The economic incentives behind financial illiterate households

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Introduction

- An **evolutionary game** is proposed to describe **investment in financial education** of a population of households and credit institutions/banks.
- On the one side, **households** bear costs related to the amount of time needed to get financially educated, but once literate they have the advantage of knowing better the opportunities in the financial markets, obtaining better conditions in the negotiation of loans and/or financial products with banks.
- On the other side, **banks** might gain profits from low financial education levels by charging higher interest rates to less financially educated households, but this could reduce households demand towards bank products and services.
- We focus on **the strategic interactions** between these two typologies of agents in a **dynamic framework** where households invest in financial literacy only if this strategy increases their utility in time, while banks invest in financial education only whether this decision increases their revenues.

Literature

- There is some evidence that **financial education in institutions and schools** has important effects on a wide range of outcomes, including both **savings and debt** (Brown al., 2016).

- Financial literacy has been repeatedly found to be associated with better planning for retirement (Lusardi & Mitchell, 2014), higher net returns earned on savings (Clark et al., 2017), and **holding of lower-interest debt** (Huston, 2012).

- **The level of financial literacy** in several developed countries **is still low** and contributes to growing wealth inequality. Benefits from increasing the level of financial literacy include more effective saving for retirement and better debt management (Lusardi & Mitchell, 2011).

- However, there are **significant costs** in terms of time and money needed **to obtain an adequate level of financial literacy**, which imply that the net value of acquiring financial literacy could be heterogeneous in the population (Michaud, 2017).

Motivations

- Lusardi (2019) shows that the level of financial literacy could be **heterogeneous** across developed countries with similar econ. and fin. structural characteristics (Table 2).
- Based on this literature, we ask ourselves whether there is an **incentive** for banks/credit institutions **to strategically have financially illiterate households** in the economy.
- For this reason, we analyze the results from the interactions between the decisions of households and banks to invest in financial education.

Table 2 Findings from the FLat World project across 15 countries

Authors	Country	Year of data	Interest rate *Q*		Inflation *Q*		Risk divers. *Q*		All 3 correct (%)	At least 1 do not know (%)	*N*
			Correct (%)	DK (%)	Correct (%)	DK (%)	Correct (%)	DK (%)			
Lusardi and Mitchell (2011c)	USA	2009	64.9	13.5	64.3	14.2	51.8	33.7	30.2	42.4	1488
Van Rooij, Lusardi, and Alessie (2011)	Netherlands	2010	84.8	8.9	76.9	13.5	51.9	33.2	44.8	37.6	1665
Bucher-Koenen and Lusardi (2011)	Germany	2009	82.4	11.0	78.4	17.0	61.8	32.3	53.2	37.0	1059
Sekita (2011)	Japan	2010	70.5	12.5	58.8	28.6	39.5	56.1	27.0	61.5	5268
Agnew, Bateman, and Thorp (2013)	Australia	2012	83.1	6.4	69.3	13.0	54.7	37.6	42.7	41.3	1024
Crossan, Feslier, and Hurnard (2011)	New Zealand	2009	86.0	4.0	81.0	5.0	49.0	2.0	24.0	7.0	850
Brown and Graf (2013)	Switzerland	2011	79.3	2.8*	78.4	4.2*	73.5*	13.0*	50.1*	16.9*	1500
Fornero and Monticone (2011)	Italy	2007	40.0*	28.2*	59.3*	30.7*	52.2*	33.7*	24.9*	44.9*	3992
Almenberg and Säve-Söderbergh (2011)	Sweden	2010	35.2*	15.6*	59.5	16.5	68.4	18.4	21.4*	34.7*	1302
Arrondel, Debbich, and Savignac (2013)	France	2011	48.0*	11.5*	61.2	21.3	66.8*	14.6*	30.9*	33.4*	3616
Klapper and Panos (2011)	Russia	2009	36.3*	32.9*	50.8*	26.1*	12.8*	35.4*	3.7*	53.7*	1366
Beckmann (2013)	Romania	2011	41.3	34.4	31.8*	40.4*	14.7	63.5	3.8*	75.5*	1030
Moure (2016)	Chile	2009	47.4	32.1	17.7	20.9	40.6*	N/A*	7.7	53.1	14,463
Boisclair, Lusardi, and Michaud (2017)	Canada	2012	77.9	8.8	66.18	16.13	9.36	31.29	42.5	37.23	6805
Kalmi and Ruuskanen (2017)	Finland	2014	58.1	6.1	76.5	6.4	65.8	10.25	35.6	14	1477

*Questions that have slightly different wording than the baseline financial literacy questions listed in the text

The general setting of the model

This economy has two populations of homogenous agents: households (H) and banks (B).

Households borrow from banks, at each time *t,* a given amount *L* used for consumption, at an average interest rate *i*. We assume that the totality of the loan (net of reimbursement) finances durable consumption, so that **the utility for H** is simply: $U = L\,(1 - i\,)$.

Banks, on the other hand, provide credit to households, at each time *t,* making **revenues from the lending activity**: $R = L\,(1 + i\,)$.

In this model, we propose two types of financial education:

- **Financial self-education (FSE)** or **low-quality** fin. edu. that is acquired by households on their own, e.g. documenting on the internet, from relatives, friends, etc.
- **Certified financial education (CFE)** or **high-quality** fin. edu. provided by professionals (banks, qualified financial educators, financial institutions, universities, etc.) to households through seminars, courses, or classes.

Financial self-education (FSE)

Each representative household can decide whether invest or not in acquiring financial self-education (FSE). It follows that, in the economy, at each time *t*, there will be a share **x ∈ [0;1]**, of H who invests in FSE, and a complementary share **1 - x** of H who does not invest in FSE.

1. If H invest in FSE, they can negotiate the interest rate *i* on loans *L,* lowering it of an amount equal to *h > 0,* thanks to the (low-quality) education self-acquired (i.e. the **interest rate effect of FSE**).
2. Furthermore, a greater level of FSE increases of j > 0 the amount of credit the H receives from banks in the negotiation process (i.e. **the credit size effect of FSE**).
3. However, FSE has a **cost** for H (also in terms of time) equal to *a > 0.*

$$U = (L + j) (1 – (i – h)) – a$$

So, for H is convenient to invest in FSE only if the sum of the credit size and interest rate effects of FSE is larger than its cost.

Certified financial education (CFE)

Each representative bank can decide whether invest or not in certified financial education (CFE) to educate households. It follows that, in the economy, at each time *t*, there will be a share **y ∈ [0;1],** of B who invests in CFE, and a complementary share **1 - y** of B who does not invest in CFE.

1. If B invest in CFE, they face the drawback of lowering the interest rate *i* on loans *L* of an amount equal to $k > 0$, and thus their revenues because more (high-quality) financially literate H can negotiate better conditions (i.e. the **interest rate effect of CFE**).
2. In addition, CFE has a **cost** for B (also in terms of time) equal to $b > 0$.
3. However, a greater level of CFE increases of $v > 0$ the amount of credit provided by B to H (i.e. the **credit size effect of CFE**) and thus banks revenues thanks to the higher loan demand.

$$R = (L + v) (1 + i – k) – b$$

So, for B is convenient to provide CFE to H only if the credit size effect of CFE is larger than the sum of the interest rate effect and cost of investing in CFE.

The Payoff matrix of the game

- Given this setting, H choose the FSE strategy that maximizes their utility given the choice of B, while B decide the CFE strategy that maximizes their revenues given the decision of H.

- The game is characterized by **limited information** between the players: H are unaware of what will be the financial education decision of B, and, at the same time, B do not know whether H will or will not invest in financial self-education.

- The **Payoff matrix** of the two populations of agents H and B is:

$HHs \setminus Banks$	$\mathbf{NO-CFE}$	$\mathbf{CFE}$
$\mathbf{NO-FSE}$	$L(1-i);\ L(1+i)$	$(L+v)(1-i+k);\ (L+v)(1+i-k)-b$
$\mathbf{FSE}$	$(L+j)(1-i+h)-a;\ (L+j)(1+i-h)$	$(L+j+v)(1-i+k+h)-\frac{a}{y};\ (L+j+v)(1+i-k-h)-\frac{b}{x}$

- In this game, it is also possible to have situations where none of the agents invest in financial education or both types of agents invest in financial education. In the latter case, there is a **network effect** where the costs of fin. edu. *a, b* are reduced when the other typology of agents already invest in fin. edu.

The evolutionary game

- Given the Payoff matrix and the expected payoffs of each agent, we introduce the **Replicator Dynamics** (RD) in continuous time of this game, represented by the following system of two differential equations (Cabrales and Sobel, 1992):

$$\begin{cases} \dot{x} = x\,(1-x)\,(j - 2a + Lh + ay + hj - ij + hvy + kjy) \\ \dot{y} = y\,(1-y)\,(v - 2b - Lk + bx - kv + iv - hvx - kjx) \end{cases}$$

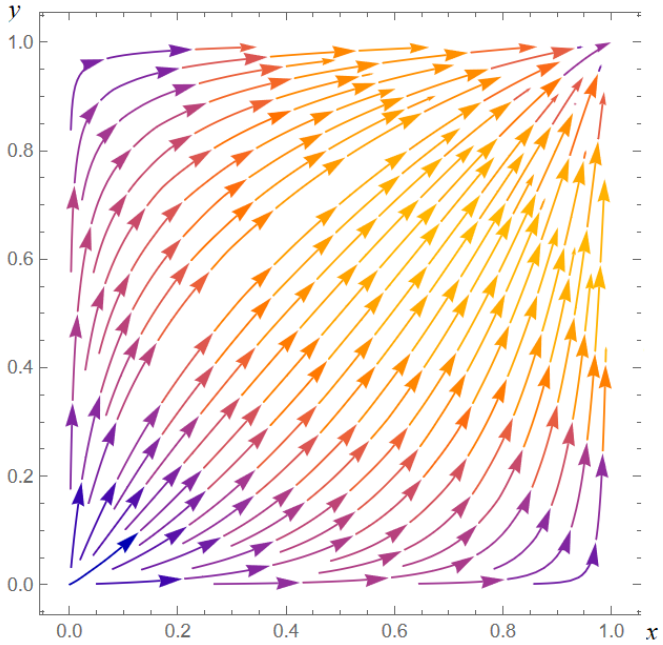
- **The RD proposes a selection mechanism where the proportion of agents (households and banks) using a dynamic strategy increases in time if its payoff is bigger than the average payoff of the corresponding population (i.e. observing expected values, or imitating the best-performing strategy).**

The RD system admits at most five steady states:

- four are the usual corner equilibria *FP1 = (0;0), FP2 = (0;1), FP3 = (1;0), FP4 = (1;1)* of the replicator dynamics;
- one is an internal equilibrium $FP5 = \left(\frac{r\,v + v - 2\,b - L\,k - k\,v}{h\,v - b + k\,u}; \frac{r\,u + 2\,a - u - L\,h - h\,u}{a + h\,v + k\,u} \right)$ which exists only if *0 < FP5 < 1* and is always unstable.

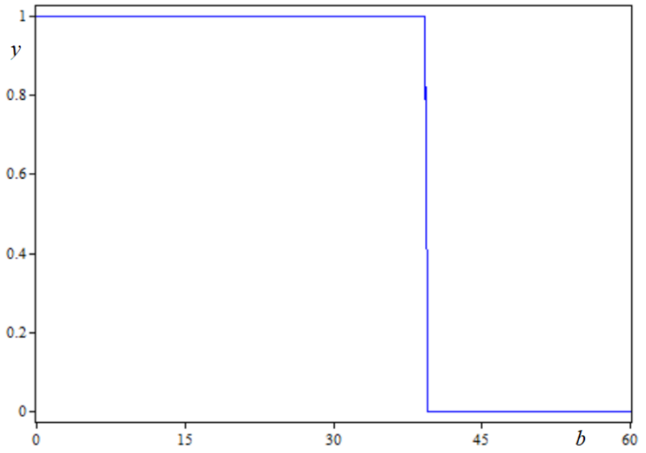
The effect of financial education costs

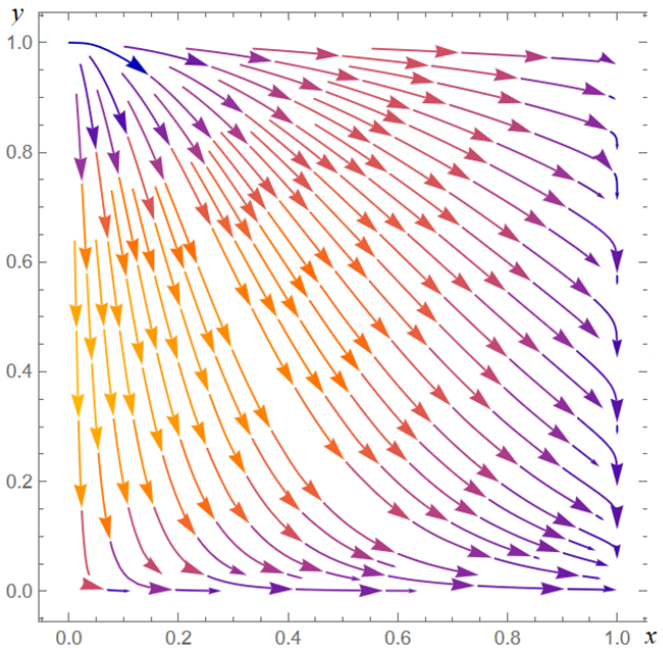
In the following, we assume that ***v > j*** (the credit size effect of CFE is larger than that of FSE), and ***k > h*** (the reduction of interest rate following CFE is greater than that of FSE).



L = 100, i = 0.06, v = 40, j = 30,
k = 0.015, h = 0.01, a = 10, b = 15.

Bifurcation diagram of *b* for *y*





L = 100, i = 0.06, v = 40, j = 30,
k = 0.015, h = 0.01, a = 10, b = 40.

We start from a situation where both financial education costs are relatively low and both agents invest in fin. edu. An increase in the cost of certified financial education *b* moves the system from *FP4 = (1;1)* to *FP3 = (1;0)* where no banks in the economy invest in CFE.

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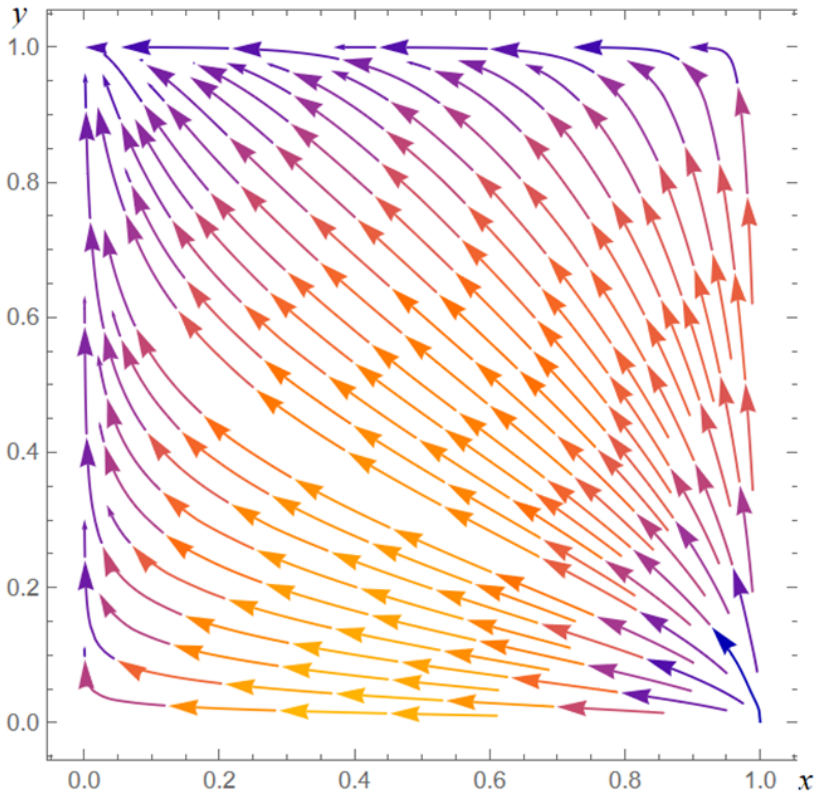
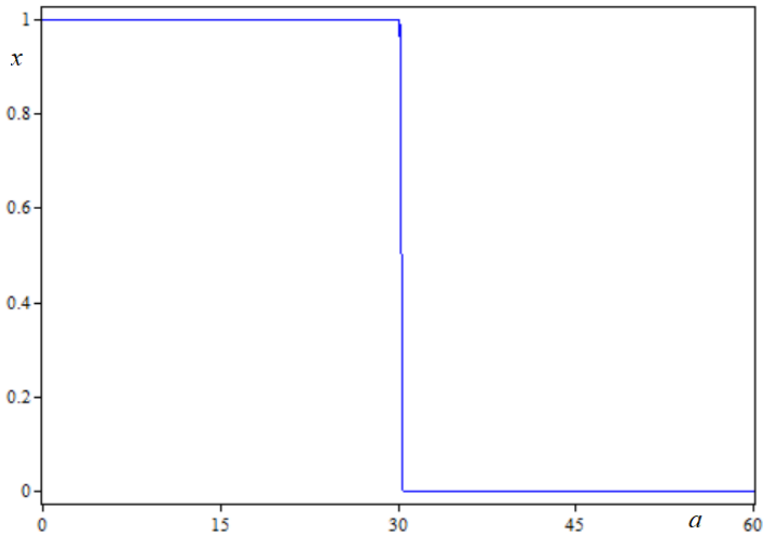


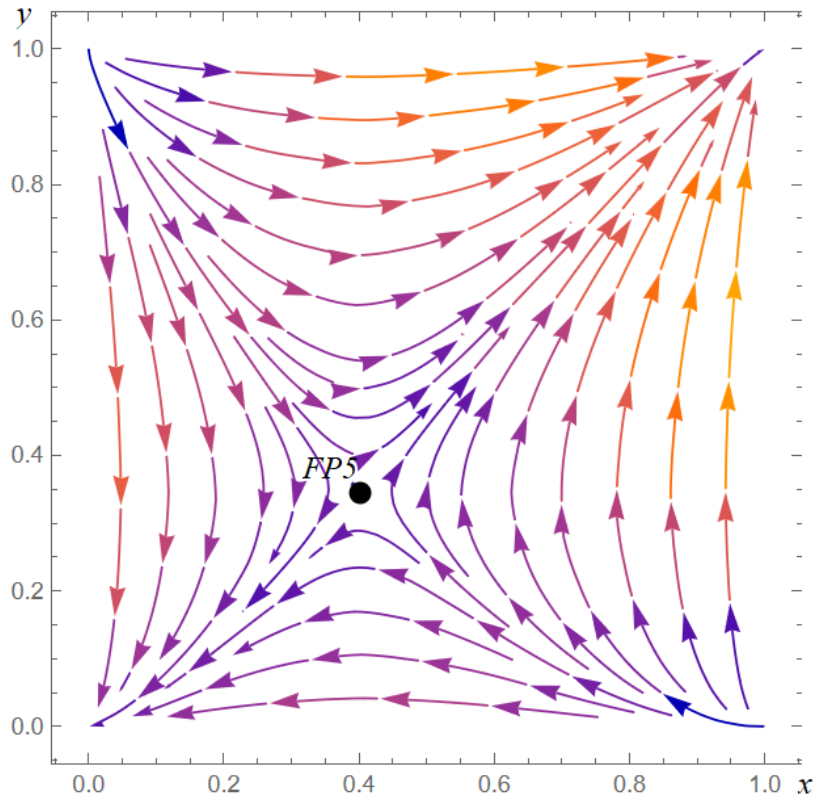
Bifurcation diagram of *a* for *x*



L = 100, i = 0.06, v = 40, j = 30, k = 0.015,
h = 0.01, a = 35, b = 15.

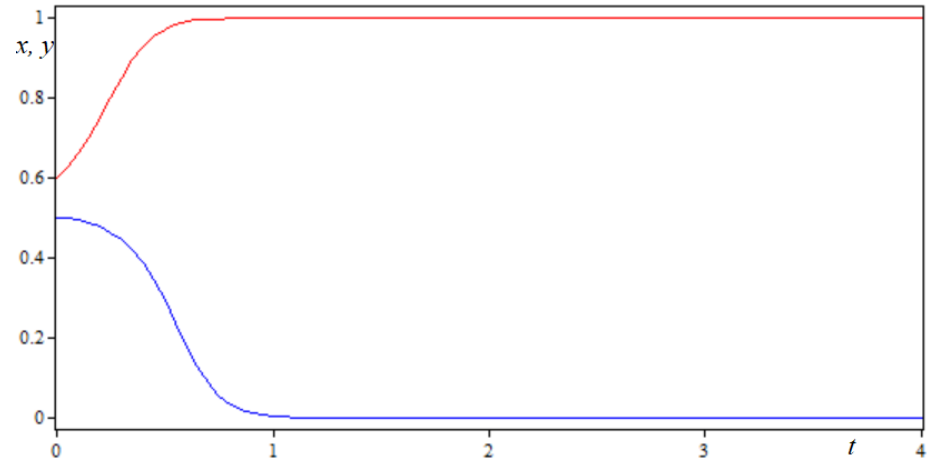
In this second case, starting again from the previous situation where both agents invest in fin. edu., an increase in financial self-education *a,* moves the system from *FP4 = (1;1)* to *FP2 = (0;1)* where no households in the economy invest in FSE.

Multi-stability



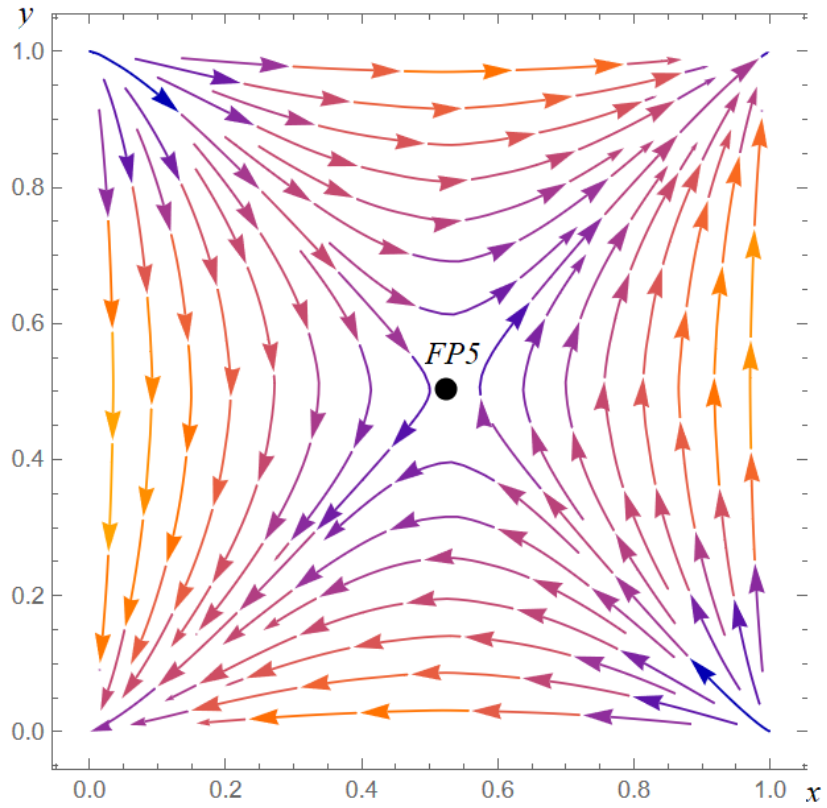
L = 100, i = 0.06, v = 40, j = 30, k = 0.015, h = 0.01, a = 18, b = 25. ***FP5 = (0.40; 0.34)***

Time series for x and y for different initial conditions

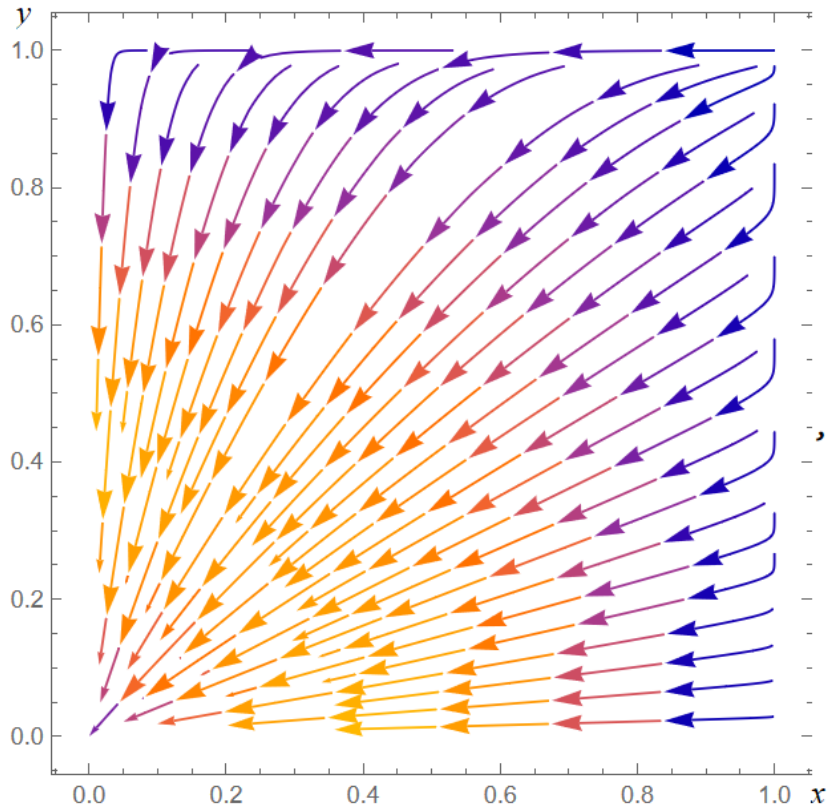


Blue time series ***i.c. = 0.5****, red time series* ***i.c. = 0.6****.*

If both costs of financial education increase, a scenario of multi-stability could arise where both FP1 and FP4 are stable equilibria. In this case, **a phenomenon of path dependency occurs**: starting from values of *x, y < FP5*, the system converges to *FP1 = (0;0)*, while for values of *x, y > FP5*, the system converges to *FP4 = (1;1)* in the long-run.



L = 100, i = 0.06, v = 40, j = 30, k = 0.015,
h = 0.01, a = 20, b = 27. ***FP5 = (0.52; 0.50)***

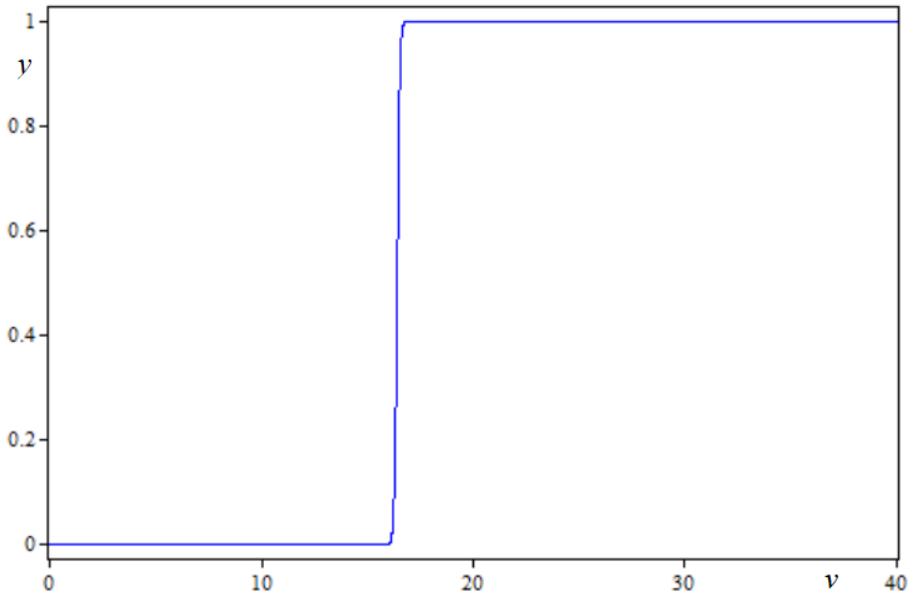


L = 100, i = 0.06, v = 40, j = 30, k = 0.015,
h = 0.01, a = 35, b = 40.

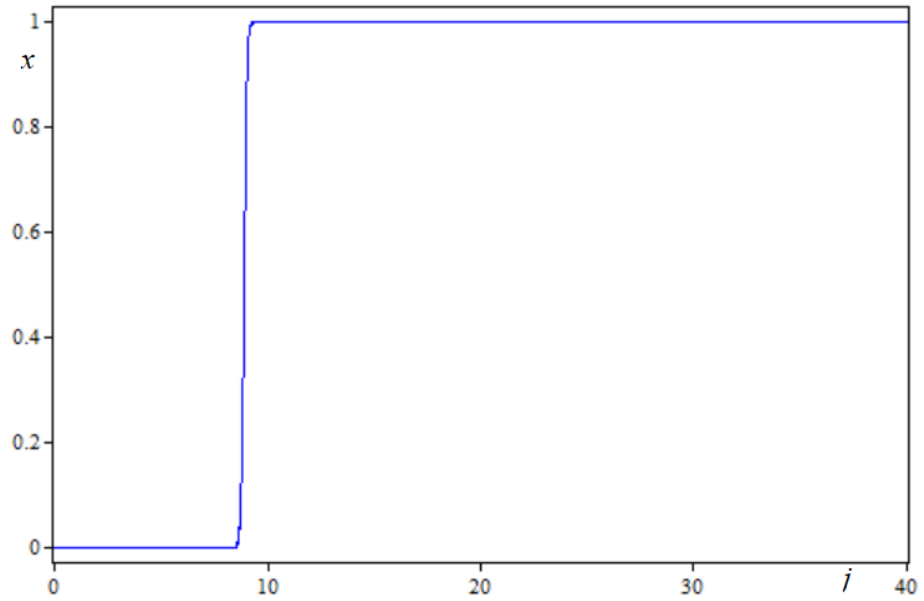
A further increase of *a* and *b* moves FP5 to the upper-right, reducing the basin of attraction of *FP4 = (1;1)* and enlarging the basin (and thus the probability) of reaching *FP1 = (0;0).* This means that economies with the same structural characteristics in terms of advantages and costs of fin. edu. can reach very different outcomes. The **efficiency of the financial markets** and the **preexisting level of fin. edu**. are crucial. In the last figure, if fin. edu. costs are too high neither agent invests in financial literacy in the long-run *FP1 = (0;0).*

The credit size effect of financial education

Bifurcation diagram of *v* for *y*



Bifurcation diagram of *j* for *x*



L = 100, i = 0.06, v = 40, j = 30, k = 0.015, h = 0.01, a = 20, b = 27.

A rise in the credit size effect of CFE (*v)* induces banks to **increase investment** in CFE. Similarly, a rise in the credit size effect of FSE (j) leads households **to invest more** FSE.

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Conclusion and future research

- This model aims at explaining a possible additional mechanism that impacts on the choice of investing or not in financial education: i.e. the **strategic interactions** between households and banks.
- We observe that households are willing to invest in financial education if and only if their utility is larger than the costs of fin. edu.
- Similarly, banks provide fin. edu. if and only if their revenues increase and, in several instances, they can have an **econ. incentive to keep households financially illiterate**.
- The strategic interaction implies that in some situations households (banks) exploit the investment in fin. edu. of the other population of agents, so that high-quality and low-quality financial education **acts as substitutes**.
- In other situations, they complement each other (**high-level equilibrium**).
- Finally, there are scenarios in which nobody invests in financial education (**low-level equilibrium**).
- **Initial conditions matter**: the initial level of financial literacy is important in determining the long-run equilibrium at which the economy converges.
- **Future research**: to consider populations of heterogeneous agents with different costs in acquiring fin. Edu., to include other actors such as the government (room for policy), and to consider non-linearity in costs and financial education effects.

References

1. Brown, M., J. Grigsby, W. van der Klaauw, J. Wen, and B. Zafar. “Financial education and the debt behavior of the young.” The Review of Financial Studies 29:9 (2016): 2490–2522.
2. Cabrales A., Sobel J. (1992). “On the limit points of discrete selection dynamics.” Journal of Economic Theory, 57(2): 407-419.
3. Clark, R., A. Lusardi, and O. S. Mitchell. “Employee financial literacy and retirement plan behavior: A case study.” Economic Inquiry 55:1 (2017): 248–259.
4. Huston, S. J. “Financial literacy and the cost of borrowing.” International Journal of Consumer Studies 36:5 (2012): 566–572.
5. Lusardi, A., and O. S. Mitchell. “Financial literacy around the world: An overview.” Journal of Pension Economics and Finance 10:4 (2011): 497–508.
6. Lusardi, A., and O. S. Mitchell. “The economic importance of financial literacy: Theory and evidence.” Journal of Economic Literature 52:1 (2014): 5–44.
7. Lusardi A. “Financial literacy and the need for financial education: evidence and implications”. Swiss Journal of Economics and Statistics (2019) 155:1.
8. Michaud, P.C. “The value of financial literacy and financial education for workers.” IZA World of Labor (2017):400.