Exploring the Relationship Between Financial Literacy and Uncertainty

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- This paper examines the relationship between **uncertainty** and **financial literacy.** We use a dynamic framework in continuous time
- We **detach** from the standard framework of optimal consumption and portfolio rules
- The "flow" of **financial education** modifies the "stock" of **financial literacy.**
- Financial returns are **random variables** (geometric Brownian motion). So, **investor performance** is a **random process**
- Financial Markets are **imperfect:** there are significant **costs** in terms of **time** and **money (price and cost)** of acquiring financial literacy.

Research questions:

1. Why do individuals under-invest in financial literacy?
2. What variables? Costs, risks, time ….
3. What relation between financial literacy and ….
4. What policies to improve financial education?

VARIABLES to model Financial literacy.

COSTS:

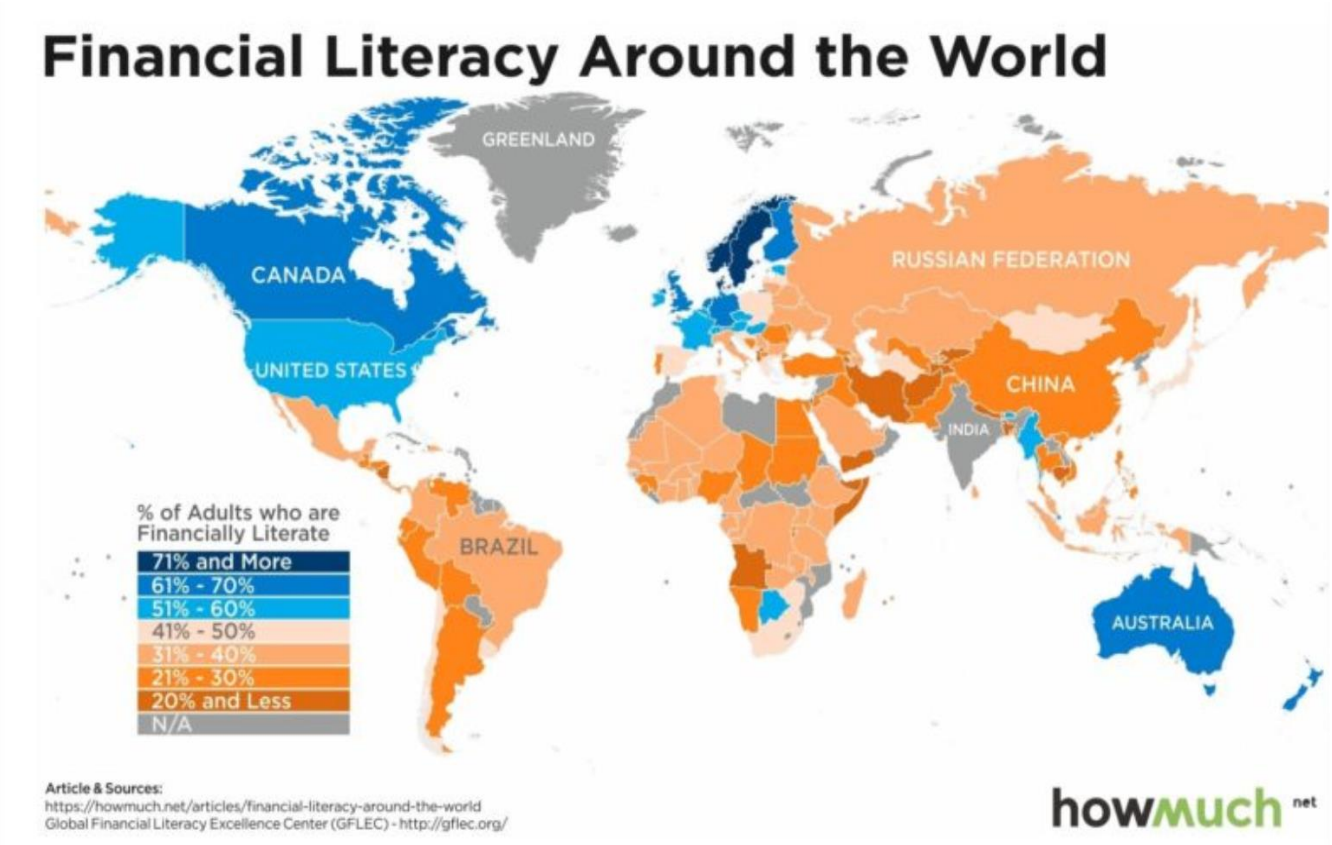
- direct costs of education
- opportunity cost of financial illiteracy
- transaction and adjustment cost of education
- Reversibility of financial education vs sunk cost

UNCERTAINTY:

- Risks
- Portfolio rules
- Precautionary saving
- Liquidity preference

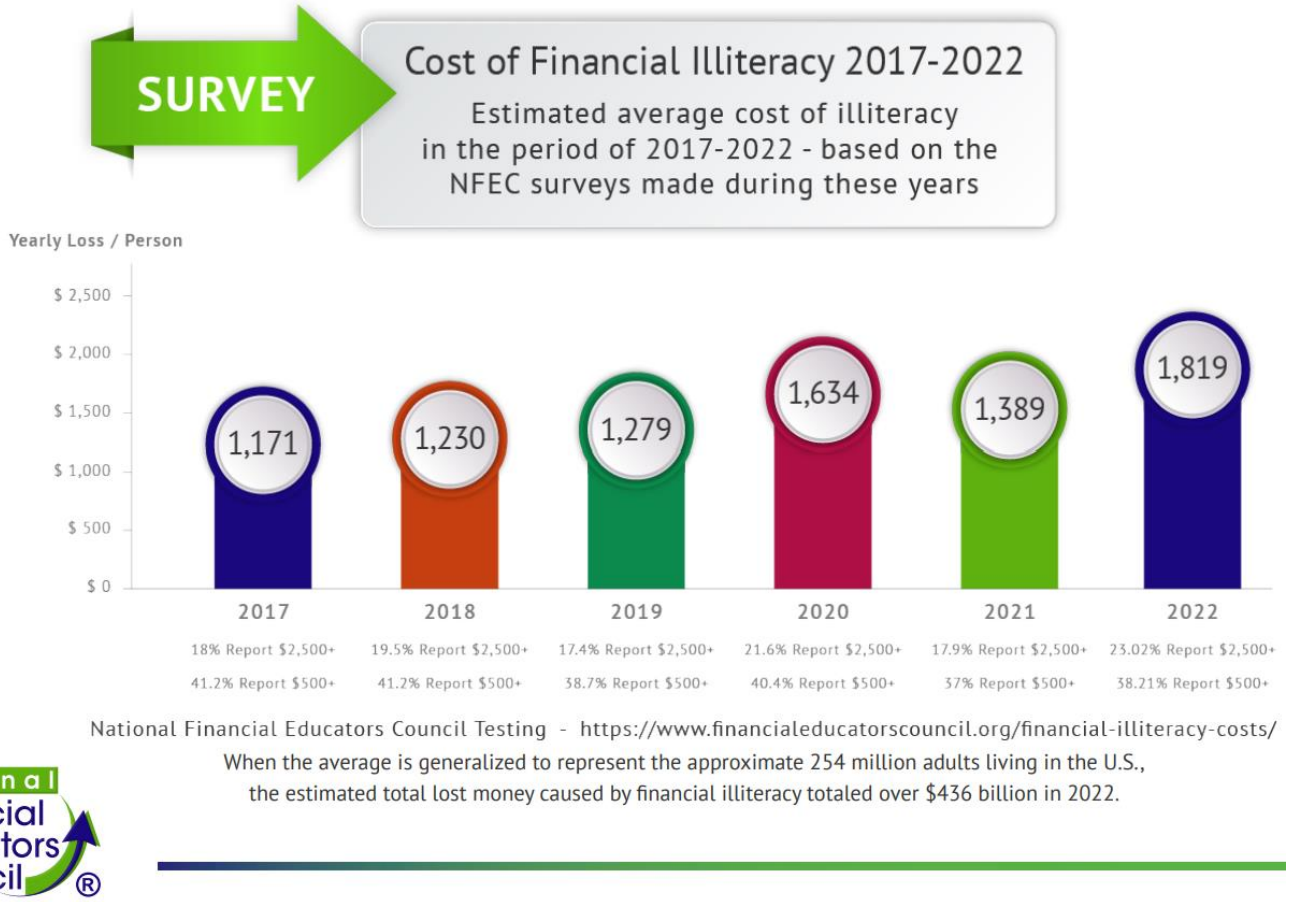
POLICY:

- School and university
- Education programs
- Transversal competences
- Orientation, incentives


Financial Literacy Around the World
GREENLAND
CANADA
UNITED STATES
BRAZIL
RUSSIAN FEDERATION
CHINA
INDIA
AUSTRALIA
% of Adults who are Financially Literate
71% and More
61% - 70%
51% - 60%
41% - 50%
31% - 40%
21% - 30%
20% and Less
N/A
Article & Sources:
https://howmuch.net/articles/financial-literacy-around-the-world
Global Financial Literacy Excellence Center (GFLEC) - http://gflec.org/
howmuch.net

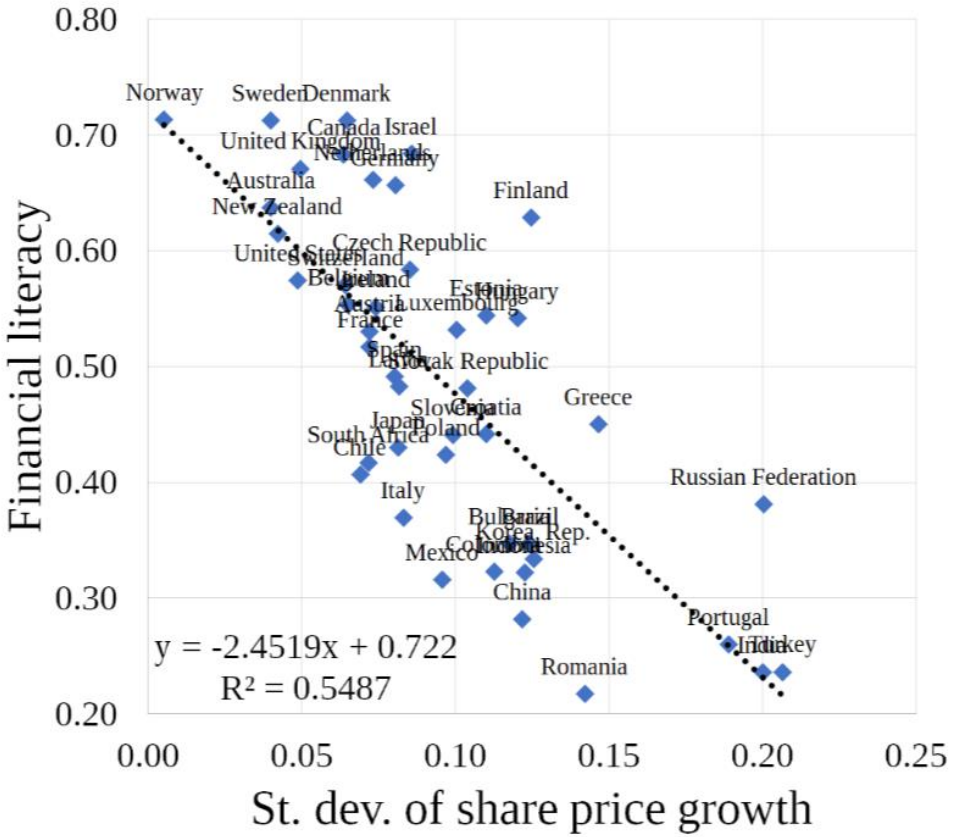
Implicit COSTS:

The annual survey asks U.S. adults to respond to a single question: "During the past year, about how much money do you **think you lost because you lacked knowledge about personal finances**?"



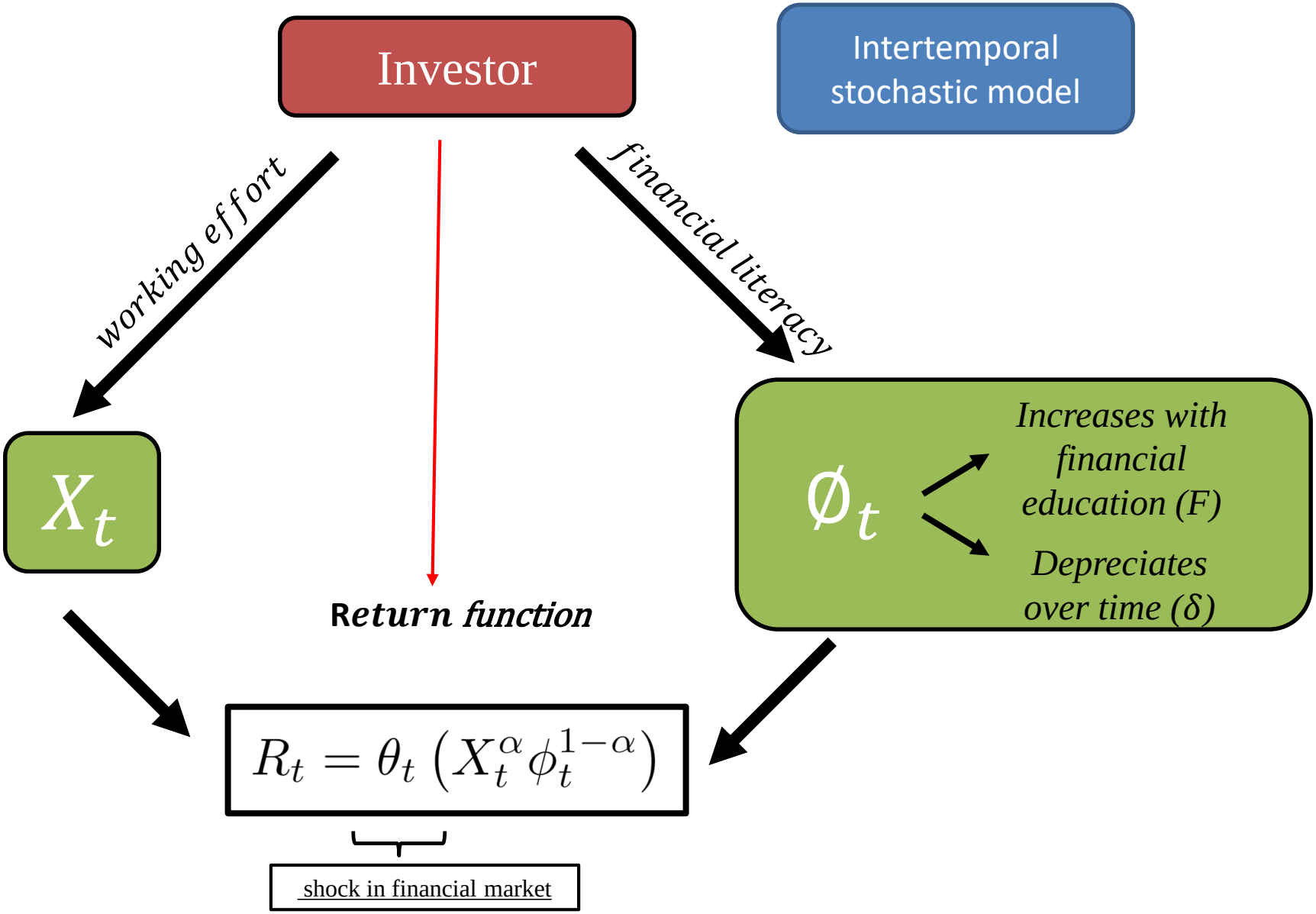
National Financial Educators Council®

Figure 1: The relationship between **Financial Literacy** and **Market Risk (2020)**



Note. Measure of **financial literacy (stock)** is from the S&P Global Financial Literacy Survey, which is based on interviews with more than 150,000 adults in over 140 countries. It represents the most comprehensive global measurement of financial literacy. The index for **financial market risk** is the standard deviation (st.dev) of share price growth rates (OECD).

- The literature provides evidence that a large proportion of the **population knows little** about **finance** and that many individuals are unfamiliar with concepts, such as ***risk diversification*** and ***interest compounding***.
- **Financial literacy** affects **investors' portfolio returns**.
- Van Rooij et al. (2011) find that **financial education** is associated with **greater wealth** and a **higher profitability** in the stock market.
- Christelis et al. (2010) and McArdle et al. (2009) find that the **score** on a basic **math test** is a **strong predictor** of **financial wealth**, stockholding and the fraction of wealth held in stocks.
- Jappelli and Padula (2013 a,b) shows that **financial literacy** may **raise** the **equity premium reducing** the **volatility of returns**. And that financial literacy is higher in presence of a small-scale public pension system.
- However, they do not provide a **theoretical model** to discuss the channels through which this occurs.


Investor
Intertemporal stochastic model
working effort
financial literacy
X_t
$\emptyset_t$
Increases with financial education (F)
Depreciates over time (δ)
Return function
$R_t = \theta_t \left(X_t^{\alpha} \phi_t^{1-\alpha} \right)$
shock in financial market

Investor return function

$$R_t = \theta_t \left(X_t^{\alpha} \phi_t^{1-\alpha} \right)$$

Shock (over θ_t)

Overall return of portfolio (R_t) — *working effort* (X_t^{α}) — *financial literacy* ($\phi_t^{1-\alpha}$)

Financial risk

$$d\theta(t) = \sigma\theta(t) dz_t$$

Wiener process (dz_t)

Accumulation of financial literacy

$$d\phi_t = (F_t - \delta\phi_t)dt$$

Gross rate of investment (F_t) — *Depreciation rate of knowledge* ($\delta\phi_t$)

The investor aims to **maximize** the **expected value** of the **future returns** of his **portfolio**. Assuming that the **discount rate** ρ is **constant**, the expected value is:

Max:

$$J(\phi_t, \theta_t) = \max_{F_s, X_s} E_t \int_t^{\infty} \left[\theta_s X_s^{\alpha} \phi_s^{1-\alpha} - p^X X_s - (p^{\phi} - \mu) F_s - \frac{\gamma}{2} {F_s}^2\right] e^{-\rho(s-t)} ds$$

s.t.

$$d\phi_t = (F_t - \delta\phi_t)dt \qquad\qquad d\theta(t) = \sigma\theta(t)dz_t$$

Where:

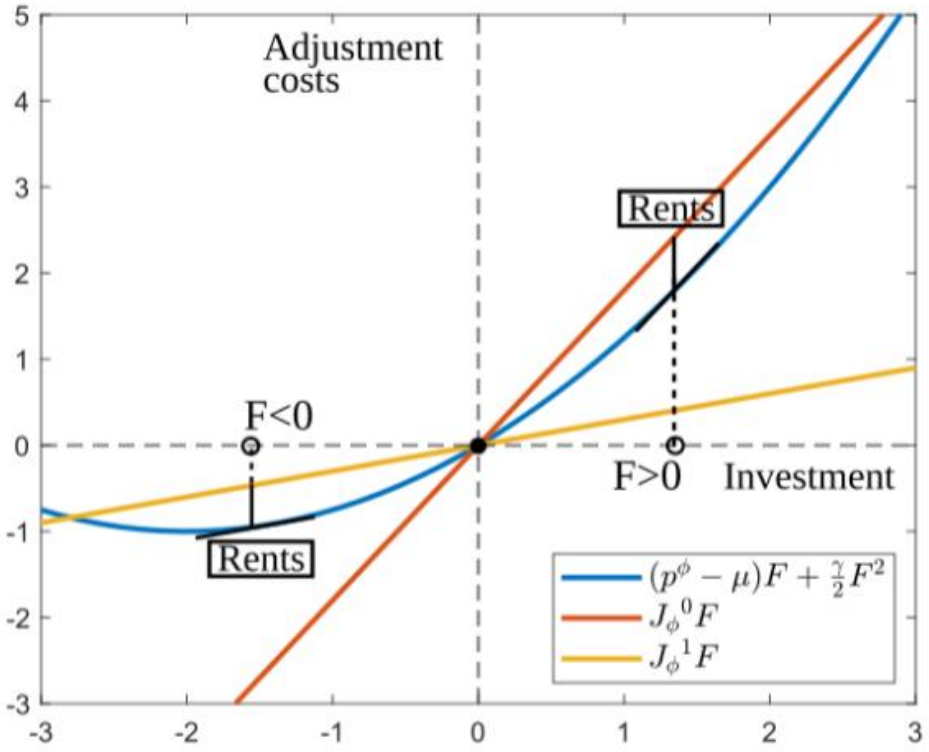
p^X is the **opportunity cost** of the **working hours** of the investor;

p^{ϕ} is the **cost of investing** time and resources in acquiring new **financial education**;

μ represents a **tax incentive** for **financial education** paid by the **government**;

$C(F) = F^2$ is a **convex cost of adjustment** for financial investment.

Figure 3: Reversible investment when $J_\phi > (p^\phi - \mu)$ and $J_\phi < (p^\phi - \mu)$



Note. In the first case, the marginal productivity of financial literacy is represented by $J_\phi{}^0$ and the red line represents the total value of the investment $J_\phi{}^0 F$. In the second case, the marginal productivity of financial literacy is represented by $J_\phi{}^1$ and the yellow line represents the total value of the investment $J_\phi{}^1 F$. The cost function is represented in both cases by the blue curve.

The **optimality condition** for the **value function** can be stated as follows:

$$\rho J(\phi_t, \theta_t)dt = \max_{F_t, X_t} \left[\theta_t X_t^{\alpha} \phi_t^{1-\alpha} - p^X X_t - (p^{\phi} - \mu)F_t - \frac{\gamma}{2}{F_t}^2\right] dt + E_t(dV)$$

To compute the **capital gain or loss**, we express the value of the **investment** as a **function** of the two **state variables** and then apply **Ito's Lemma**.

$$E_t(dV) = \left[(F_t - \delta\phi_t)J_{\phi} + \frac{1}{2}\theta_t^2\sigma^2 J_{\theta\theta}\right] dt$$

$$\rho J(\phi_t, \theta_t) = \max_{F_t, X_t} \left\{\theta_t X_t^{\alpha} \phi_t^{1-\alpha} - p^X X_t - (p^{\phi} - \mu)F - \frac{\gamma}{2}F^2 + (F_t - \delta\phi_t)J_{\phi} + \frac{1}{2}\theta_t^2\sigma^2 J_{\theta\theta}\right\}$$

to solve the model, we rely on a **two-step strategy** (Abel, 1983). At first, the investor chooses its **effort X_t** to **maximise** the **instantaneous operating return:**

$$\max_{X_t} \left[\theta_t X_t^{\alpha} \phi_t^{1-\alpha} - p^X X_t\right] = m\theta_t \, ^{\frac{1}{1-\alpha}} \phi_t$$

where:

$$m = (1-\alpha)\left(\frac{\alpha}{p^X}\right)^{\frac{\alpha}{1-\alpha}} \quad \text{and} \quad \beta = \frac{1}{1-\alpha}$$

Then, differentiating the right-hand side of (8) with respect to F_t, the investor chooses the **optimal level of investment** in **financial literacy**:

$$J_\phi = \gamma F_t + (p^\phi - \mu)$$

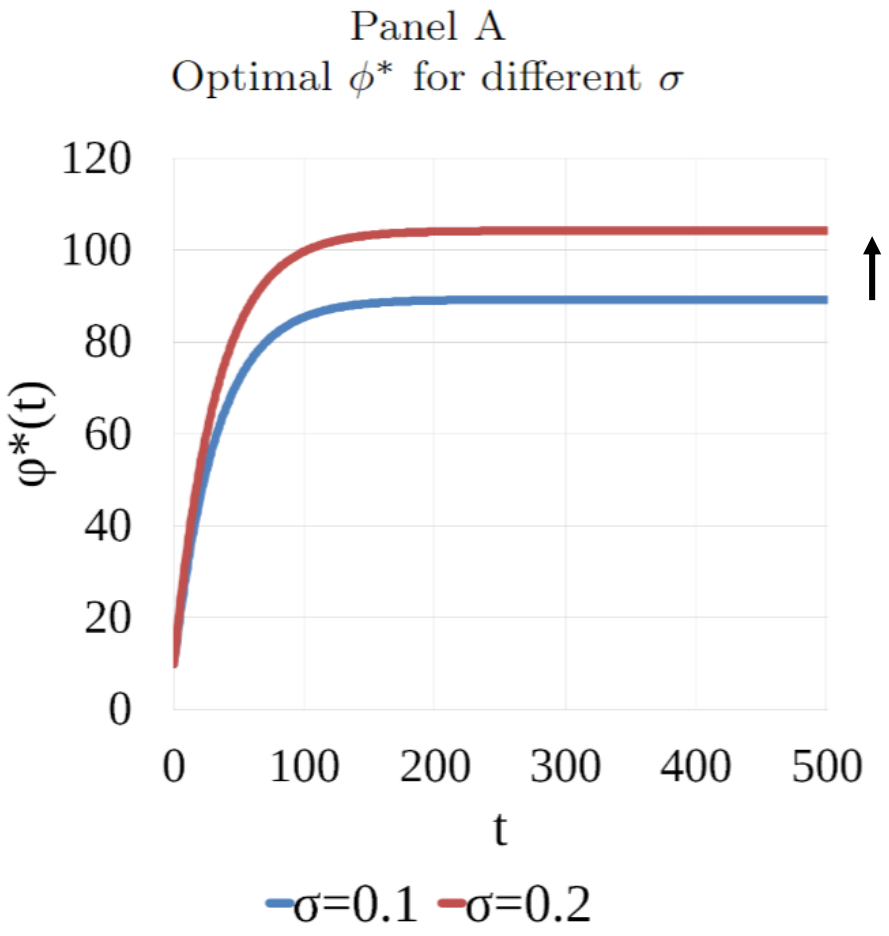
We assume that J(φ_t, θ_t) is a linear function of φ_t so that:

$$J(\phi_t, \theta_t) = J_\phi(\theta_t)\phi_t + G(\theta_t)$$

$$J_\phi = \frac{m\theta^\beta}{\rho + \delta - \frac{\alpha(\beta\sigma)^2}{2}} \qquad G(\theta) = \frac{1}{2\gamma}\left[\frac{J_\phi^2}{\rho - (1+\alpha)(\beta\sigma)^2} - \frac{2J_\phi(p^\phi - \mu)}{\rho - \frac{\alpha(\beta\sigma)^2}{2}} + \frac{(p^\phi - \mu)^2}{\rho}\right]$$

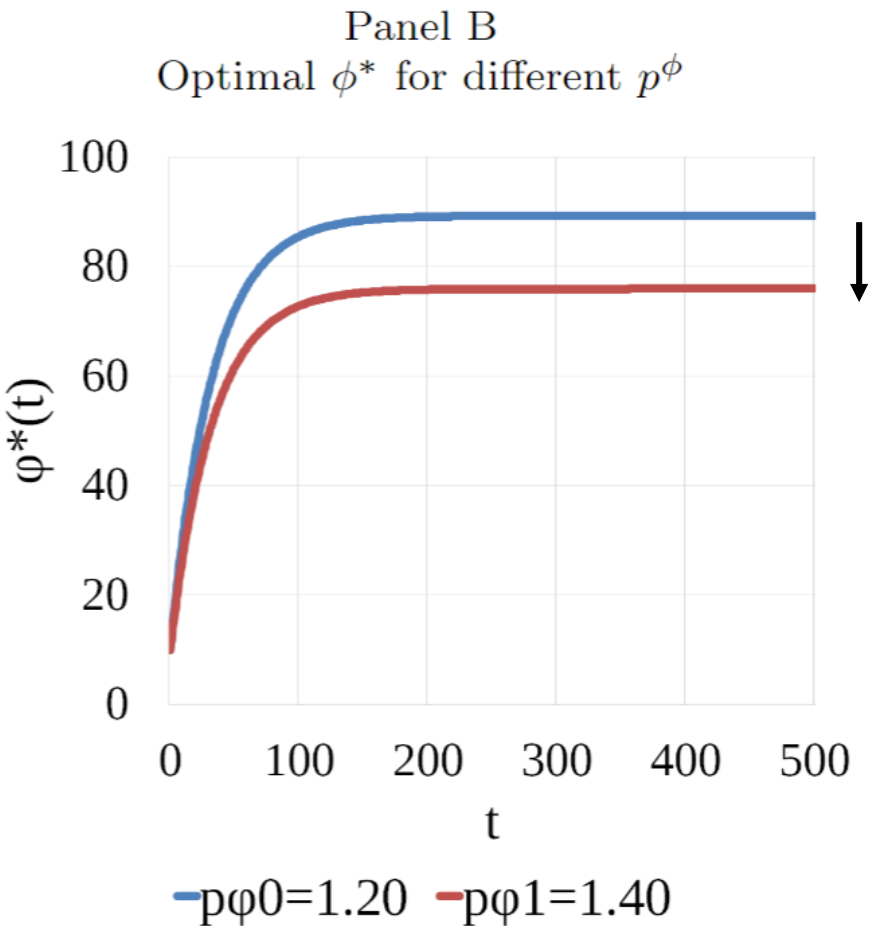
$$F_t = \frac{1}{\gamma}\left[J_\phi - (p^\phi - \mu)\right]$$

Effect of **uncertainty** on the **stock of financial literacy**



$$\frac{\partial F}{\partial \sigma} = \frac{\sigma m (\alpha\beta)^2 \theta^\beta}{\gamma \left(\delta + \rho - \frac{\alpha(\beta\sigma)^2}{2}\right)^2} > 0$$

Effect of **the price of financial education** on the **stock of financial literacy**



$$\frac{\partial F}{\partial p^\phi} = -\frac{1}{\gamma} < 0$$

- The **literature** suggests that a **large share** of the **adult population** knows little about **finance,** and that …
- … there is also evidence that **financial literacy** is **correlated** with **wealth** and **portfolio decisions**.
- However, few papers recognize that **financial literacy** is a **stock**, and that in choosing how much to invest in acquiring **financial education**, **investors** compare and balance **costs, benefits a**nd **risks.**
- We posit that the **stock of financial literacy** is related to the financial skills acquired during the **lifetime**.
- But, this stock of knowledge **depreciates** over time at a rate that differs among individuals, and initial **disparities** might attenuate or compound depending on individual investment in acquiring financial literacy.

- Mainly we find that there are significant **costs** in terms of **time** and **money** of acquiring financial literacy
- **Transaction costs** slowdowns the investment in financial education … but can creates rents if **reversible**
- Financial Literacy contributes to improve **Market efficiency**
- In terms of **policy**, the mix of cost in education, public education programms, tax incentives, and financial market uncertainty can influence the relationship between financial literacy and risk.

Thank you for your attention

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