert and Wydick, 2017). We account for this possibility of remaining bias in two ways. First, we implement the unobservable selection and coefficient stability approach of Oster (2019) to test the sensitivity of our results to possible bias driven by unobserved heterogeneity. Second, following Janzen et al. (2017), we note that it is difficult to imagine a specific form of unobserved heterogeneity – especially after accounting for risk preferences – that would lead to an inverted U-shaped relationship between the aspirations gap and investment choices.

5. Results

In this section, we present results from our two estimation approaches. First, in Tables 2 and 3, we present results from estimating Eq. (2) imposing a quadratic functional form on the aspirations gap variable. Second, in Fig. 3, we present the non-parametric fit of the relationship between the income aspirations gap and investment in agricultural technologies from estimating Eq. (3) using a semi-parametric approach. Finally, in Table 4, we present results using a sub-sample of our data to demonstrate the robustness of our core results. Additional robustness tests, which we discuss in more detail in Section 5.3, are presented in the Supplemental Appendix.

5.1. Farm renovation expenditures

We begin by studying farmer's expenditure on farm renovations, which represents an investment with a relatively long-term payoff schedule. As the productivity of cacao trees declines due to ageing and other causes, renovating a cacao orchard represents a means to enhance future production and farm revenue. In addition to the associated expenses, cacao farm renovations have a relatively long waiting period (normally four to five years) before starting to reap benefits from the harvest of pods and beans. During the previous decade the Ecuadorian government led renovation initiatives of low-yielding cacao plantations

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[9] The nature of the data and its contextual framework in this study is cross-sectional, which signifies that an observed U-shaped relationship should be interpreted as a comparative analysis between individuals rather than indicative of individual trajectory or progression.

[10] Some of these variables might be intermediary outcome variables and, therefore, could be considered "bad controls" (Angrist and Pischke, 2008). As such, we report coefficients both with and without $\mathbf{X_{ie}}$ included in the regression.
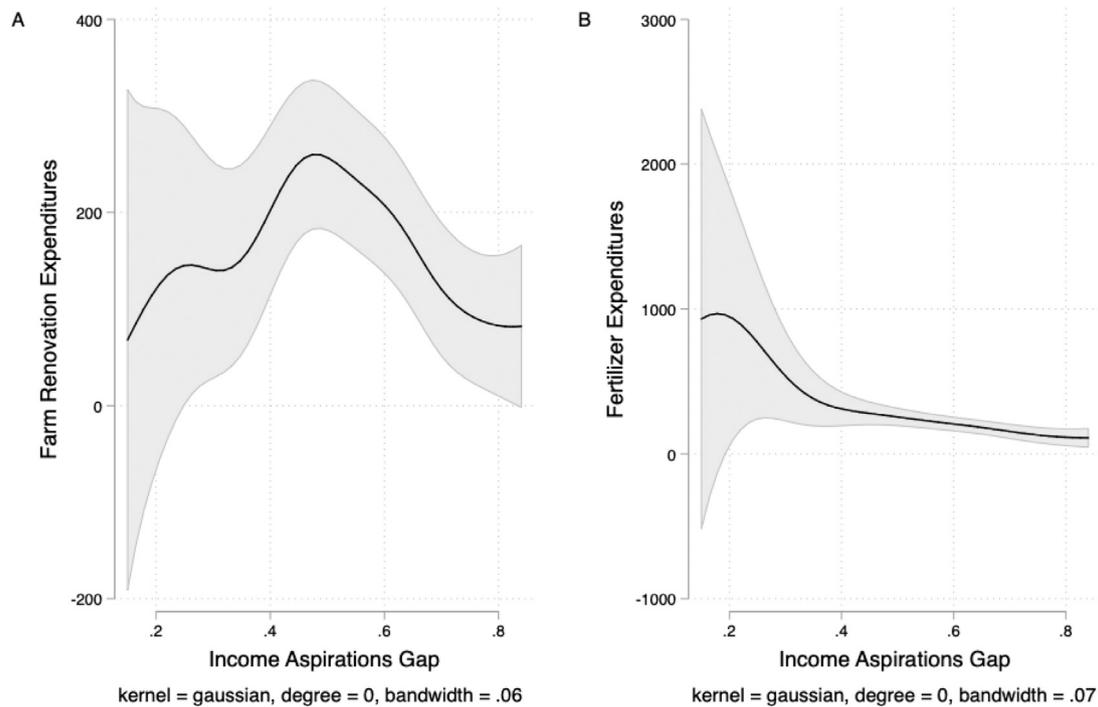
Fig. 3. Non-parametric regression. *Note*: This figure illustrates non-parametric estimates of the relationship between the aspirations gap and agricultural investments while controlling for the DOSPERT investing measure of risk preference. Panel A uses farm renovation expenditures as a measure of investment. Panel B uses fertilizer expenditures as a measure of investment. These non-parametric illustrations are robust to alternative estimation methods. Figure A7 in the Supplemental Appendix shows similar results using binscatter plots to illustrate the non-parametric relationship between the income aspirations gap and investments.

Table 2
Farm renovation expenditures, long-term investment.

	(1)	(2)	(3)	(4)	(5)
Aspiration gap	2608***	2759***	2598**	2558***	2327**
	(630.1)	(638.4)	(1049)	(634.1)	(1056)
Squared aspiration gap	−2620***	−2762***	−2542**	−2547***	−2250**
	(580.5)	(597.9)	(878.6)	(576.1)	(860.2)
DOSPERT investing index		14.11**	14.33		
		(5.069)	(8.716)		
PT risk aversion (σ)				−23.29	−50.78
				(45.68)	(55.03)
PT probability distortion (α)				74.19	63.55
				(54.53)	(58.80)
PT loss aversion (λ)				−5.014	−4.711
				(7.165)	(7.082)
Observations	523	523	523	523	523
R-squared	0.010	0.019	0.070	0.014	0.065
Canton fixed effects?	No	No	Yes	No	Yes
Additional controls?	No	No	Yes	No	Yes
Oster's Delta					
Aspiration gap		<0	16.70	15.59	5.54
Squared aspiration gap		<0	14.83	10.17	5.99
U-test results:					
Turning point	0.497	0.499	0.511	0.502	0.515
Fieller 95% CI	[0.438; 0.536]	[0.446; 0.538]	[0.438; 0.551]	[0.435; 0.545]	[0.412; 0.565]
Sasabuchi p-value	0.000	0.000	0.003	0.001	0.005
Slope at min	1822.5	1930.5	1830.8	1793.8	1631.9
Slope at max	−1792.7	−1881.6	−1671.3	−1721.6	−1452.3

Notes: This table reports ordinary least squares (OLS) regression estimates with total farm renovation expenditures as the dependent variable. The aspirations gap represents the difference between an individual's aspired monthly income and their current monthly income divided by their aspired monthly income. The DOSPERT investing variable represents a psychometric scale that assesses risk-taking in investment behavior. The risk aversion, probability distortion, and loss aversion variables are prospect theory risk preference parameters. Oster's Delta is calculated by comparing regression results in a given column to the regression results in column (1) using the psacalc Stata command. Standard errors clustered at the canton level are reported in the parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3
Fertilizer expenditures, short-term investment.

	(1)	(2)	(3)	(4)	(5)
Aspiration gap	−5038	−4926	−138.4	−5149	−230.1
	(5850)	(5880)	(696.6)	(5868)	(809.8)
Squared aspiration gap	3698	3592	112.9	3850	209.1
	(4772)	(4803)	(499.4)	(4827)	(594.8)
DOSPERT investing index		10.52**	3.528		
		(4.262)	(6.042)		
PT risk aversion (σ)				−167.6	−104.4**
				(142.6)	(44.34)
PT probability distortion (α)				67.39*	72.02
				(38.14)	(44.27)
PT loss aversion (λ)				−22.40	0.0958
				(17.81)	(3.432)
Observations	523	523	523	523	523
R-squared	0.031	0.033	0.743	0.044	0.747
Canton fixed effects?	No	No	Yes	No	Yes
Additional controls?	No	No	Yes	No	Yes
U-test results:					
Turning point	0.681	0.685	0.761	0.669	0.733
Fieller 95% CI	[−∞; ∞]	[−∞; ∞]	[−∞; ∞]	[−∞; ∞]	[−∞; ∞]
Sasabuchi p-value	0.297	0.310	0.373	0.282	0.322
Slope at min	−3928.7	−1848.2	−1097,3	−3993.5	−1154
Slope at max	1174.8	1108.4	141.17	1319.8	212.01

Notes: This table reports ordinary least squares (OLS) regression estimates with total fertilizer expenditures as the dependent variable. The aspirations gap represents the difference between an individual's aspired monthly income and their current monthly income divided by their aspired monthly income. The DOSPERT investing variable represents a psychometric scale that assesses risk-taking in investment behavior. The risk aversion, probability distortion, and loss aversion variables are prospect theory risk preference parameters. Standard errors clustered at the canton level are reported in the parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

heavily affected by pests and diseases—mostly through the provision of free certified seedlings (Villacis et al., 2022a).[11]

In Table 2, we report results from estimating Eq. (2) with the farmer's expenditures in farm renovations as the dependent variable. Column (1) serves as a baseline regression that estimates the relationship between the income aspirations gap and expenditures in farm renovations with no risk preference variables, canton fixed effects, or additional control variables included. In this column, we find strong evidence for an inverted U-shaped relationship. The coefficient on the aspiration gap variable is positive and statistically significant, while the coefficient on the squared aspiration gap variable is negative and statistically significant. Additionally, U-test results reinforce this finding.[12] In particular, we can reject the null hypothesis of a monotonic relationship. The estimated turning point in the inverted U-shaped relationship is at roughly the midpoint in the range of possible values of the income aspirations gap variable.

In column (2), we include the DOSPERT investing index into our main regression specification estimating the relationship between the income aspirations gap and expenditures in farm renovations. Similar to the results in column (1), and despite the fact that column (2) accounts for the farmer's risk preferences with the DOSPERT investing index, we again find strong evidence for an inverted U-shaped relationship. The coefficient on the aspiration gap variable remains positive and statistically significant while the coefficient on the squared aspiration gap variable remains negative and statistically significant. Additionally, U-test results reinforce this finding.

We implement several robustness and sensitivity checks on these results. First, we estimate Eq. (1) with canton fixed effects to account for any unobservable geographic heterogeneity at the canton level and with the full vector of additional control variables. We show these

results in column (3) of Table 2 and again find strong evidence for an inverted U-shaped relationship between the income aspirations gap and expenditures in farm renovations. Again, U-test results are able to formally reject the null hypothesis of a monotonic relationship.

In a second robustness check, we use prospect theory risk preference parameters measuring risk aversion, probability distortion, and loss aversion as an additional measure of risk preferences. We include these variables into our main regression specification estimating the relationship between the income aspirations gap and expenditures in farm renovations. In column (4) of Table 2, we continue to find strong evidence of an inverted U-shaped relationship. Finally, in column (5) of Table 2, we included canton fixed effects and additional control variables and find that the observed inverted U-shape relationship is robust to the inclusion of these variables as well.[13]

As a final sensitivity check, we implement the coefficient stability and unobservable selection approach formalized by Oster (2019). This approach allows for the estimation of a proportional selection coefficient (noted as "Oster's delta") based on a comparison of the coefficients of interest and the R-squared in a "short" regression and in a "long" regression.[14] We first compare the results in column (1) with the results in column (2), which includes the DOSPERT investing variable. The R-squared almost doubles in size between columns (1) and (2), but the coefficients on the aspirations gap and squared aspirations gap measures remain stable. In fact, the coefficients are larger in absolute value in column (2) than in column (1), which Oster (2019) notes

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[11] It is estimated that almost 10 million seedlings were donated to cover approximately 14,000 hectares of new cacao plantations (MAGAP, 2017).

[12] The U-test tests for a non-monotonic relationship by testing the null hypothesis of a monotonic relationship if both H_0^L and H_0^H are rejected at a given level of statistical significance. Here H_0^L tests if $\alpha_1 + 2\alpha_2 g_l \leq 0$ vs. $\alpha_1 + 2\alpha_2 g_l > 0$ and H_0^H tests if $\alpha_1 + 2\alpha_2 g_h \geq 0$ vs. $\alpha_1 + 2\alpha_2 g_h < 0$ (Lind and Mehlum, 2010).

[13] With these results, it is important to note, that although there may be sound and credible motivation for the use of prospect theory risk preference parameters in this context, we do not find that these parameters mean much empirically in Table 2. Therefore, the absence of evidence that the inclusion of prospect theory risk preference parameters explain away the inverted U-shaped relationship should not necessarily be taken as evidence that prospect theory risk preference parameters definitively do not matter. It might be the case that these parameters are simply too noisy to predict investment behavior in our context and perhaps differently and more accurately measured parameters would perform differently.

[14] Oster's delta, or the proportional selection coefficient, can be estimated using the psacalc command in Stata.

Table 4
Robustness test, sub-sample with > 0, farm renovation expenditures.

	(1)	(2)	(3)	(4)	(5)
Aspiration gap	5949***	6105***	5247**	5568***	3976*
	(1972)	(1895)	(2029)	(1565)	(1996)
Squared aspiration gap	−6041***	−6197***	−4765***	−5705***	−3581**
	(1728)	(1658)	(1453)	(1350)	(1585)
DOSPERT investing index		26.69**	35.66**		
		(11.29)	(14.83)		
PT risk aversion (σ)				−127.3	−279.1
				(150.3)	(195.8)
PT probability distortion (α)				84.23	20.34
				(95.27)	(117.3)
PT loss aversion (λ)				−11.84	−21.20
				(21.92)	(27.42)
Observations	180	180	180	180	180
R-squared	0.026	0.042	0.195	0.031	0.190
Canton fixed effects?	No	No	Yes	No	Yes
Additional controls?	No	No	Yes	No	Yes
U-test results:					
Turning point	0.492	0.493	0.551	0.488	0.555
Fieller 95% CI	[0.351; 0.545]	[0.367; 0.547]	[0.248; 0.653]	[0.373; 0.545]	[−0.78; 0.814]
Sasabuchi p-value	0.007	0.005	0.017	0.003	0.041
Slope at min	4137.0	4246.5	3817.6	3856.8	2902.2
Slope at max	−4199.0	−4304.7	−2758.0	−4016.3	−2038.9

Notes: This table reports ordinary least squares (OLS) regression estimates with total farm renovation expenditures as the dependent variable on the sub-sample of farmers with at least some farm renovation expenditures. The aspirations gap represents the difference between an individual's aspired monthly income and their current monthly income divided by their aspired monthly income. The DOSPERT investing variable represents a psychometric scale that assesses risk-taking in investment behavior. The risk aversion, probability distortion, and loss aversion variables are prospect theory risk preference parameters. Standard errors clustered at the canton level are reported in the parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

implies robustness to unobservable selection bias. Next, we compare the results in column (1) with the results in column (3), which includes not only the DOSPERT investing variable, but also the full set of controls and canton fixed effects. Oster's delta for the aspirations gap and the squared aspirations gap variables in column (3) are 16.70 and 14.83, respectively, providing strong support for robustness to potential unobservable selection bias. As Oster (2019) notes, any omitted variables would need to be 14 and 16 times, respectively, more important than the included variables to explain away these results.

Next, we compare the results in column (1) with the results in column (4), which include the prospect theory risk variables. The R-squared increases by nearly 50 percent, but again the coefficients on the aspirations gap and squared aspirations gap measures remain stable. These results provide support for robustness to potential unobservable selection bias. Finally, we compare the results in column (1) with the results in column (5), which includes not only the prospect theory variables, but also the full set of controls and canton fixed effects. Oster's delta for the aspirations gap and the squared aspirations gap variables in column (5) are 8.79 and 7.81, respectively. These results provide further evidence of the robustness of our results to potential unobservable selection bias.

We now turn to our second estimation approach using the semi-parametric regression specification in Eq. (3). Panel A of Fig. 3 plots the non-parametric fit of the relationship between the income aspirations gap and expenditures in farm renovation, controlling for the DOSPERT investing measure of risk preferences. These results visually support the parametric results reported in Table 2. As the income aspiration gap increases, so does expenditures on farm renovations, but only up to about the midpoint in the range of possible values in the income aspirations gap measure. After roughly the midpoint, as the income aspirations gap increases expenditures on farm renovations decline.

5.2. Fertilizer expenditures

We now turn to studying farmer's fertilizer expenditure. Fertilization is generally viewed as a beneficial management practice and represents an investment with a relatively short-term payoff schedule.

However, in our sample, only 53 percent of farmers report using fertilizer, and other studies have reported even lower use of fertilizer among cacao farmers in Ecuador (Barrera et al., 2019). Older plantations being less intensively managed and differences in agronomic practices related to the use of different varieties often limit production output (USDA FAS, 2015).

In Table 3, we report results from estimating Eq. (2) with the farmer's fertilizer expenditures as the dependent variable. Column (1) again serves as a baseline regression that estimates the relationship between the income aspirations gap and fertilizer expenditures with no risk preference variable, canton fixed effects, or additional control variables included. In this column, we do not find evidence for an inverted U-shaped relationship. In fact, the coefficient on the aspiration gap variable is negative and not statistically significant at conventional levels. In addition, the coefficient on the squared aspiration gap variable is positive and not statistically significant at conventional levels. Additionally, the U-test results show that we fail to reject a monotonic relationship between the income aspirations gap and fertilizer expenditures.

In column (2), we include the DOSPERT investing index in our main regression specification estimating the relationship between the income aspirations gap and fertilizer expenditures. Similar to the results in column (1), we again do not find evidence for an inverted U-shaped relationship.

The remainder of the results in Table 3 continues to support the observation of no inverted U-shaped relationship between the income aspirations gap and fertilizer expenditures. Column (3) of Table 3 includes canton fixed effects and additional control variables, and again, shows no evidence of an inverted U-shape relationship. Column (4) includes prospect theory risk preference parameters in the regression specification. Despite the fact that at least one of these variables is a relevant predictor of fertilizer expenditures, again shows no evidence of an inverted U-shape relationship. Finally, column (5) shows a similar finding when canton fixed effects and additional control variables are included in the regression specification.

Finally, we turn to our second estimation approach using the semi-parametric regression specification in Eq. (3). Panel B of Fig. 3 plots the

non-parametric fit of the relationship between the income aspirations gap and fertilizer expenditures controlling for the DOSPERT investing measure of risk preferences. These results visually support the parametric results reported in Table 3 that did not find evidence of an inverted U-shaped relationship. If anything, there seems to be a slight monotonically negative relationship. As the income aspiration gap increases, fertilizer expenditures decline. While the relationship is relatively weak and not statistically different from zero at conventional levels, farmers with larger income aspiration gaps invest less in fertilizer. One way to interpret this observation is that cacao farmers in this setting do not see fertilizer use as an effective means to increase their future income. While fertilizer may have the potential to increase farm productivity, profitability, and income in the immediate or short-term, the returns to fertilizer applications are viewed as having no direct influence on projected income for the future.

5.3. Robustness tests

We now further investigate the robustness of our main finding that aspirations that are ahead, but not too far ahead, of current levels provide the best incentive for relatively long-term investments. We test robustness in three ways. First, we estimate results on the sub-sample of our data that reports more than zero farm renovation expenditures. Next, we estimate results by considering unobserved heterogeneity at the experimental session level. Finally, following Liu (2013), we use an alternative representation of the PT risk preference parameters elicited in our experimental sessions.

In this sub-section, we show the results of the analysis on the sub-sample with at least some farm renovation expenditures. This analysis is motivated by the distribution of farm renovation expenditures in our sample being both highly skewed and containing many zeros. As this raises concerns about a possible spurious relationship driven by the shape of this distribution, we limit our sample to only those farmers who have more than zero farm renovation expenditures. In doing so, we more precisely estimate the relationship between the income aspirations gap and *intensive margin* investment expenditures.

In Table 4, we report results from estimating Eq. (2) using the sub-sample of farmers with greater than zero farm renovation expenditures. Similar to the other tables in this paper, Column (1) serves as a baseline regression that estimates the relationship between the income aspirations gap and expenditures in farm renovations with no risk preference variable, canton fixed effects, or additional control variables included. In this column, even among a restricted sub-sample, we find strong evidence for an inverted U-shaped relationship. The coefficient on the aspiration gap variable is positive and statistically significant, while the coefficient on the squared aspiration gap variable is negative and statistically significant. In column (2), we include the DOSPERT investing index into our main regression specification estimating the relationship between the income aspirations gap and expenditures on farm renovations. We again find strong evidence for an inverted U-shaped relationship.

In the remainder of the results in Table 4, we continue to find evidence for an inverted U-shaped relationship between the income aspirations gap and expenditures in farm renovations. Column (3) of Table 4, includes canton fixed effects and additional control variables, and the inverted U-shaped relationship persists. Column (4) includes prospect theory risk preference parameters in the regression specification and again shows evidence of an inverted U-shape relationship. Finally, column (5) shows similar, albeit slightly weaker, results when canton fixed effects and additional control variables are included in the regression specification. Taken together, the results in Table 4 support the core finding in our paper that there exists an inverted U-shape relationship between the income aspirations gap and farm renovation expenditures, even conditional on various risk preference parameters.

We present the additional robustness tests in the Supplemental Appendix. In particular, Table A2 reproduces the results from Table 2 in

the main manuscript but accounts for potential unobserved heterogeneity at the experimental session level. To do this, we cluster the standard errors in all specifications at the experimental session level, and include experimental session fixed effects. The results are qualitatively similar to those shown in Table 2. Next, Table A3 reproduces some of the results from Table 2 in the main manuscript using an alternative representation of the elicited prospect theory risk preference parameters. Particularly, we follow Liu (2013) and replace the values of λ with a dummy variable equal to one to indicate individuals who are loss averse (i.e., $\lambda > 1$). We also replace the values of α with a dummy variable equal to one to indicate individuals who put excessive decision weight on small probabilities (i.e., $\alpha < 1$). Again, the results are qualitatively similar to those shown in Table 2. Finally, in Table A4 we reproduce some of the results from Table 2 but account for risk preferences using dummy variables defined by (i) discrete values (3–21) of the DOSPERT index, and (ii) discrete values (0–2) using the breaks in the distribution for each of the prospect theory variables illustrated in Fig. 2. These results account for any non-linear influence of our measures of risk preferences and are qualitatively similar to those shown in Table 2.

6. Discussion

Agricultural and economic development nearly always requires some level of investment in agricultural technologies. The investment decisions of smallholder farmers are constrained by several factors, including market structures, property rights, and psychological factors. In this paper, we focus on the latter and investigate investments in agricultural technologies and their relationships with aspirations and risk preferences.

Our analysis leads to two key results. First, we find that an inverted U-shaped relationship between the income aspirations gap and investments in agriculture exists when considering investments with a relatively long-term payoff schedule (e.g., farm renovations) and does not exist when considering investments with a relatively short-term payoff schedule (e.g., fertilizer use). Thus, the length of the payoff schedule could represent an important source of heterogeneity in understanding how aspirations relate to investment choices. Second, we find that the observed inverted U-shaped relationship is robust to the inclusion of experimentally-elicited risk preference parameters in our regression specifications. Risk preferences, particularly in the context of investment in agricultural technologies, are an important factor for understanding investment behavior (Liu, 2013). Thus, they represent a potentially important omitted variable in previous studies investigating the inverted U-shaped relationship between the income aspirations gap and investments. Although no definitive causality can be drawn, our empirical results are consistent with existing theory that suggest that aspirations that are ahead – but not too far ahead – of current levels provide the best incentive for investments (Genicot and Ray, 2017).

6.1. Policy implications

The study of the formation and evolution of aspirations entails a multidimensional analysis encompassing social, cultural, contextual, and psychological dimensions. Understanding the intricate processes underlying the development of aspirations is crucial for policymakers, educators, and social scientists, as it can inform the design of interventions and programs aimed at promoting individual well-being, fostering personal development, and facilitating societal progress.

In our specific application, we show evidence that aspirations correlate to relatively long-term investments in agricultural technology. More generally, our results show that psychological factors can shape investment in agricultural technology. Therefore, policy interventions that aim to alleviate these psychological constraints can be a valuable addition to popular agricultural policies (e.g., crop insurance, purchase contracts, provision of free/subsidized agricultural inputs, etc.). Cash transfers programs and other initiatives promoting exposure to

role models and media content have been shown to increase aspirations (Beaman et al., 2012; Bernard and Taffesse, 2014; Macours and Vakis, 2014). This type of interventions can be of interest for policymakers trying to promote investments in agricultural technologies, especially after episodes of natural disasters or conflict. Recent evidence suggests that people become more hopeless and have lower aspirations for the future after experiencing this type of shocks (Kosec and Mo, 2017; Moya and Carter, 2019).

However, it is important to note that the existence of an inverted U-shaped relationship and behavior consistent with "aspirations frustration" highlights that raising aspirations by themselves could have a negative effect on psychological and economic well-being (McKenzie et al., 2022). To the extent that policymakers are committed to provide integral development initiatives, they must tackle both of these challenges. As such, efforts to inspire increased investment in productivity-improving agricultural technologies may benefit from incorporating components that aim to alleviate both psychological and economic constraints.

6.2. Limitations and directions for future work

The findings and limitations of our study suggest several directions for future work. First, our results highlight the importance of time horizons and payoff schedules when linking agricultural investments and aspirations. Future work might consider the role of psychological mechanisms related to time preferences – such as present bias and discount rates – when assessing how aspirations influence different types of agricultural investments. Second, our results focus exclusively on income aspirations rather than treating aspirations as a multidimensional concept (Fruttero et al., 2021). Future work might use multidimensional aspirations to evaluate how agricultural investment decisions are influenced by aspirations in different domains. Third, our study did not control for the "recency effect" of shocks. Although in our study area no major weather events have been reported during the last decade, evidence suggests that individuals who experience shocks (e.g., due to natural disasters or conflict) become more hopeless and have lower aspirations for the future (Kosec and Mo, 2017; Moya and Carter, 2019). In the context of agriculture, future research could explore how agro-ecological shocks influence the relationship between aspirations and agricultural investments.

CRediT authorship contribution statement

Alexis H. Villacis: Conceptualization, Data curation, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Jeffrey R. Bloem:** Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Ashok K. Mishra:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.foodpol.2023.102477.

References

Abbott, Philip C, Benjamin, Tamara J, Burniske, Gary R, Croft, Marcia M, Fenton, Marieke, Kelly, Colleen R, Lundy, Mark, Rodríguez Camayo, Fernando, Wilcox, Michael D, 2018. An Analysis of the Supply Chain of Cacao in Colombia. United States Agency for International Development.

Amores, FM, Vasco, SA, Eskes, AB, Suarez, C, Quiroz, JG, Loor, RG, Jimenez, JC, Zambrano, J, Bolaños, MJ, Reynel, VH, et al., 2011. On-Farm and On-Station Selection of New Cocoa Varieties in Ecuador. Final Report of the CFC/ICCO/Bioversity International Project on "Cocoa Productivity and Quality Improvement: A Participatory Approach, 59, pp. 59–72.

Angrist, Joshua D., Pischke, Jörn-Steffen, 2008. Mostly harmless econometrics. In: Mostly Harmless Econometrics. Princeton University Press.

Barrera, Víctor Hugo, Escudero, Luis, Racines Jaramillo, Marcelo Rafael, García, César, Arévalo, Juan, Casanova, Teresa, Loor, Gastón, Tarqui, Omar, Plaza, Luis, Sotomayor, Ignacio, et al., 2019. La Cadena de Valor del Cacao y el Bienestar de los Productores en la Provincia de Manabí-Ecuador. INIAP, Estación Experimental Santa Catalina 2019, Quito, EC.

Beaman, Lori, Duflo, Esther, Pande, Rohini, Topalova, Petia, 2012. Female leadership raises aspirations and educational attainment for girls: A policy experiment in India. Science 335 (6068), 582–586.

Bernard, Tanguy, Dercon, Stefan, Orkin, Kate, Taffesse, Alemayehu, et al., 2018. The future in mind: Short and Long-Run Impact of an Aspirations Intervention in Rural Ethiopia. Working Paper, University of Oxford.

Bernard, Tanguy, Taffesse, Seyoum, 2014. Aspirations: An approach to measurement with validation using Ethiopian data. J. Afr. Econ. 23 (2), 189–224.

Besley, Timothy, Case, Anne, 1993. Modeling technology adoption in developing countries. Am. Econ. Rev. 83 (2), 396–402.

Blais, Ann-Renée, Weber, Elke U., 2006. A domain-specific risk-taking (DOSPERT) scale for adult populations. Judgm. Decis. Mak. 1 (1).

Bloem, Jeffrey R., 2021. Aspirations and investments in rural myanmar. J. Econ. Inequal. 19 (4), 727–752.

Bloem, Jeffrey R, Boughton, Duncan, Htoo, Kyan, Hein, Aung, Payongayong, Ellen, 2018. Measuring hope: A quantitative approach with validation in rural myanmar. J. Dev. Stud. 54 (11), 2078–2094.

Bocquého, Géraldine, Jacquet, Florence, Reynaud, Arnaud, 2014. Expected utility or prospect theory maximisers? Assessing farmers' risk behaviour from field-experiment data. Eur. Rev. Agric. Econ. 41 (1), 135–172.

CFN, Corporación Financiera Nacional, 2018. Ficha sectorial: Cacao y chocolate. https://www.cfn.fin.ec/wp-content/uploads/2018/04/Ficha-Sectorial-Cacao.pdf, Retrieved March 01, 2022.

Conley, Timothy G., Udry, Christopher R., 2010. Learning about a new technology: Pineapple in Ghana. Amer. Econ. Rev. 100 (1), 35–69.

Duflo, Esther, Kremer, Michael, Robinson, Jonathan, 2011. Nudging farmers to use fertilizer: Theory and experimental evidence from Kenya. Amer. Econ. Rev. 101 (6), 2350–2390.

Feder, Gershon, Just, Richard E., Zilberman, David, 1985. Adoption of agricultural innovations in developing countries: A survey. Econom. Dev. Cult. Chang. 33 (2), 255–298.

Figner, Bernd, Weber, Elke U., 2011. Who takes risks when and why? Determinants of risk taking. Curr. Dir. Psychol. Sci. 20 (4), 211–216.

Foster, Andrew D., Rosenzweig, Mark R., 2010. Microeconomics of technology adoption. Annu. Rev. Econ. 2 (1), 395–424.

Fruttero, Anna, Muller, Noel, Calvo-Gonzalez, Oscar, 2021. The Power and Roots of Aspirations: A Survey of the Empirical Evidence. World Bank Policy Research Working Paper Series, World Bank, Washington, DC.

Genicot, Garance, Ray, Debraj, 2017. Aspirations and inequality. Econometrica 85 (2), 489–519.

Goldstein, Markus, Udry, Christopher, 2008. The profits of power: Land rights and agricultural investment in ghana. J. Polit. Econ. 116 (6), 981–1022.

Janzen, Sarah A, Magnan, Nicholas, Sharma, Sudhindra, Thompson, William M, 2017. Aspirations failure and formation in rural nepal. J. Econ. Behav. Organ. 139, 1–25.

Kahneman, Daniel, Tversky, Amos, 1979. Prospect theory: An analysis of decision under risk. Econometrica 47 (2), 263–291.

Knapp, Ladina, Wuepper, David, Finger, Robert, 2021. Preferences, personality, aspirations, and farmer behavior. Agric. Econ. 52 (6), 901–913.

Kosec, Katrina, Mo, Cecilia Hyunjung, 2017. Aspirations and the role of social protection: Evidence from a natural disaster in rural Pakistan. World Dev. 97, 49–66.

Liebenehm, Sabine, Waibel, Hermann, 2014. Simultaneous estimation of risk and time preferences among small-scale cattle farmers in West Africa. Am. J. Agric. Econ. 96 (5), 1420–1438.

Lind, Jo Thori, Mehlum, Halvor, 2010. With or without U? The appropriate test for a U-shaped relationship. Oxf. Bull. Econ. Stat. 72 (1), 109–118.

Liu, Elaine M., 2013. Time to change what to sow: Risk preferences and technology adoption decisions of cotton farmers in China. Rev. Econ. Stat. 95 (4), 1386–1403.

Lybbert, Travis J., Wydick, Bruce, 2017. Hope as aspirations, agency, and pathways: poverty dynamics and microfinance in Oaxaca, Mexico. In: The Economics of Poverty Traps. University of Chicago Press, pp. 153–177.

Lybbert, Travis J., Wydick, Bruce, 2018. Poverty, aspirations, and the economics of hope. Econom. Dev. Cult. Chang. 66 (4), 709–753.

Macours, Karen, Vakis, Renos, 2014. Changing households' investment behaviour through social interactions with local leaders: Evidence from a randomised transfer programme. Econ. J. 124 (576), 607–633.

MAGAP, Ganadería Acuacultura y Pesca, 2017. Proyecto de reactivación de café y cacao nacional fino de aroma. https://www.icco.org/wp-content/uploads/2019/07/CB-Ecuador.pdf, Retrieved March 01, 2022.

Magruder, Jeremy R., 2018. An assessment of experimental evidence on agricultural technology adoption in developing countries. Annu. Rev. Resour. Econ. 10, 299–316.

McKenzie, David, Mohpal, Aakash, Yang, Dean, 2022. Aspirations and financial decisions: Experimental evidence from the Philippines. J. Dev. Econ..

Mobarak, Ahmed Mushfiq, Saldanha, Neela A., 2022. Remove barriers to technology adoption for people in poverty. Nat. Hum. Behav. 1–3.

Moya, Andrés, Carter, Michael R., 2019. Violence and the formation of hopelessness: Evidence from internally displaced persons in Colombia. World Dev. 113, 100–115.

Mullainathan, Sendhil, 2007. Psychology and development economics. Behav. Econ. Appl. 85–113.

Oster, Emily, 2019. Unobservable selection and coefficient stability: Theory and evidence. J. Bus. Econom. Statist. 37 (2), 187–204.

Ray, Debraj, 2006. Aspirations, poverty, and economic change. Underst. Poverty 1, 409–421.

Robinson, Peter M., 1988. Root-N-consistent semiparametric regression. Econometrica 931–954.

Ross, Phillip H., 2019. Occupation aspirations, education investment, and cognitive outcomes: Evidence from Indian adolescents. World Dev. 123, 104613.

Starmer, Chris, 2000. Developments in non-expected utility theory: The hunt for a descriptive theory of choice under risk. J. Econ. Lit. 38 (2), 332–382.

Sunding, David, Zilberman, David, 2001. The agricultural innovation process: research and technology adoption in a changing agricultural sector. Handb. Agric. Econ. 1, 207–261.

Tanaka, Tomomi, Camerer, Colin F., Nguyen, Quang, 2010. Risk and time preferences: Linking experimental and household survey data from Vietnam. Amer. Econ. Rev. 100 (1), 557–571.

Tversky, Amos, Kahneman, Daniel, 1992. Advances in prospect theory: Cumulative representation of uncertainty. J. Risk Uncertain. 5 (4), 297–323.

USDA FAS, U.S. Department of Agriculture, Foreign Agricultural Service, 2015. Ecuador cacao update and outlook. https://www.fas.usda.gov/data/ecuador-ecuador-cocoa-update-and-outlook, Retrieved March 01, 2022.

Villacis, Alexis H., Alwang, Jeffrey R., Barrera, Victor, 2021. Linking risk preferences and risk perceptions of climate change: A prospect theory approach. Agric. Econ. 52 (5), 863–877.

Villacis, Alexis H., Alwang, Jeffrey R., Barrera, Victor, 2022a. Cacao value chains and credence attributes: lessons from ecuador. J. Agribus. Dev. Emerg. Econ. 12 (4), 549–566.

Villacis, Alexis H, Alwang, Jeffrey R, Barrera, Victor, Dominguez, Juan, 2022b. Prices, specialty varieties, and postharvest practices: Insights from cacao value chains in Ecuador. Agribusiness 38 (2), 426–458.

Weber, Elke U., Blais, Ann-Renee, Betz, Nancy E., 2002. A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors. J. Behav. Decis. Mak. 15 (4), 263–290.