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6 August 2025

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Abstract

Investment decisions differ depending on the age of the investor in terms of both the quantity and the composition of the investments. First, this age-dependency of investment decisions is due to changes in risk aversion over the life-cycle, i.e. older investors are normally less willing to bear risks compared to younger investors. Second, older individuals encounter less residual capacity in order to compensate for potential losses, i.e. a potential loss might not be neutralized within the years of residual life expectancy. Simultaneously, both channels lead to less risk taking on the financial market of older investors, and correspondingly, to lower returns on average. This paper shows that intergenerational altruism might neutralize the shift of investment decisions towards less risky assets. In particular, in case the next generation can compensate for potential losses which is internalized and recognized by the investor, the shift in investment decisions might be neutralized or even reversed.

Keywords: Role and Effects of Psychological, Emotional, Social, and Cognitive Factors on Decision Making in Financial Markets; Household Saving, Borrowing, Debt, and Wealth
JEL-Codes: G41, G51

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1 Introduction

“A prevalent stereotype is that people become less risk taking and more cautious as they get older.”

– Mather et al. (2012)

“Research on decision-making strategies among younger and older adults suggests that older adults may be more risk averse than younger people in the case of potential losses.”

– Albert and Duffy (2012)

Private investment decisions in assets differ throughout the life-cycle in terms of both composition and quantity. The age-dependency of investment decisions is mainly driven by two separate channels. First, aging investors encounter less capacities in order to compensate for potential losses due to a decline in residual life expectancy. As a consequence, though the financial wealth might increase over the life-cycle until retirement, the investor invests less in risky assets close to retirement in relation to the overall wealth. This effect is amplified by an increase in risk aversion over the life-cycle due to behavioral and biological reasons. Second, according to this paper, intergenerational altruism towards descendants might neutralize the effect of less risky investments over the life course. In particular, investors with direct descendants might internalize the higher returns corresponding with risky investments in favor of their children in the long run, and hence, might be more willing to bear risks.

The age-dependency of investment decisions has to be related to at least two strands of the literature. One strand of the literature analyzes risk preferences over the life-cycle. These studies mainly highlight an increase in risk aversion and a decline in risk tolerance over the life-cycle due to behavioral and biological reasons as well as adverse shocks. In particular, Tymula et al. (2013) analyze several cognitive patters over the life-cycle for cohorts ranging between 12 years of age and 90 years of age and find that “both elders and adolescents are more risk-averse than their midlife counterparts” (p. 17143). Dohmen et al. (2017) complementarily disentangle age, cohort and cognitive aging effects and conclude based on panel data originating from Germany and the Netherlands “that (the) willingness to take risks decreases over the life course linearly until approximately age 65 after which the slope becomes flatter.” (p. F95) Consistently, Sahm (2012) detects a modest decline in risk tolerance over the life course. The increase in risk aversion throughout the life-cycle might be due to biological reasons, i.e. cognitive aging processes as highlighted in Bonsang and Dohmen (2012). In addition, Donkers et al. (2001) rely on a household panel data and find an increase in risk aversion over the life course based on lotteries. This result is in line with Dohmen et al. (2011) who rely on lotteries based on representative samples as well.

Another strand of the literature analyzes age-dependent risk preferences in the context of financial investments. In particular, these studies arrive at very different conclusions. From a theoretical perspective, Cagetti (2003) develops a life-cycle model of wealth accumulation and concludes “that wealth accumulation is driven mostly by precautionary motives at the beginning of the life-cycle, whereas savings for retirement purposes become significant only closer to retirement.” (p. 339) Chen et al. (2024) rely on a theoretical model as well and find “that the investor increases consumption to seek immediate gratification, and simultaneously increases life insurance purchasing to fulfill a legacy need. However, at a later stage in the life-cycle, the investor confronts slower wealth accumulation and reduces consumption and life insurance purchasing accordingly.” (p. 107115) While Cagetti (2003) and Chen et al. (2024) discuss wealth accumulation in general, Gomes and Michaelides (2005) refer to the composition of the investments in particular. Accordingly, Gomes and Michaelides (2005) point out based on a calibrated model that risk averse stock holders do not invest exclusively in stocks. Due to an increase in risk aversion throughout the life-cycle, investors favor less risky investments over the life-cycle, leading to a decline in stock investments. Consistently, Cocco et al. (2005) calibrate a lifetime model for consumption and portfolio choice and conclude that “since labor income substitutes for riskless asset holdings, the optimal share invested in equities is roughly decreasing over life.” (p. 491) In line with the hypothesis raised in this paper as well, Michaelides and Zhang (2017) propose that older individuals should mitigate stock market activity before retirement even though changing market conditions should be reflected. In contrast, Peijnenburg (2018) highlights that over the life-cycle individuals “learn about the equity premium and increase their allocation to stocks.” (p. 1963).

In light of the literature review, the followings two gaps are detected: First, most of the studies examining the age-dependency of investment decisions discussed above are based on calibrated theoretical models rather than empirical assessments. This theoretical focus is primarily due to a lack of data regarding both individual wealth and investment decisions. Second, neither the theoretical models nor the empirical assessments, take into account the role of intergenerational altruism for the composition of investment decisions over time. In order to fill these gaps, I complement a theoretical model with an empirical investigation incorporating intergenerational altruism. Regarding the former, I rely on a traditional overlapping generations (OLG) model with intergenerational altruism and age-dependent investment decisions. In this model intergenerational altruism is capable of neutralizing the shift from risky to less risky investments since investors take a long run perspective. Regarding the latter, I rely on the data originating from the so-called Sozio-ökonomisches Panel SOEP (2022) published by the German Institute for Economic research (DIW) for the assessment of the age-dependency of investment decisions

in particular and risk aversion in general from an empirical perspective. With respect to the dependent variable, I utilize two main indicators of interest as part of an simultaneous equation model: First, I make use of a willingness to take risks indicator ranging between 0 (perfectly risk averse) and 10 (perfectly risk loving). Second, I make use of an investment variable which captures the share of (risky) stock investments relative to (less risky) bond investments out of a hypothetical total investment of 50,000 Euro. Accordingly, I utilize the fact that stock returns exhibit a higher expected volatility and a higher expected risk compared to bonds. Regarding the main independent variables of interest, I utilize the age of the individual to capture age dependencies in risk aversion and investment decisions. In order to figure out whether the relationship between individual ages on the one hand and risk aversion as well as investment decisions on the other hand differ in case of own children, the risk aversion indicator is interacted with a variable which is equal to 1 for individuals with at least one child and 0 otherwise. Apart from the main variables of interest, I incorporate several covariates. The empirical results show that older individuals become more risk averse whilst the relationship between risk aversion and the ratio of stock relative to bond investments is mitigated or even reversed in case of children, especially before retirement.
The paper is structured as follows: Section 2 lays out a simple theoretical OLG model in order to derive the hypotheses. Section 3 is devoted to the description of the data set and the empirical estimation strategy in order to verify or falsify the hypotheses. Section 4 concludes.

2 Theory

As part of the theoretical setup, I rely on a an OLG model originally formalized by Samuelson (1958) and extended by Barro (1974) in light of intergenerational altruism. In the following section, I set out the concrete assumptions of the OLG model.

2.1 Assumptions

According to the OLG model, the world is composed of a series of generations living for two periods, s, i.e. a working period, 1, and a retirement period, 2, $s \in \{1;2\}$. While the generation born in period t is retired, the generation born in period $t+1$ generates income on the labor market, reflecting overlapping generations. Each generation, t, maximizes the **utility**, U_t, which is composed of the utility generated out of the consumption in period 1, c_{1t}, and expected utility generated out of the consumption in period 2, c_{2t}. Moreover, due to intergenerational altruism, the investor internalizes the expected utility generated by the subsequent generation $t+1$, U_{t+1}. Formally,

$$U_t = U(c_{1t}) + \beta\mathbb{E}[U(c_{2t})] + \gamma\mathbb{E}[U(c_{1t+1}) + \beta U(c_{2t+1})] \tag{1}$$

while $0 < \gamma < 1$ highlights the altruism intensity, i.e. the higher γ the more the generation t internalizes the utility of generation $t+1$. In addition, parameter $0 < \beta < 1$ serves as the intertemporal discount factor which is invariant across generations, i.e. the higher β the more the generation prefers consumption in period 2 over consumption in period 1. According to the specification, the utility is additively separable across time and generations. Regarding the utility function, I assume the following constant relative risk aversion (CRRA) form originating from Pratt (1976):

$$U(c_{st}) = \frac{c_{st}^{1-\rho_s}}{1-\rho_s} \tag{2}$$

while $\rho_s \neq 1$ serves as a risk aversion indicator with $\rho_2 > \rho_1$ since risk aversion increases over the life-cycle.

Each generation encounters an intertemporal **budget constraint**, i.e. in period 1 exogenous labor income, w_{1t}, is generated which might be consumed immediately through c_{1t} or invested on the capital market through savings, s_{1t}. Regarding savings, generation t can choose between a risky investment, s_{1t}^r, generating a return, r_r, or a risk-free investment, s_{1t}^f, generating a return, $r_f < r_r$. While the risk-free return is deterministic, the risky return is stochastic, i.e. normally distributed with a mean of μ and a variance of σ^2:

$$r_r \sim N(\mu, \sigma^2) \tag{3}$$

The share of savings which is invested in risky assets is denoted as λ_t while the share which is invested in risk-free assets is denoted as $1-\lambda_t$. As a consequence, the average portfolio return is given by:

$$\mathbb{E}[r_p] = \lambda_t \mu + (1-\lambda_t) r_f =: \bar{r}_p \tag{4}$$

Apart from labor income, generation t receives a bequest of h_{t-1} from the previous generation $t-1$ in period 1. Correspondingly, in period 2, generation t might provide a bequest, h_t, to the subsequent generation as well. Formally, the budget constraint for the first period can be formulated in terms of λ_t as follows:

$$w_{1t} - \underbrace{[\lambda_t s_{1t} + (1-\lambda_t) s_{1t}]}_{s_{1t}} + h_{t-1} = c_{1t} \tag{5}$$

For the second period the budget constraint is given by:

$$\underbrace{(1+r_r)\lambda_t s_{1t} + (1+r_f)(1-\lambda_t) s_{1t}}_{s_{2t}} - h_t = c_{2t} \tag{6}$$

Even though the budget constraints can be formulated in terms of s_{1t} and s_{2t} directly and independently of λ_t, the formulation in terms of λ_t is utilized in the following section in order to assess the sensitivity of risky investments dependent on intergenerational altruism and shifts in risk aversion over the life-cycle.

2.2 First order conditions

Consolidating the utility function and the intertemporal budget constraint leads to the following **optimization problem** for generation t:

$$\max_{c_{1t}, s_{1t}, \lambda_t, h_t} U_t = U(c_{1t}) + \beta E[U(c_{2t})] + \gamma E[U(c_{1t+1}) + \beta U(c_{2t+1})] \tag{7}$$

s.t.

$$w_{1t} - [\lambda_t s_{1t} + (1 - \lambda_t) s_{1t}] + h_{t-1} = c_{1t} \tag{8}$$

$$(1 + r_r)\lambda_t s_{1t} + (1 + r_f)(1 - \lambda_t) s_{1t} - h_t = c_{2t} \tag{9}$$

First, **first order conditions regarding consumption**, c_{1t} and c_{2t}, can be combined to the Euler equation:

$$U'(c_{1t}) = \beta \mathbb{E}_t[(1 + r_p) U'(c_{2t})] \tag{10}$$

or equivalently in light of the CRRA utility function:

$$c_{1t}^{-\rho_1} = \beta \mathbb{E}_t[(1 + r_p) c_{2t}^{-\rho_2}] \tag{11}$$

According to the Euler equation, the marginal utility out of the consumption today is equal to the discounted marginal utility out of the consumption tomorrow.

Second, the **first order condition regarding bequests**, h_t, can be formulated as:

$$\gamma \mathbb{E}_t[U'(c_{1t+1})] = \beta \mathbb{E}_t[U'(c_{2t})] \tag{12}$$

Or equivalently in light of the CRRA utility function:

$$\gamma \mathbb{E}_t[c_{1t+1}^{-\rho_1}] = \beta \mathbb{E}_t[c_{2t}^{-\rho_2}] \tag{13}$$

Accordingly, optimal bequests, h_t, are determined such that the marginal utility of the subsequent generation out of consumption in period 1 weighted with the altruism parameter γ equals the marginal utility of the own consumption in period 2 weighted with β. Combined with the Euler equation, the first order condition can be reformulated as follows:

$$\gamma \mathbb{E}_t[U'(c_{1t+1})] = U'(c_{1t}) \mathbb{E}_t \left[\frac{1}{1 + r_p} \right] \tag{14}$$

Third, the **first order condition regarding the share of risky investments**, λ_t, has to be determined throughout several steps. Since $\frac{\partial c_{1t}}{\partial \lambda_t} = 0$, I consider a reduced optimization problem:

$$\max_{\lambda_t} \beta \mathbb{E}[U(c_{2t})] + \gamma \mathbb{E}[U(c_{1,t+1})] \tag{15}$$

subject to the budget constraint. Following Merton (1969) and Campbell and Viceira (2001), I utilize a second-order Taylor approximation of expected utility:

$$\mathbb{E}[U(c_{2t})] \approx U(\mathbb{E}[c_{2t}]) + \frac{1}{2}U''(\mathbb{E}[c_{2t}]) \cdot \mathrm{Var}(c_{2t}) \tag{16}$$

From the budget constraint:

$$c_{2t} = s_{1t}(1 + r_p) - h_t \tag{17}$$

I derive

$$\mathbb{E}[c_{2t}] = s_{1t}(1 + \bar{r}_p) - h_t, \quad \mathrm{Var}(c_{2t}) = s_{1t}^2 \lambda_t^2 \sigma^2 \tag{18}$$

with

$$\bar{r}_p = \lambda_t \mu + (1 - \lambda_t) r_f \tag{19}$$

In a next step, I compute the total derivative of the following reduced expression:

$$\frac{d}{d\lambda_t} \left[\beta \mathbb{E}[U(c_{2t})] + \gamma \mathbb{E}[U(c_{1,t+1})]\right] = 0 \tag{20}$$

For the parent utility term, $\mathbb{E}[U(c_{2t})]$, I differentiate the approximation based on the Taylor series:

$$\begin{aligned} \frac{d}{d\lambda_t}\mathbb{E}[U(c_{2t})] &= U'(\mathbb{E}[c_{2t}]) \cdot \frac{d\mathbb{E}[c_{2t}]}{d\lambda_t} \\ &\quad + \frac{1}{2}\left(U'''(\mathbb{E}[c_{2t}]) \cdot \frac{d\mathbb{E}[c_{2t}]}{d\lambda_t} \cdot \mathrm{Var}(c_{2t}) + U''(\mathbb{E}[c_{2t}]) \cdot \frac{d\mathrm{Var}(c_{2t})}{d\lambda_t}\right) \end{aligned}$$

while making use of:

$$\frac{d\mathbb{E}[c_{2t}]}{d\lambda_t} = s_{1t}(\mu - r_f), \quad \frac{d\mathrm{Var}(c_{2t})}{d\lambda_t} = 2 s_{1t}^2 \lambda_t \sigma^2 \tag{21}$$

Note that while the third derivative appears in the total derivative of expected utility, I follow the standard approach in the literature (e.g., Campbell and Viceira (2001)) and omit higher-order terms beyond the second-order approximation, assuming that the consumption variance is sufficiently small.

For the child utility term, $\mathbb{E}[U(c_{1,t+1})]$, I assume that portfolio returns influence child consumption via bequest transmission in a linear manner:

$$\frac{dc_{1,t+1}}{d\lambda_t} = s_{1t}(\mu - r_f) \tag{22}$$

Therefore:

$$\frac{d}{d\lambda_t}\mathbb{E}[U(c_{1,t+1})] = U'(c_{1,t+1}) \cdot s_{1t}(\mu - r_f) \tag{23}$$

Setting the total derivative equal to zero leads to:

$$\beta \left[U'(\mathbb{E}[c_{2t}]) \cdot s_{1t}(\mu - r_f) + U''(\mathbb{E}[c_{2t}]) \cdot s_{1t}^2 \lambda_t \sigma^2\right] + \gamma U'(c_{1,t+1}) \cdot s_{1t}(\mu - r_f) = 0 \tag{24}$$

Factoring out $s_{1t}(\mu - r_f)$, I get:

$$s_{1t}(\mu - r_f)\left[\beta U'(\mathbb{E}[c_{2t}]) + \gamma U'(c_{1,t+1})\right] + \beta U''(\mathbb{E}[c_{2t}]) \cdot s_{1t}^2 \lambda_t \sigma^2 = 0 \tag{25}$$

Solving for λ_t yields:

$$\lambda_t = -\frac{s_{1t}(\mu - r_f)}{s_{1t}^2 \sigma^2} \cdot \frac{\beta U'(\mathbb{E}[c_{2t}]) + \gamma U'(c_{1,t+1})}{\beta U''(\mathbb{E}[c_{2t}])} \tag{26}$$

Substituting the first and second derivative of the CRRA utility function,

$$U'(c) = c^{-\rho_2}, \quad U''(c) = -\rho_2 c^{-\rho_2 - 1}$$

I derive:

$$\lambda_t = \frac{1}{\rho_2} \cdot \frac{\mu - r_f}{\sigma^2 s_{1t}} \cdot \mathbb{E}[c_{2t}] \cdot \left(1 + \frac{\gamma}{\beta} \cdot \frac{U'(c_{1,t+1})}{U'(\mathbb{E}[c_{2t}])}\right) \tag{27}$$

Therefore, the final expression for the optimal investment decision is given by:

$$\lambda_t = \frac{\mu - r_f}{\sigma^2 \rho_2} \cdot \frac{\mathbb{E}[c_{2t}]}{s_{1t}} \cdot \left(1 + \frac{\gamma}{\beta} \cdot \frac{U'(c_{1,t+1})}{U'(\mathbb{E}[c_{2t}])}\right) \tag{28}$$

The equation for λ_t is essentially composed of two parts: The first part, $\frac{\mu - r_f}{\sigma^2 \rho_2}$, was derived similarly by Merton (1969) and highlights the mean-variance trade-off in investment decisions. The second part, $\frac{\mathbb{E}[c_{2t}]}{s_{1t}} \cdot \left(1 + \frac{\gamma}{\beta} \cdot \frac{U'(c_{1,t+1})}{U'(\mathbb{E}[c_{2t}])}\right)$, is model specific and reflects the effects of intergenerational altruism on the share of risky investments. Combining these two parts, the share of risky investments, λ_t, is determined by the Sharpe ratio divided by the risk aversion parameter, ρ_2, multiplied with $\frac{\mathbb{E}[c_{2t}]}{s_{1t}} \cdot \left(1 + \frac{\gamma}{\beta} \cdot \frac{U'(c_{1,t+1})}{U'(\mathbb{E}[c_{2t}])}\right)$. As a consequence, the share in risky investments increases in the expected excess return of risky assets, $E(\mu - r_f)$, and decreases in the variance of the returns, σ^2. Moreover, based on the equation above, risk aversion and altruism unfold opposite effects on the share of risky investments. First, the share of risky investments is negatively associated with the risk aversion parameter, ρ_2. Since risk aversion is amplified throughout the life-cycle as highlighted in the literature review, the share of risky investments is mitigated ceteris paribus. Second, the share of risky investments depends positively on the intergenerational altruism. Enhanced intergenerational altruism increases the share of risky investments as the parent generation internalizes the higher expected returns corresponding with risky investments in the long run.

In the following subsection, I derive the sensitivity of investment decisions regarding changes in risk aversion and intergenerational altruism formally.

2.3 Sensitivity of investment decisions

In order to assess the sensitivity of investment decisions in risky assets over the life-cycle, I have to take into account the effect of intergenerational altruism on the one hand and a shift in risk aversion on the other hand. Both effects work in opposite directions as highlighted in the following proposition.

Proposition: *The share of investments in risky assets, λ_t, follows an ambiguous development over the life cycle. On the one hand, the share of investments in risky assets is mitigated due to an increase in risk aversion, $\frac{\partial \lambda_t}{\partial \rho_2} < 0$. On the other hand, intergenerational altruism leads to an increase in the share of investments in risky assets, $\frac{\partial \lambda_t}{\partial \gamma} > 0$.*

Proof: First, to derive the partial derivative of the share of risky investments regarding the risk aversion parameter, the optimal investment decision highlighted in equation 28 has to be expressed more precisely in light of the CRRA utility function. Under the CRRA utility function it holds:

$$U'(c) = c^{-\rho_2} \quad \Rightarrow \quad \frac{U'(c_{1,t+1})}{U'(\mathbb{E}[c_{2t}])} = \left(\frac{c_{1,t+1}}{\mathbb{E}[c_{2t}]}\right)^{-\rho_2} = B \tag{29}$$

Assuming that

$$A := \frac{\mu - r_f}{\sigma^2} \cdot \frac{\mathbb{E}[c_{2t}]}{s_{1t}}, \quad B := \left(\frac{c_{1,t+1}}{\mathbb{E}[c_{2t}]}\right)^{-\rho_2} \tag{30}$$

equation 28 can be reformulated as follows:

$$\lambda_t = \frac{A}{\rho_2} \cdot \left(1 + \frac{\gamma}{\beta} B\right) \tag{31}$$

Building the derivative regarding ρ_2 yields:

$$\frac{\partial \lambda_t}{\partial \rho_2} = A \cdot \left[-\frac{1}{\rho_2^2}\left(1 + \frac{\gamma}{\beta} B\right) + \frac{1}{\rho_2} \cdot \frac{\gamma}{\beta} \cdot \frac{\partial B}{\partial \rho_2}\right] \tag{32}$$

Since

$$\frac{\partial B}{\partial \rho_2} = -\ln\left(\frac{c_{1,t+1}}{\mathbb{E}[c_{2t}]}\right) \cdot B < 0 \tag{33}$$

I finally get:

$$\frac{\partial \lambda_t}{\partial \rho_2} = A \cdot \left[-\frac{1}{\rho_2^2}\left(1 + \frac{\gamma}{\beta} B\right) - \frac{1}{\rho_2} \cdot \frac{\gamma}{\beta} \cdot B \cdot \ln\left(\frac{c_{1,t+1}}{\mathbb{E}[c_{2t}]}\right)\right] < 0 \tag{34}$$

as $A > 0$, $\rho_2 > 0$, $B > 0$, and under the assumption that $c_{1,t+1} > \mathbb{E}[c_{2t}]$ which translates into $\ln(\cdot) > 0$. The requirement $c_{1,t+1} > \mathbb{E}[c_{2t}]$ implies that enhanced risk aversion ceteris paribus leads to a decline in the share of risky investments as long as children can afford a sufficient amount of consumption. In other words, more risk averse parents are ceteris paribus only willing to increase their investments in risky assets as long as the children cannot afford a sufficient amount of consumption and this effect has to be sufficiently strong. Otherwise an increase in risk aversion mitigates investments in risky assets.
Second, the share of risky investments is positively associated with the altruism parameter, γ, since generation t internalizes the higher utility of the subsequent generation $t+1$ in the course of riskier financial investments on average. Formally, the partial derivative of the share of risky investments regarding the altruism parameter is given as follows:

$$\frac{\partial \lambda_t}{\partial \gamma} = \frac{\mu - r_f}{\sigma^2 \rho_2} \times \frac{\mathbb{E}[c_{2t}]}{s_{1t}} \cdot \left(\frac{1}{\beta} \cdot \frac{U'(c_{1,t+1})}{U'(\mathbb{E}[c_{2t}])}\right) > 0 \tag{35}$$

Combining the effects of age-dependent risk aversion and altruism on the share of risky investments, the net effect is ambiguous. On the one hand, older individuals are more risk averse which leads to a shift from risky investments to less risky investments. On the other hand, the negative effect of age-dependent risk aversion on the share of risky investments is mitigated or even eliminated through intergenerational altruism. ■

In light of the theoretical section, risk aversion and intergenerational altruism unfold opposite effects on the share of risky investments. Whilst enhanced risk aversion leads to a decline of risky investments over the life-cycle, intergenerational altruism leads to an increase in risky investments since the higher returns for the subsequent generation are internalized by the current generation.
The following section is devoted to an empirical analysis which is segmented into a descriptive analysis and a prescriptive analysis. While the descriptive analysis is devoted to a graphical representation of the age-dependent development of investment decisions for investors with and without children, in the prescriptive section the theoretical prediction derived above is verified by contrasting risky financial investments for older investors with and without children in order to account for intergenerational altruism.

3 Evidence

3.1 Descriptive analysis

In order to assess the age-dependency of investment decisions in light of intergenerational altruism empirically, I utilize several independent and dependent variables, consistently originating from the Socio-Economic Panel (SOEP) assembled by the German Institute for Economic Research (DIW) in Germany. Since I focus on particular investment variables as part of the SOEP survey, I utilize a particular SOEP module, the so-called Investment Survey (IS) which was conducted exclusively during the survey year 2014. Since the investment survey was conducted exclusively in 2014, the empirical assessment is based on cross-sectional rather than panel data. Regarding the dependent variable, I mainly make use of a particular investment variable highlighting the individual share of stock investments relative to bond investments out of a hypothetical total investment volume of 50,000 Euro. In general, stock investments are subject to higher expected returns compared to less risky investments like bonds as well as higher volatilities reflecting higher risks. Apart from the investment variable, I take into account the willingness to take risks which is equal to 1 in case of a perfect willingness to take risks and 0 in case of no willingness to take risks at all which implies perfect risk aversion.
Regarding the independent variables, I make use of the age in years of each individual in order to capture the age-dependency of risk aversion and investment decisions. Moreover, I base my analyses on the number of kids of each individual in order to capture intergenerational altruism which is reflected in the investment decisions and the willingness to bear risks. The independent variables are complemented by several covariates. In particular, as control variables, I make use of a gender dummy variable which is 1 for male participants and 0 otherwise, reflecting differences in risk aversion between male and female investors. Moreover, I make use of an indicator which is equal to 1 if the individual gained at least a university degree and 0 otherwise as well as an indicator which is equal to 1 if the individual is married and 0 otherwise. Finally, the aggregate wealth of each individual is of interest as well since it captures paths dependencies in wealth accumulation over the life-cycle, i.e. older individuals normally have more financial capacity in order to engage in financial investments compared to younger individuals. However, due to missing values in the corresponding variable it is not considered.
The following table summarizes the main descriptive statistics for both the two dependent variables as well as the independent variables, i.e. the number of observations, the mean, the standard deviation as well as the minimum and the maximum.

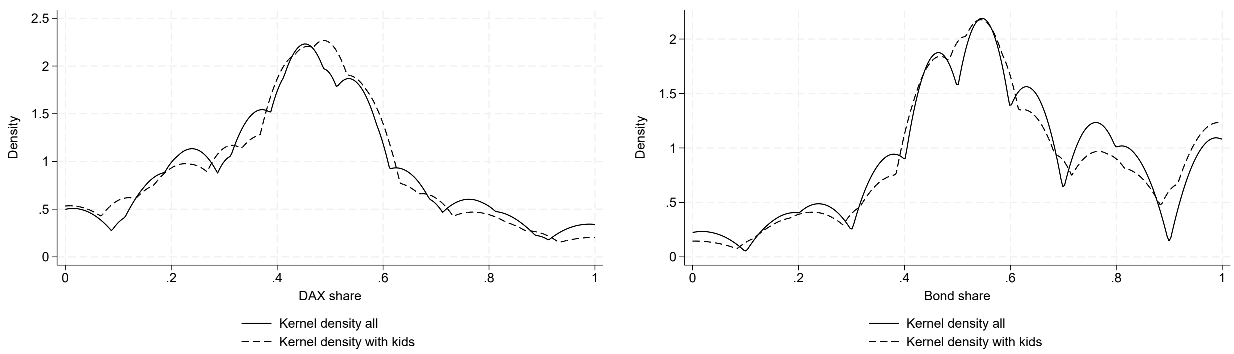
Table 1: Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Financial ratio	951	1.730152	16.34815	0	499
Stock share	997	22677.43	11939.17	0	50,000
Bond share	1,967	30051.4	12305.18	0	50,000
Risk	59,323	4.637021	2.411388	0	10
Age	48,494	52.71594	18.25553	16	97
Child	48,466	1.165931	1.238517	0	10
Uni	73,232	.041826	.2001927	0	1
Male	73,232	.226554	.4186044	0	1
Married	73,232	.1995576	.3996705	0	1

Notes: This table reports the descriptive statistics for both the dependent variable and the independent variables. Whilst the the financial ratio is defined as the ratio of stock to bond investments out of an investment volume of 50,000 Euro, the stock (bond) share is equal to the amount of Euro which are invested in stocks (bonds) out of a total investment volume of 50,000 Euro. The risk variable reflects the willingness to bear risks and is defined between 0 (no willingness to bear risks) and 1 (perfect willingness to bear risks). Apart from the main dependent variables, the covariates comprise the individual age, a variable indicating potential children which is equal to 1 in case of at least 1 child and 0 otherwise, as well as an interaction effect between age and kids. In addition, the table reports an indicator for being married and for a university degree. Accordingly, for each variable the number of observations, the mean value, the standard deviation as well as the minimum and maximum are listed.

Complementary to the main descriptive statistics, the following figure 1 reports kernel density estimates for the main outcome variable, i.e. the share of stock and bond investments relative to all hypothetical nvestments amounting to 50,000 Euro according to the IS survey. On the left hand side of the figure the kernel density estimate of stock investments in the German DAX index is illustrated for all investors and for investors with children. On the right hand side of the figure the kernel density estimate of bond investments is depicted for all investors and for investors with children. Consistently, for both figures the kernel density estimate is based on an Epanechnikov kernel and focuses on investors above age 60. Focusing on investors above age 60 internalizes the transitions into retirement. Both figures show that the share of DAX (bond) investments roughly follow a normal distribution and the mean of the DAX (bond) investments is higher (lower) for investors with children. While the mean share of stock (bond) investments is 43.15 % (63.49%) for all stock (bond) investors above age 60, it is 43.23% (63.23%) for all stock (bond) investors above age 60 with children. This modest difference might be driven by two effects working in opposite directions. First, risk aversion if amplified for older individuals which leads to a substitution of riskier stock investments by less risky bond investments. This effect is amplified since older individuals have less capacity to compensate for potential losses as the residual life expectancy declines. Second, intergenerational altruism leads to longer investment horizons which incentivizes riskier investments. Since both groups account for the same age group, the first effect is basically neutralized such that the second effect might drive the slight differences in line with the theoretical prediction in section 2. In fact, it might be the case that individuals with children exhibit additional differences apart from the investment horizons. For instance, individuals with more financial capacity might be more likely to get children in the first place.

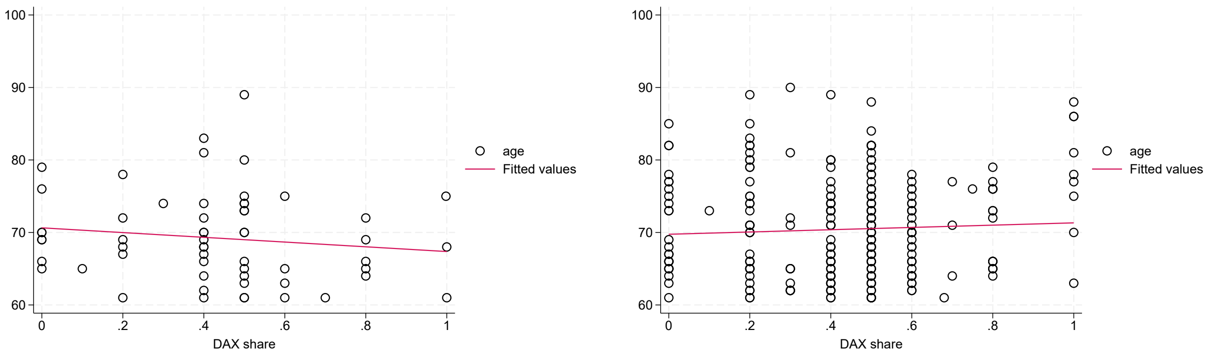
Figure 1: Kernel density estimate of the share of DAX and bond investments



Notes: This figure illustrates kernel density estimates for the share of stock and bond investments relative to all investments based on an Epanechnikov kernel. On the left hand side the kernel density estimate is illustrated for all investors in stocks of the German DAX index with and without children whilst the figure on the right hand side illustrates the kernel density estimate for investors in bonds with and without children.

In addition to the kernel density estimates, the following figure 2 reports the correlation between the share of stock investments relative to all investments and the age based on scatter plots. On the left hand side of the figure, the correlation between the individual age and the share of stock investments is illustrated for all individuals above age 60 without children. Again, by focussing on investors above age 60 close to retirement, I account for the optimization behavior of investors who have to save for the sake of retirement (which increases risk-taking) but encounter a reduced residual life-expectancy to compensate potential losses (which mitigates risk-taking). Apparently, the scatter plot illustrates a negative association between the individual age and the share of stock investments. This negative association between the age and the share of stock investments can be explained with a decline in residual life expectancy in order to compensate potential losses and an increase in risk aversion. The corresponding correlation coefficient between the age and the share of stock investments for investors above age 60 amounts to -13.90%. On the right hand side of the figure, the correlation between the individual age and the share of stock investments is illustrated for investors above age 60 with at least one child. Accordingly, whilst the share of stock investments is decreasing over the life-cycle, if the individuals has at least one child the relationship turns positive which is in line with the theoretical predictions. In particular, individuals with own children have a longer time horizon as they internalize the returns generated by the subsequent generation, fostering risk-taking by the preceding generation. The corresponding correlation coefficient for investors with at least one child and above 60 years amounts to +5.3%.

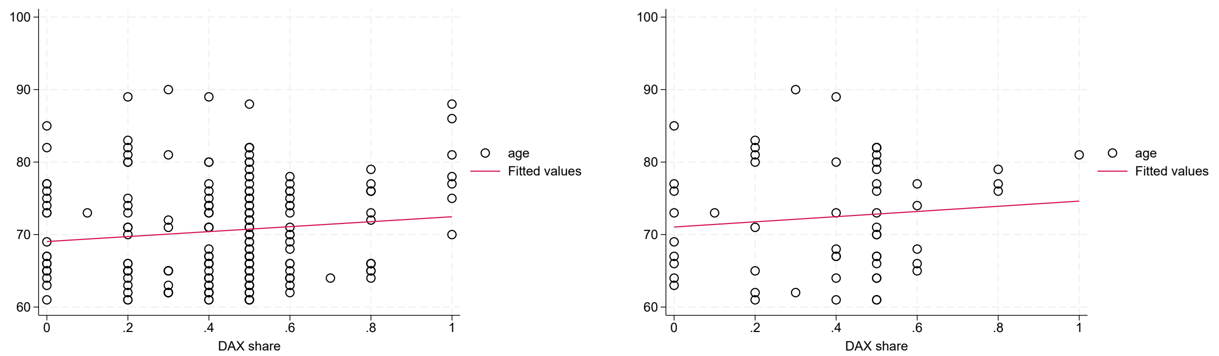
Figure 2: The age-dependency of investment decisions for individuals without and with children



Notes: This figure illustrates the correlation between the age and the share of stock investments relative to all investments for different investors based on a scatter plot. In the figure on the left hand side, the share of stock investments is related to the individual age for all individuals without children. On the right hand side the share of stock investments is related to the individual age for individuals with at least one child. Consistently, both groups are older than 60 years in order to internalize transitions into retirement.

Moreover, figure 3 reports the correlation between the share of stock investments relative to all investments and the age for investors with more than one child as well. Consistently, on the left hand side of the figure, the correlation between the individual age and the share of stock investments is illustrated for all individuals with at least two children. Again, the association is positive whilst the corresponding correlation coefficient increases to +11.51%. On the right hand side of the figure, the correlation between the individual age and the share of stock investments is illustrated for individuals with at least three children. The corresponding correlation coefficient equals +10.78%.

Figure 3: The age-dependency of investment decisions for individuals with more than 2 and more than 3 children



Notes: This figure illustrates the correlation between the age and the share of stock investments relative to all investments for different investors based on a scatter plot. In the figure on the left hand side, the share of stock investments is related to the individual age for all individuals with more than 2 children. On the right hand side the share of stock investments is related to the individual age for individuals with at least three children. Consistently, both groups are older than 60 years in order to internalize transitions into retirement.

Whilst the descriptive statistics highlight the age-dependency of investment decisions, the following section is devoted to an assessment of the strength and the statistical significance of this relationship.

3.2 Prescriptive analysis

Complementary to the descriptive section, as part of an empirical assessment, I rely on a simultaneous equation model (SEM) in order to determine the age-dependency of risk preferences and investment decisions for investors with and without children, accordingly. Formally, the SEM is composed of the following two equations:

$$RISK_i = \alpha + \beta_1 AGE_i + \beta_2 CHILD_i + \beta_3 AGE_i \times CHILD_i + \beta_4 X_i' + \epsilon_i \quad (36)$$

$$RATIO_i = \gamma + \delta_1 RISK_i + \delta_2 CHILD_i + \delta_3 CHILD_i \times RISK_i + \delta_4 Z_i' + \mu_i \quad (37)$$

In the first equation, the dependent variable $RISK_i$ reflects the willingness to bear risks on a scale between 0 (perfectly risk averse) to 10 (perfectly risk loving) whilst the dependent variable $RATIO_i$ in the second equation refers to the share of (risky) stock investments in the German DAX index relative to (less risky) bond investments out of a total investment volume of 50,000 Euro. As part of the SOEP questionnaire in the IS survey, participants are provided with hypothetical 50,000 Euro and have to allocate this amount to investments on the German stock exchange and bonds. Generally, investments on the stock exchange are considered to be more volatile and riskier compared to investments in bonds but also provide higher expected

returns.
The independent variable AGE_i reflects the age in years of each individual while the variable $CHILD_i$ serves as an indicator which is equal to 1 in case of at least one child and 0 otherwise. Finally, the coefficient attached to the interaction $AGE_i \times CHILD_i$ indicates whether the relationship between the willingness to take risks and age is affected by own children. From a theoretical point of view, regarding equation 1, I expect a decline in the willingness to bear risks for older individuals while the relationship between children and risk taking is ambiguous. On the one hand, the consequences of adverse income shocks in reaction to enhanced risk taking are more severe with own children in the short run. On the other hand, risky decisions often correspond with higher returns which might be utilized by children in the long run, especially in case of investments on the financial market. According to the literature, the first effect often dominates the second, i.e. parenthood enhances the individual risk aversion (see e.g. Görlitz and Tamm (2020)). In fact, parents might also be more willing to bear risks as they decided to have children in the first place. As a consequence, since the relationship between the individual age and risk taking is expected to be negative and the relationship between own children and risk taking is ambiguous, the coefficient attached to the interaction effect $AGE_i \times CHILD_i$ is ambiguous, too.
Consistently, in equation 2, the decline in the willingness to take risks for older individuals according to equation 1, is expected to translate into a decline in stock relative to bond investments, i.e. the willingness to bear risks and stock relative to bond investments move in the same direction. However, own children might mitigate or even eliminate this effect in light of intergenerational altruism. Accordingly, I expect a negative coefficient between the willingness to take risks and the child indicator, taking into account that the risk is mitigated for older individuals according to equation 1. Combining the results of both equations implies that an increasing age mitigates the willingness to take risks according to equation 1 while the declining willingness to take risks leads to a decline in stock relative to bond investments according to equation 2. However, own children might be capable to mitigate or even eliminate the dampening effect on the ratio of stock to bond investments as investors with children take a longer investment horizon. In fact, investors with and without children might differ in various aspects apart from risk preferences and investment horizons. In order to increase the efficiency of the estimates and in order to account for omitted variables, I utilize additional covariates denoted as X_i and Z_i, respectively.
The following tables 2 and 3 provide the estimation results for the SEM which is composed of equation 1 in the bottom and equation 2 in the top of the table, respectively. In both tables, columns (1) and (4) refer to investors above age 50, whilst columns (2) and (5) refer to investors above age 60 and columns (3) and (6) refer to investors above age 70. Both tables differ slightly in the model specifications regarding the covariates utilized. Consistently for both

tables, according to the estimation of equation 1, older individuals show in fact less willingness to bear risks compared to younger individuals. The decline in risk tolerance for older investors is potentially due to biological and behavioral reasons and is in line with the literature review in section 1. According to the estimation of equation 2, the decline in the willingness to take risks translates into a reduction in stock relative to bond investments since the coefficient is positive. However, in line with the theoretical predictions, own children mitigate the declining effect of stock investments relative to bond investments as the coefficient attached to the interaction effect is negative throughout all model specifications.

Regarding covariates, the indicator reflecting a completed academic education is not significantly linked to risk taking even though some studies highlight a positive relationship, i.e. Black et al. (2018) show based on wealth data from Sweden that "for men, an extra year of education increases market participation by two percentage points and the share of financial wealth allocated to stocks by 10 percent." Moreover, in line with numerous other studies male individuals have a significantly higher risk tolerance compared to female individuals (see e.g. Charness and Gneezy (2012)). In contrast, married individuals are not more prone to risk taking as they potentially encounter more downside risks as a couple in contrast to unmarried pairs since the coefficients are insignificant.

To sum up, according to the estimation results, an increasing age corresponds with a decline in the willingness to take risks, whilst this decline translates into a substitution of risky stock investments by less risky bond investments. However, in case of at least 1 child the substitution of risky stock investments is mitigated or even eliminated. In fact, these estimation results cannot necessarily be interpreted as causal effects. Investors with children might differ in certain additional unobservable characteristics. Alternatively, risk preferences might have an impact on the decision to have children in the first place. From this perspective, the results are interpreted as correlations rather than causal effects.

Table 2: Results of the Simultaneous Equation Model (SEM) Specification 1

	(1) Ratio > 50 years 3SLS	(2) Ratio > 60 years 3SLS	(3) Ratio > 70 years 3SLS	(4) Ratio > 50 years 3SLS	(5) Ratio > 60 years 3SLS	(6) Ratio > 70 years 3SLS
Risk	1.656**	2.655**	6.919**	1.785**	2.821**	6.970**
	(2.31)	(2.23)	(2.52)	(2.06)	(2.05)	(2.29)
Risk × Child	-1.076**	-2.143**	-6.074***	-1.221*	-2.268*	-6.121**
	(-2.16)	(-2.32)	(-2.60)	(-1.81)	(-1.96)	(-2.28)
Child				0.328	0.197	0.0951
				(0.32)	(0.13)	(0.04)
Constant	-1.944	-1.475	-2.800	-2.514	-2.092	-3.030
	(-0.75)	(-0.39)	(-0.37)	(-0.75)	(-0.43)	(-0.32)
	Risk	Risk	Risk	Risk	Risk	Risk
Age	-0.0378***	-0.0463**	-0.146***	-0.0341***	-0.0480**	-0.146***
	(-3.16)	(-2.19)	(-2.96)	(-2.80)	(-2.29)	(-2.96)
Child	0.0327	0.115	0.187	-0.0153	0.107	0.187
	(0.30)	(0.90)	(1.14)	(-0.14)	(0.84)	(1.14)
Risk × Child	0.00465	-0.00160	-0.00652	0.00440	-0.000886	-0.00651
	(0.94)	(-0.26)	(-0.68)	(0.88)	(-0.14)	(-0.68)
Uni	-2.330	-2.539	-2.638	-3.094	-2.617	-2.638
	(-1.04)	(-1.09)	(-1.07)	(-1.36)	(-1.12)	(-1.07)
Male	0.965***	0.972***	1.221***		0.995***	1.221***
	(4.88)	(3.68)	(2.85)		(3.80)	(2.85)
Married	0.193	0.181	0.348			0.348
	(0.88)	(0.61)	(0.73)			(0.73)
Constant	6.204***	7.054***	14.71***	6.690***	7.264***	14.71***
	(8.35)	(4.79)	(3.91)	(9.12)	(5.08)	(3.91)
R^2	0.0669	0.0649	0.1376	0.0206	0.0649	0.1376
Observations	514	313	135	514	313	135

Notes: This table reports the estimation results of simultaneous equation models (SEM). Whilst the estimation results in column (1) and (4) focus on individuals above age 50, the estimation results in columns (2) and (5) focus on individuals above age 60 and the estimation results in columns (3) and (6) focus on investors above age 70. All estimation results are based on robust standard errors.* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3: Results of the Simultaneous Equation Model (SEM) Specification 2

	(1) Ratio > 50 years 3SLS	(2) Ratio > 60 years 3SLS	(3) Ratio > 70 years 3SLS	(4) Ratio > 50 years 3SLS	(5) Ratio > 60 years 3SLS	(6) Ratio > 70 years 3SLS
Risk	1.653*	2.529*	6.418**	1.644*	2.444*	6.418**
	(1.87)	(1.82)	(2.09)	(1.86)	(1.76)	(2.09)
Child	0.357	0.252	0.283	0.337	0.212	0.283
	(0.34)	(0.17)	(0.11)	(0.32)	(0.14)	(0.11)
Risk × Child	-1.191*	-2.234*	-6.137**	-1.183*	-2.180*	-6.137**
	(-1.76)	(-1.93)	(-2.29)	(-1.75)	(-1.89)	(-2.29)
Male	1.485	2.372	5.455	1.197	2.409	5.455
	(0.74)	(0.73)	(0.73)	(0.60)	(0.74)	(0.73)
Constant	-2.814	-2.232	-3.880	-2.623	-1.995	-3.880
	(-0.83)	(-0.45)	(-0.39)	(-0.77)	(-0.40)	(-0.39)
	Risk	Risk	Risk	Risk	Risk	Risk
Age	-0.0342***	-0.0483**	-0.146***	-0.0380***	-0.0466**	-0.146***
	(-2.81)	(-2.30)	(-2.96)	(-3.17)	(-2.20)	(-2.96)
Child	-0.0152	0.107	0.186	0.0316	0.115	0.186
	(-0.14)	(0.84)	(1.14)	(0.29)	(0.90)	(1.14)
Age $\times Child$	0.00440	-0.000895	-0.00647	0.00469	-0.00158	-0.00647
	(0.88)	(-0.15)	(-0.67)	(0.95)	(-0.25)	(-0.67)
Uni	-3.092	-2.617	-2.642	-2.329	-2.540	-2.642
	(-1.36)	(-1.12)	(-1.07)	(-1.04)	(-1.09)	(-1.07)
Male		0.990***	1.209***	0.962***	0.967***	1.209***
		(3.78)	(2.82)	(4.86)	(3.66)	(2.82)
Married			0.340	0.192	0.177	0.340
			(0.71)	(0.88)	(0.60)	(0.71)
Constant	6.694***	7.285***	14.73***	6.217***	7.078***	14.73***
	(9.12)	(5.09)	(3.92)	(8.37)	(4.81)	(3.92)
R^2	0.0206	0.0640	0.1376	0.0669	0.0649	0.1376
Observations	514	313	135	514	313	135

Notes: This table reports the estimation results of simultaneous equation models (SEM). Whilst the estimation results in column (1) and (4) focus on individuals above age 50, the estimation results in columns (2) and (5) focus on individuals above age 60 and the estimation results in columns (3) and (6) focus on investors above age 70. All estimation results are based on robust standard errors.* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The following section provides a conclusion of the theoretical and empirical results.

4 Conclusion

The paper is devoted to an assessment of the age-dependency of investment decisions in light of intergenerational altruism. Accordingly, I raised the following two research questions: First, does risk aversion increase over the life-cycle, corresponding with a transition of investments from risky stock to less risky bond investments? Second, can children and intergenerational altruism mitigate or even eliminate the shift of financial investments from risky stock investments to less risky bond investments? In order to answer these research questions, I combined a theoretical model with an empirical investigation.

Theoretically, I utilized a traditional OLG model with age-dependent risk aversion and intergenerational altruism according to which investors solve a trade-off between expected returns on the one hand and the expected risks of their financial investments on the other hand. Due to an increase in risk aversion over the life-cycle and less capacity to compensate for potential losses, investors tend to shift their investments from higher returns to lower risks over the life-cycle, especially close to retirement. However, intergenerational altruism embedded in the OLG model indicates that children are capable of neutralizing this shift towards less risky investments. Due to a longer investment horizon of parents originating from intergenerational altruism, the negative effect of enhanced risk aversion in investment decisions is mitigated or even eliminated.

Empirically, in order to verify the theoretical hypotheses, I relied on a simultaneous equation model based on a specific investment questionnaire as part of the German SOEP panel. According to the simultaneous equation model, older individuals are generally more risk averse compared to younger investors, especially close to retirement. This increase in risk aversion translates into a decline in risky stock investments and an increase in less risky bond investments in line with the theoretical predictions. However, this effect is neutralized or even reversed for individuals with at least one child, potentially reflecting intergenerational altruism compensating the dampening effect of enhanced risk aversion. Therefore, the empirical results are in line with the theoretical predictions.

Whilst the literature generally highlights the age dependency of investment decisions, this paper shows that intergenerational altruism is capable of neutralizing the decline in risky investments over the life-cycle.

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