

# The Production of Financial Literacy

Giovanni Gallipoli and Sebastian Gomez-Cardona

UBC

# Research questions

- Open questions about the acquisition of financial literacy (finlit)
- Noisy proxies often used in isolation
- Objective. Examine dynamic process of finlit development and explore questions such as:
  - How do financial competencies evolve over the life-cycle?
  - How do observable traits (income, age, education) shape finlit?
  - Do risk attitudes matter and how?
  - What are the dynamic effects of finlit on distribution of wealth?

# Development of financial literacy in adulthood

- Estimate dynamic model of skill formation, as often done for cognitive and non-cognitive skills (Cunha, Heckman, and Schennach, 2010; Attanasio, Meghir, and Nix, 2020)
- Dynamic process as sequence of steps with imperfectly substitutable inputs
- Productivity (TFP) depends on household characteristics
- Use wealth outcomes as “anchor” to quantify magnitudes

# Data and empirical approach

- Need longitudinal sample with measures of financial outcomes and competencies
- German Panel of Household Finances (PHF 2011, 2014, 2017; Schmidt et al. 2019)
- Household level data. Financial Knowledgeable Person (FKP) answers questions related to assets, wealth, risk attitudes, financial competence
- Financial competence questions (Big 3; Lusardi and Mitchell)
  - Inflation
  - Diversification
  - Compound interest rate
  - Discretionary savings

Selection

Questions

Data details

# Model without Anchoring

$$\theta_{i,t+1}^1 = (s_1(\theta_{i,t}^1)^\rho + s_2(\theta_{i,t}^2)^\rho + (1 - s_1 - s_2)(\theta_{i,t}^3)^\rho)^{\frac{1}{\rho}} \exp[\beta + \alpha X_{i,t} + b\hat{\nu}_{i,t} + u_{i,t}]$$

where

- $\theta^1$ : financial literacy
- $\theta^2$ : household resources
- $\theta^3$ : risk attitudes
- $X$ : age, marital status and years of education
- $\hat{\nu}_{i,t}$ : control function for possible endogeneity of  $\theta_{i,t}^2$

$$\ln \theta_{i,t}^2 = \beta_0 + \beta_1 \ln \theta_{i,t}^1 + \beta_2 \ln \theta_{i,t}^3 + \beta_3 X_{i,t} + \beta_4 Y_{i,t} + \nu_{i,t}$$

Control function requires exogenous variation ( $Y_{i,t}$ : wealth per-capita across regions)

# Model with Anchoring

- Anchor scale of  $\theta^1$  with units of a financial outcome ( $Z$ )

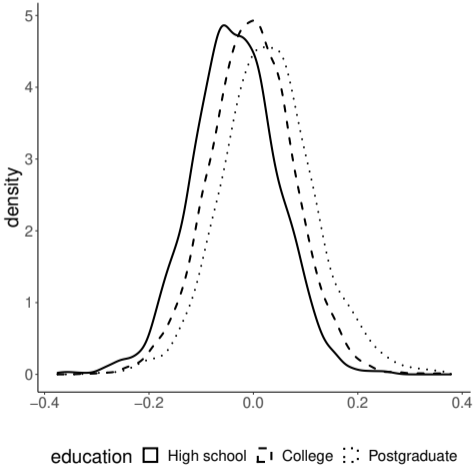
$$(\theta_{i,t+1}^1)^{\gamma_1} = (s_1(\theta_{i,t}^1)^{\rho\gamma_1} + s_2(\theta_{i,t}^2)^{\rho} + (1 - s_1 - s_2)(\theta_{i,t}^3)^{\rho})^{\frac{1}{\rho}} \exp[-\gamma_0 + \beta + \alpha X_{i,t} + b\hat{v}_{i,t} + u_{i,t}]$$

$$Z_{i,t+1} = \gamma_0 + \gamma_1 \ln(\theta_{i,t+1}^1) + \epsilon_{i,t}$$

- We use excess wealth growth as the  $Z$  anchoring variable:
  1. Net wealth change  $r_{i,t} = \frac{w_{i,t}}{w_{i,t-1}} - 1$ . Includes savings, cap. gains, reinvested dividends
  2. Regress wealth growth ( $r_{i,t}$ ) on observables
  3. Compute the predicted (fitted) wealth growth ( $\hat{r}_{i,t}$ )
  4. Compute excess growth (three-year growth rates):

$$Z_{i,t} = r_{i,t} - \hat{r}_{i,t}$$

Estimated density of latent financial literacy factor  $\theta^1$ . Normalized P.D.F. - by education.



# Production Function Estimates - with Anchoring

$$(\theta_{i,t+1}^1)^{\gamma_1} = (s_1(\theta_{i,t}^1)^{\rho\gamma_1} + s_2(\theta_{i,t}^2)^\rho + (1 - s_1 - s_2)(\theta_{i,t}^3)^\rho)^{\frac{1}{\rho}} \exp[-\gamma_0 + \beta + \alpha X_{i,t} + u_{i,t}]$$

$$Z_{i,t+1} = \gamma_0 + \gamma_1 \ln(\theta_{i,t+1}^1) + \epsilon_{i,t}$$

Table 1: 90% confidence intervals based on 100 replications in square brackets

Finlit	0.17 [0,0.97]	children	-0.008 [-0.03,0.02]
Resources	0.674 [0.018,0.827]	education	-0.12 [-0.154,-0.005]
age	0.026 [-0.016,0.065]	$\rho$	0 [-0.127,0.021]
age <sup>2</sup>	-0.001 [-0.002,0.001]	$\gamma_0$	-0.013 [-0.024,0.087]
female	0.028 [-0.012,0.051]	$\gamma_1$	1.145 [0.051,2.797]



# The role of general education - I

- Life-cycle profile for high-school graduates is steeper than for more educated individuals. This suggests decreasing returns and catch-up process
- Patterns consistent with negative estimates of education gradient
- To illustrate this: consider two individuals,  $i$  and  $j$ , with same characteristics including initial finlit ( $\theta_{i,t}^1 = \theta_{j,t}^1$ ), but different education ( $educ_i > educ_j$ )
- Difference in finlit in  $t + 1$  is approximately

$$\ln \left( \frac{\theta_{i,t+1}^1}{\theta_{i,t}^1} \right) - \ln \left( \frac{\theta_{j,t+1}^1}{\theta_{j,t}^1} \right) = \alpha_{educ} (educ_i - educ_j). \quad (1)$$

- If finlit grows faster for  $j$ , the LHS is negative and  $\alpha_{educ} < 0$
- Heterogeneity reflects pace of growth in finlit given initial levels.

# The role of general education - II

- Figure shows average value of latent financial literacy factor by age and education group

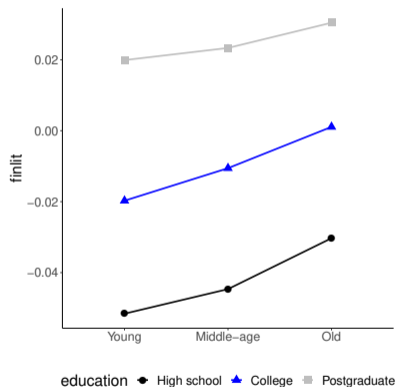


Figure 1: Average latent financial literacy (wave 3) by education group and age

# Production Function Estimates - Young vs Old

Table 2: Production function and anchor equation - Young vs Old. 90% confidence intervals in square brackets.

	Young	Old
Finlit	0.134 [-0.037,0.896]	0.206 [0.053,0.918]
Resources	0.714 [0.065,0.864]	0.653 [0.045,0.841]
female	0.031 [-0.006,0.07]	0.024 [-0.019,0.045]
children	-0.008 [-0.036,0.017]	-0.015 [-0.027,0.014]
education	-0.122 [-0.146,-0.016]	-0.117 [-0.158,-0.013]
$\rho$	0.001 [-0.129,0.034]	-0.001 [-0.145,0.039]
$\gamma_0$	0.031 [-0.059,0.205]	-0.031 [-0.076,0.085]
$\gamma_1$	1.446 [0.074,3.377]	1.013 [-0.114,2.754]

- Pass-through from financial competencies to wealth growth ( $\gamma_1$ ) among younger households is significant and almost 1/3 above point estimate for the whole population. For older households the coefficient loses significance.
- Differences in skill formation: the weight of lagged financial literacy ( $s_1$ ) is 0.13 for the young and 0.21 for the old.
- In contrast, the weight of household resources decreases with age, suggesting a crystallization of financial competencies as age progresses.
- Taken together, these patterns indicate that the accumulation of financial literacy depends on learning by doing and that the learning process might be more vigorous at younger ages.

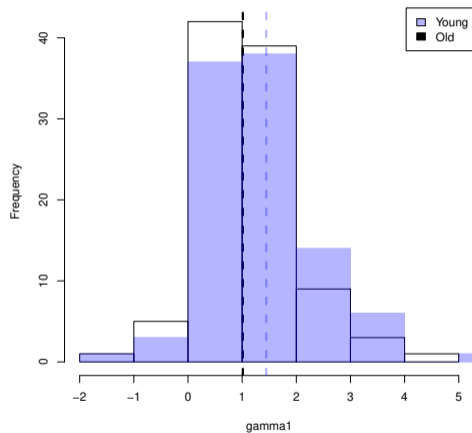


Figure 2: Distribution of  $\gamma_1$ . Dotted line is central estimate, by age

# Risk tolerance and learning-by-doing

Table 3: Risk tolerance among young. 90% confidence intervals in square brackets.

	Low risk tolerance	High risk tolerance
Finlit	0.242 [-0.004,0.948]	0.063 [-0.039,0.806]
Resources	0.639 [0.034,0.828]	0.767 [0.188,0.944]
Constant	0.172 [-0.142,0.481]	-0.346 [-0.535,0.187]
$\rho$	-0.028 [-0.274,0.042]	0.033 [-0.123,0.062]
$\gamma_0$	0.263 [-0.077,0.576]	-0.203 [-0.521,0.237]
$\gamma_1$	1.222 [-0.103,3.449]	2.116 [0.19,3.311]

# Risk tolerance and learning-by-doing: $\gamma_1$

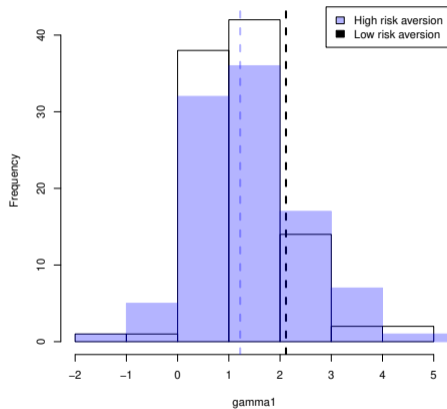


Figure 3: Empirical distribution of semi-elasticity of excess returns ( $\gamma_1$ ) to financial literacy, young age group. Dotted line is central estimate, by risk tolerance.

# Decreasing Returns to Financial Literacy?

**Table 4:** Point estimates of the semielasticity of excess returns to financial literacy ( $\gamma_1$ ) for samples corresponding to different terciles of financial literacy  $\theta^1$  (Tercile 1 is the lowest financial literacy set). 90% confidence intervals based on 100 replications in square brackets. Control variables for gender, age, education, children and marital status included

	Tercile 1	Tercile 2	Tercile 3
$\gamma_1$	1.905	1.753	-0.087
	[0.214,3.854]	[-2.537,4.237]	[-1.16,2.281]

$\gamma_1$  by group



# Wealth Accumulation and the Financial Literacy Channel

- we use the skill formation and the excess-return equations to simulate wealth paths in large samples
- How much wealth inequality can heterogeneity in initial conditions generate?
- How much wealth inequality can be attributed to the financial literacy channel?

$$(\theta_{i,t+1}^1)^{\gamma_1} = (s_1(\theta_{i,t}^1)^{\rho\gamma_1} + s_2(\theta_{i,t}^2)^{\rho} + (1 - s_1 - s_2)(\theta_{i,t}^3)^{\rho})^{\frac{1}{\rho}} \exp[-\gamma_0 + \beta + \alpha X_{i,t} + u_{i,t}]$$

$$Z_{i,t+1} = \gamma_0 + \gamma_1 \ln(\theta_{i,t+1}^1) + \epsilon_{i,t}$$

$$r_{i,t} = Z_{i,t} + \hat{r}_{i,t}$$

$$w_{i,t} = w_{i,t-1}(1 + r_{i,t})$$

# Conclusions

- Financial competencies exhibit high persistence. Initial conditions matter
- Risk attitudes important: they facilitate experimentation and learning by doing
- Early life heterogeneity in latent financial literacy and risk attitudes can account for a large share of the growth in wealth dispersion
- Evidence of decreasing returns to financial literacy
- Ongoing work: quantify contribution of financial literacy channel to wealth dispersion over life cycle
- Designing programs to foster financial literacy: most efficient intervention may depend on household characteristics

We use the following criteria to select our sample

1. The household is part of the three waves of the PHF
2. FKP is the same across waves
3. The observation is part of the third implicate. The PHF consists of five different imputed data sets (implicates). Creating more than one dataset is a generally accepted norm. The Survey of Consumer Finances (SCF) also has five implicates

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To preserve anonymity the Bundesbank classifies four broad regions:

- North: Bremen, Hamburg, Lower Saxony and Schleswig-Holstein
- South: Baden-Württemberg, Bavaria and Hesse
- West: North Rhine-Westphalia, Rhineland-Palatinate and Saarland
- East: Berlin, Brandenburg, Mecklenburg-West Pomerania, Saxony, Saxony-Anhalt and Thuringia

We impute years of education using the highest level of education

- Lower secondary school: 9
- Higher secondary school and East German standard school up to 10th grade: 10
- University of applied sciences diploma, technical school or entrance diploma: 12
- Studying in a professional education institution: 14
- University degree: 16
- Doctorate: 20

## Financial competence questions (1/2)

1. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?
  - 1.1 More than today
  - 1.2 Exactly the same
  - 1.3 **Less than today**
  - 1.4 Don't know
  - 1.5 Prefer not to say
2. Buying a single company's stock usually provides a safer return than a stock mutual fund.
  - 2.1 True
  - 2.2 **False**
  - 2.3 Don't know
  - 2.4 Prefer not to say

1. Suppose you had \$100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?
  - 1.1 **More than \$102**
  - 1.2 Exactly \$102
  - 1.3 Less than \$102
  - 1.4 Don't know
  - 1.5 Prefer not to say
2. Let's assume you've taken out a loan of \$1,000 on which you're paying interest of 20% per annum. If you do not pay down any of the loan and interest is also charged on the accrued interest the following year, how many years would it take for the debt to double?
  - 2.1 Less than two years
  - 2.2 **At least two years but less than 5 years**
  - 2.3 At least 5 years but less than 10 years
  - 2.4 At least 10 years
  - 2.5 Don't know
  - 2.6 Prefer not to say

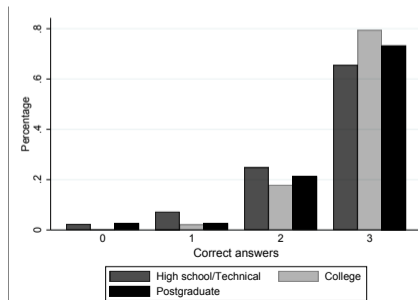
# Descriptive statistics - Financial competence

Table 5: Financial literacy questions. Share of people who answered correctly

Question	Wave 1	Wave 2	Wave 3
Q. inflation	0.940	0.929	0.938
Q. diversification	0.796	0.789	0.819
Q. compound interest 1	0.896	0.908	0.887
Q. compound interest 2	-	-	0.615

Desc. Stats

Other covariates



# Descriptive statistics

	Mean	sd	p50
Household characteristics			
Income	66,137	77,962	49,400
Wealth	438,317	2,096,601	194,500
FKP characteristics			
Years of education	12.2	3.2	10
Age	55.3	14.6	57
Risks above average	0.030		
Female	0.408		
Single	0.139		
Married	0.666		

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# Financial competence and covariates

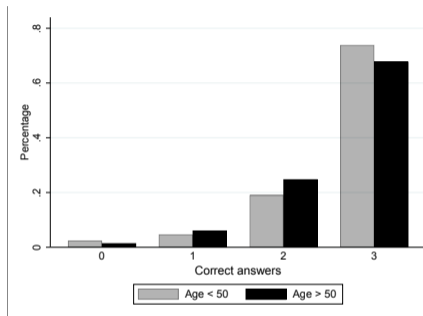


Figure 4.1: Age

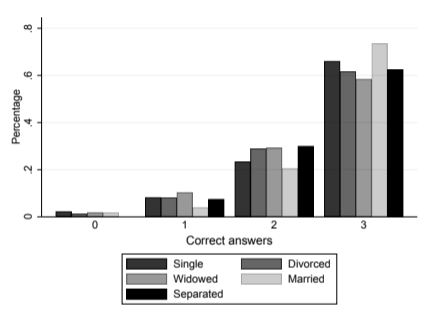


Figure 4.2: Marital status

Figure 4: Histogram of the correct number of financial literacy questions in the first wave by age and marital status

Table 6: Measurements

Measure	Wave 3	Wave 2	Wave 1
Financial literacy			
Q. inflation	x	x	x
Q. diversification	x	x	x
Q. compound interest 1	x	x	x
Q. compound interest 2	x		
Discretionary savings	x	x	x
Household resources			
Income	x	x	x
Net wealth	x	x	x
Make ends meet	x	x	x
Risk attitudes			
Self-assessed risk	x	x	x
Risk preference	x	x	x
Self-assessed patience	x	x	x

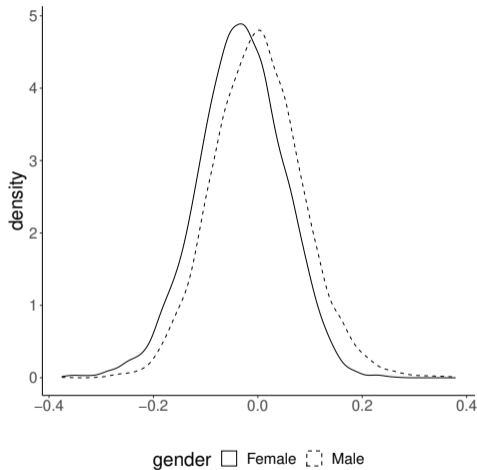


Figure 5: Density: estimated latent financial literacy (wave 3) conditional on gender

# Densities $\theta^2$ , $\theta^3$

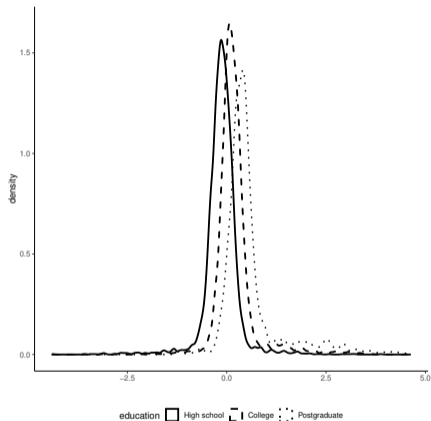


Figure 6.1: Density of latent risk in the most recent wave ( $\theta_3^2$ ) conditional on education

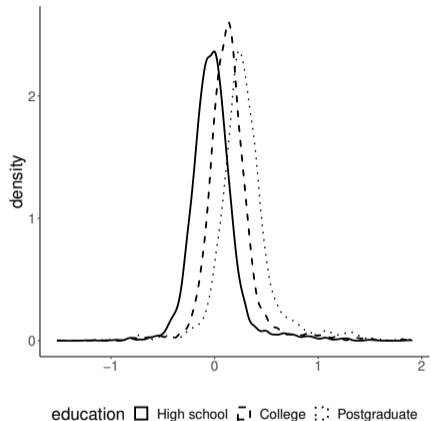


Figure 6.2: Density of latent risk in the most recent wave ( $\theta_3^3$ ) conditional on education

Figure 6: Density: estimated latent variables (wave 3)

Table 7: Share of signal in each measure

Wave	3	2	1
Financial literacy			
Q. inflation	0.09	0.19	0.03
Q. diversification	0.25	0.35	0.25
Q. compound interest 1	0.05	0.35	0.01
Q. compound interest 2	0.23		
Discretionary savings	0	0.15	0
Resources			
Income	0.11	0.18	0.41
Net wealth	0.74	0.58	0.32
Make ends meet	0.01	0.01	0.01
Risk preferences			
Self-assessed risk	0.04	0.02	0.02
Risk preference	0.25	0.97	0.93
Self-assessed patience	0	0	0

$$\ln \left( \frac{\theta_{i,t+1}^1}{\theta_{i,t}^1} \right) - \ln \left( \frac{\theta_{j,t+1}^1}{\theta_{j,t}^1} \right) = \alpha_{educ} (educ_i - educ_j). \quad (2)$$

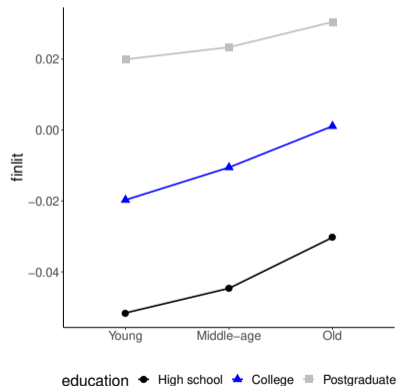


Figure 7: Average latent financial literacy (wave 3) by education group and age

# Decreasing Returns to Financial Literacy

Table 8: Median of excess wealth growth, percentiles of  $\log(\theta^1)$  and estimates of  $\gamma_1$  by group

Group	Median $Z_{i,3}$	Percentiles $\log(\theta_{i,3}^1)$			$\hat{\gamma}_1$
		p10	p50	p90	
All	0.026	-0.122	-0.015	0.091	1.145 [0.051,2.797]
Young	0.103	-0.134	-0.021	0.080	1.446 [0.074,3.377]
Old	-0.004	-0.117	-0.013	0.096	1.013 [-0.114,2.754]
Young - Low risk tolerance	0.106	-0.143	-0.033	0.060	1.222 [-0.103,3.449]
Young - High risk tolerance	0.101	-0.120	-0.007	0.094	2.116 [0.19,3.311]

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