University of Cyprus
Department of Economics

Working Paper 04-2021

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A Collective Investment in Financial Literacy by Heterogeneous Households*

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This Version: July 2021

Abstract

Skills obtained by a national strategy, plus intrinsic skills, contribute to each household's financial literacy, which is shown to determine whether and to what extent a household invests. Ends-against-the-middle preferences arise as to the strategy's funding: Households with too low or too high total skills have a decreasing utility, as opposed to households with moderate skills. Moreover, the property of single-peaked preferences is violated. Our central result is that, despite the lack of well-behaved preferences, competing office-motivated political candidates propose the same—efficient—funding level under plausible assumptions, including that they are sufficiently differentiated about issues other than financial literacy.

Keywords: financial literacy, electoral competition, ends-against-the-middle, differentiated candidates

JEL Classification: G53, D72, H52

*We thank Andreas Milidonis, George Nishiotis, Stavros Zenios and Nicholas Ziros for valuable comments.

1 Introduction

A consensus appears among policy-makers regarding the urgency for boosting financial literacy. For example, the Council on Financial Literacy of the Organisation for Economic Co-operation and Development (2020)

> *"recommends that [governments] establish and implement national strategies that take [an approach] which recognises the importance of financial literacy—through legislation where appropriate—and agrees its scope at the national level [...]".*

Recommendations along the same lines stem from a prima facie reasoning: Since financial illiteracy impairs individual financial performance, a national strategy that promotes financial literacy is warranted. An avalanche of empirical evidence shows that the premise of this reasoning is valid: There exists a positive relationship between financial literacy and financial performance.[1]

Yet, as any other government intervention, a financial literacy strategy needs to address a standard trade-off: Diverting resources for promoting financial literacy automatically implies an opportunity cost in that other public policies will receive less funding. Moreover, to the extent heterogeneous citizens benefit to a varying degree from a financial literacy strategy, the answer to the above trade-off may also be heterogeneous. Thus, a political economic aspect of this problem arises: Can citizens collectively address the above trade-off? More precisely, does a representative democracy deliver an equilibrium funding level for a financial literacy national strategy? If so, is it efficient?

To answer these questions, we study how two candidates competing for an office form their strategy on the novel issue of financial literacy. Understanding that such a novel issue can hardly ever be the focal point of an electoral competition, we consider that candidates compete in two dimensions: (i) each takes a stance

[1] See Lusardi and Mitchell (2014) and Gomes et al. (2021) for comprehensive reviews of related literature.

about the funding level of a financial literacy strategy; (ii) each features some fixed characteristics—which might represent their long-standing position on traditional policy domains, such as redistribution or government size, or non-policy attributes, such as race or religion. The distance between the candidates' fixed characteristics is an inverse measure of the importance of financial literacy for the electoral competition.

On their part, households-voters make a political and a financial decision. On the political front, households, who have preferences over both dimensions of electoral competition, choose their government by casting their vote between the two candidates. On the financial front, once the government is set, and thus the financial literacy strategy has been funded and implemented, each household decides about the allocation of a private endowment between two alternatives: storage with unit returns, and a risky asset with returns that depend positively on each household's financial literacy.

Financial literacy, in turn, is an increasing and concave function of financial skills that stem from two sources: (i) the financial literacy national strategy that offers a uniform level of skills across households; (ii) intrinsic skills that come from sources other than the national strategy—e.g., personal talent, or observing family financial habits. The second source causes household heterogeneity over financial skills for any given funding level of the strategy. This heterogeneity is reflected in households' financial decisions. In particular, we show that participation in the financial market, i.e., investing in a risky asset, requires a minimum threshold of financial skills. Households with financial skills below this threshold do not participate and solely store. Households with financial skills above this threshold invest an amount that is increasing with their skills.

In this setting, ends-against-the-middle preferences emerge: Households with too low or too high total skills have a decreasing utility with respect to the national strategy's funding. For households in the lower end this happens because their exposure to the risky asset, if any, is too small—even though the concavity of the financial literacy function implies that the marginal increase of their investment returns is substantial. Households in the upper end have a negative stance because an increase of their—already high—skills via a national strategy has an insignificant impact on their investment returns. Households with moderate skills favor further funding of the strategy since neither their exposure to the risky asset nor the improvement of their financial skills via the strategy is insubstantial.

Moreover, we obtain that households' preferences may or may not be single-peaked—depending on their intrinsic skills and the potential of the national strategy to add to these skills. Specifically, the property of single-peaked preferences is violated for households that can shift from the lower end (with a decreasing utility) to the middle (with an increasing utility).

Our central result is that despite the lack of well-behaved preferences, an equilibrium, which is unique, convergent and efficient, exists under plausible assumptions. Specifically, we show that when a unique funding level that maximizes aggregate welfare exists, two candidates that are differentiated enough with respect to their fixed characteristics converge to proposing this funding level. Note that enough candidates' differentiation is akin to the issue of financial literacy being 'secondary' enough during the electoral campaign, which we view as a plausible assumption: While financial literacy plays a central role in determining households' financial performance (as shown by empirical evidence and modeled in our setting), it is far from having a central position in the political debate.

We also show that for a range of intrinsic skills' distributions, the property of single-peaked preferences is preserved for all households. In these cases, an equilibrium exists when candidates are sufficiently differentiated, as well as when they are not differentiated at all. The equilibrium with no candidates' differentiation is in line with the standard median-voter theorem (Downs (1957)): Whenever an equilibrium exists, it reflects the ideal policy of the median voter, which need not coincide with the efficient policy. Such a result would suggest that a representative democracy cannot handle well the issue of financial literacy, which is in contrast to our central result. Thus, it is crucial to identify whether financial literacy is of primary importance during the campaign, or not. If not (i.e., candidates are differentiated enough over issues other than financial literacy), mechanism design questions do not arise since a representative democracy delivers the efficient outcome; if yes (i.e., candidates are identical over issues other than financial literacy), alternative ways of policy formation may be considered.

Yet, in societies that are polarized enough with respect to intrinsic skills, the two approaches lead to the same equilibrium, and therefore, to a strong policy prediction. In particular, if intrinsic skills belong to the upper end, or intrinsic skills belong to the lower end and the potential of a national strategy to add to these skills is not large, a unique equilibrium, that deprives a national strategy of any funding, arises for any level of candidate differentiation. To the extent intrinsic skills reflect households' capability to deal with financial complexity by themselves, this result echoes the call by Hastings et al. (2013) regarding the complementarity of simplifying financial products with educating how to cope with financial complexity. Our findings suggest that promoting financial literacy in a society where households have already some grasp of financial complexity is a legitimate move; but, as long as financial products are so complicated that they alienate households from the market, discussing the funding of a financial literacy national strategy in a democracy is in vain.

The remainder of the paper proceeds as follows. In Section 2 we position our paper in the related literature. In Section 3 we present the economic and political setup under consideration. In Section 4 we derive the competitive equilibrium for any given funding level, we characterize households' preferences, and investigate the equilibrium funding level as a political outcome. We discuss our analysis in Section 5, and we conclude in Section 6. Proofs are given in the Appendix.

2 Related Literature

Our work contributes to the theoretical literature on financial literacy.[2] In an early contribution, Delavande et al. (2008) study the decision of acquiring costly financial knowledge in a static model. Jappelli and Padula (2013) study how individuals decide to invest in financial literacy which is costly and depreciates over time. Lusardi et al. (2017) further the inquiry of the optimal investment of individuals in financial literacy to explain how such a decision also impacts wealth inequality. The main deviating feature of our paper is its focus on the *collective* decision about investing in financial literacy, which complements the aforementioned papers' investigation of *individual* decisions about enhancing financial literacy. Thus, we contribute a novel, political economic, perspective to the theoretical literature on financial literacy.

In terms of modeling, in our static setting—as in Delavande et al. (2008)—each household makes one simple financial decision: It allocates capital between a safe and a risky asset. This is clearly a much simpler financial environment as compared to the models presented by Jappelli and Padula (2013) and Lusardi et al. (2017), where households make intertemporal choices. This simplification is necessary to analytically characterize the preferences over funding a financial literacy national strategy, which turn out to be far from trivial. In doing so, we feed an analysis that also contributes to the political economy literature.

Specifically, our paper relates to the work by Epple and Romano (1996a), Epple and Romano (1996b), and Glomm and Ravikumar (1998), and more recently, Epple and Romano (2014) and Epple et al. (2018), who have shown that an equilibrium exists under certain conditions even when ends-against-the-middle and non-single-peaked policy preferences arise. A common feature of the forms of electoral competition under consideration in the aforementioned studies is that the policy variable at hand is either the only one, or at least one of the most prominent ones. Adopt-

[2]We cite empirical studies in Sections 3 and 4 to motivate modeling choices and to discuss analytical results.

ing a form of electoral competition with differentiated candidates, we show that an equilibrium can exist even when the policy variable is of secondary importance in the political debate. We thus contribute an alternative approach that is relevant to the extent the policy at hand, though consequential for voters' utility, is not at the center of the political stage.

Finally, the lack of single-peaked preferences over the financial literacy policy makes the problem of existence of an equilibrium non-trivial since all the analyses in the recently developed literature on electoral competition with differentiated candidates (Krasa and Polborn, 2012; Krasa and Polborn, 2014, Dziubiński and Roy, 2011; Xefteris, 2017) assume single-peakedness. We thus contribute to this strand of the literature by demonstrating that single-peaked preferences over the strategic dimension are not a sine-qua-non condition for equilibrium existence: Concavity of total welfare is a sufficient condition for equilibrium existence in an electoral competition with enough candidate differentiation.

3 Model Setup

We describe in turn the economic and political environment under consideration.

3.1 Economic Environment

We consider a continuum of households of mass one. Let I denote the unit interval $[0, 1]$ and $i \in I$ denote an individual household. Each household is initially endowed with one unit of capital. Let κ_r^i denote the amount that is invested by household i in a risky asset, and $\kappa_s^i = 1 - \kappa_r^i$ denote the amount that is stored by household i with returns equal to one. Perfect competition prevails in all markets, and there is no discount of future consumption.

Investment returns are contingent on the state of the world which may be *good* with probability p, or *bad* with probability $1 - p$, where $p \in (0, 1)$. The state of the world is revealed once all investment decisions have been made. If the state of the world is good, per unit returns equal R; if the state of the world is bad, returns are zero. To rule out trivial solutions where $\kappa_r^i = 0$ for all $i \in I$, we only consider constellations with $pR > 1$.

The investment returns that are ultimately received by household i depend positively on its financial literacy level, which, in turn, is a function of its financial skills.[3] Formally, if the good state occurs, household i receives $\gamma(h^i)R\kappa_r^i$ output units, where $\gamma(h^i)$ denotes the financial literacy level of a household with financial skills h^i.[4] We use the term *"financial skills"* in a generic manner to refer to all factors that contribute to a household's financial literacy level.[5] A household with $h^i \geq 1$ is perfectly financially literate, i.e., $\gamma(1) = 1$ and $\gamma' = 0$ for all $h^i \geq 1$. Moreover, we normalize $\gamma(0) = 0$, and we assume $\gamma' > 0$, $\gamma'' < 0$ and $\gamma''' < 0$ for all $h^i \in [0, 1)$.[6]

Financial skills h^i stem from two sources. First, there exists a government that invests λW in a financial literacy national strategy, where W is a strictly positive constant that denotes an initial public endowment, and $\lambda \in [0, 1]$ is the policy variable that determines the fraction of public endowment that is devoted to the national strategy. Second, each household inherits intrinsic financial skills $\eta^i \sim \mathcal{U}(0, 1)$ that is a residual measure capturing all financial skills obtained by household i from sources other than the national strategy—including, for example, personal talent, or observing family financial habits.[7] Total financial skills of household i

[3] A positive relationship between financial skills, financial literacy and investment returns is in line with empirical evidence (see, among others, recent studies by Von Gaudecker (2015), Bianchi (2018), Song (2020) and Fagereng et al. (2020)). See Lusardi and Mitchell (2014) and Gomes et al. (2021) for comprehensive reviews of related literature.

[4] $1 - \gamma(h^i)$ reflects the cost incurred by household i to receive one unit of investment returns. This cost represents resources employed to cover personal financial literacy shortfalls. They may be monetary, such as fees paid to financial advisors, or non-monetary, such as time and effort to learn and practice the workings of the financial markets.

[5] According to the Organisation for Economic Co-operation and Development (2020), financial literacy is defined as *"a combination of financial awareness, knowledge, skills, attitudes and behaviours necessary to make sound financial decisions [...]"*.

[6] The assumption that $\gamma''' < 0$ simplifies the analysis. See also Footnote 12.

[7] Considering a uniform distribution simplifies the analysis. We consider more general distributions in Section 5.

read

$$h^i = \eta^i + \alpha\lambda W, \tag{1}$$

where $\alpha > 0$ is a parameter that denotes the effectiveness of the strategy in enhancing financial literacy. This means that a national strategy uniformly adds skills to the population. Our understanding is that this happens via a rich toolkit with different policies targeting different segments of the population—in line with a national strategy's wide range as described by the Organisation for Economic Co-operation and Development (2020). We abstract from each policy tool's specificity, and we leave the task of estimating α to econometricians.[8]

The government uses the rest of public endowment, i.e., $(1-\lambda)W$, to produce a public good g. For analytical convenience we assume

$$g = \beta(1-\lambda)W \tag{2}$$

where $\beta > 0$ is a given constant that reflects the effectiveness of the public good. The utility of household i is given by

$$U^i = g + p \cdot \ln \overline{c}^i + (1-p) \cdot \ln \underline{c}^i, \tag{3}$$

where $\overline{c}^i$ and $\underline{c}^i$ denote household i's consumption in the good state and the bad state of the world, respectively. Specifically, in the good state of the world, household i consumes κ_s^i plus investment returns $\gamma R \kappa_r^i$. In the bad state of the world, household

[8]The effectiveness of different policy tools varies, and may be subject to controversy. For example, empirical studies about the—seemingly straightforward—relationship between financial education programs and financial literacy are not conclusive. See, for example, Willis (2011), Meier and Sprenger (2013) and Fernandes et al. (2014). See Hastings et al. (2013) for a critical review.

i only consumes $\kappa_s^i = 1 - \kappa_r^i$. Therefore, we write

$$\overline{c}^i = 1 + \kappa_r^i(\gamma R - 1); \tag{4}$$

$$\underline{c}^i = 1 - \kappa_r^i. \tag{5}$$

3.2 Political Environment

We employ a standard model of electoral competition between two differentiated candidates, L and R, who maximize their vote-shares (see Dziubiński and Roy (2011), Krasa and Polborn (2012), Krasa and Polborn (2014), Xefteris (2017)). The electoral competition takes place in two dimensions, so each candidate $J \in \{L, R\}$ is characterized by her platform (x^J, λ^J). For each $J \in \{L, R\}$, $x^J \in \mathbb{R}$ is considered to be her exogenously fixed characteristic (i.e. ethnicity, culture, religion, ideological background etc.),[9] while $\lambda^J \in [0, 1]$ is the financial literacy strategy's funding level that she chooses to maximize her vote-share. Without loss of generality we assume that $x^L = -x^R = -d/2 < 0$. That is, L is the leftist candidate and R is the rightist one, and $d > 0$ is a measure of how differentiated these candidates are in their fixed characteristics.

For simplicity, we consider that the households-voters' preferences over candidates' fixed characteristics and the funding of the financial literacy strategy are orthogonal, and single-peaked with respect to the candidates' fixed characteristics. Assuming that preferences over the issues are orthogonal is not an inconsequential assumption, but as we will argue later the main result that we obtain applies also to cases in which preferences over the two issues are correlated. Having single-peaked preferences over candidates' characteristics on the other hand, is a quite natural assumption, as it only implies that a household-voter with fixed characteristic $x \in \mathbb{R}$ likes more candidates that are more similar to him, than candidates whose fixed

[9] Attributing to each candidate a vector of multiple fixed characteristics does not change our analysis.

characteristics are very far from his.

Formally, we consider that the voters' fixed characteristics are distributed uniformly on $Q = [-q, q]$ for some $q > 0$; and that for all households with fixed characteristic $\tilde{x} \in Q$, the distribution of intrinsic financial skills (the η^is) are as described in Subsection 3.1. The overall utility of a household i characterized by the fixed characteristic $x^i \in Q$ and the intrinsic financial skills η^i, when candidate J wins is given by

$$v(x^J, \lambda^J | x^i, \eta^i) = -(x^J - x^i)^2 + w \times U^i(\eta^i | \lambda^J) \tag{6}$$

where $w > 0$ captures the relative weight assigned to financial literacy vis-à-vis the importance of the fixed characteristics during the election.

The households-voters observe the candidates' platforms and vote for the candidate that, if elected, would maximize their overall utility. Indeed, in a model with infinitely many voters, like ours, any behavior constitutes a voting equilibrium. But since we only assume a continuum of voters for analytical convenience, we should observe that in any arbitrarily large—but finite—society, sincere voting constitutes the unique weakly dominant strategy for each voter. Hence, assuming that voters behave sincerely is perfectly in line with the households' incentives and, therefore, constitutes the single most reasonable behavior during the election.

Two features of our model account for our understanding that financial literacy policies are not the only, and most likely not the most important, issue for voters. First, we model electoral competition in two dimensions, thus refraining from a model of electoral competition with identical candidates that only choose λ. Second, the importance of financial literacy for the electoral outcome is weighted by w. These two features allow us to study the funding of a financial literacy national strategy as the outcome of a political process that indeed includes other important issues.

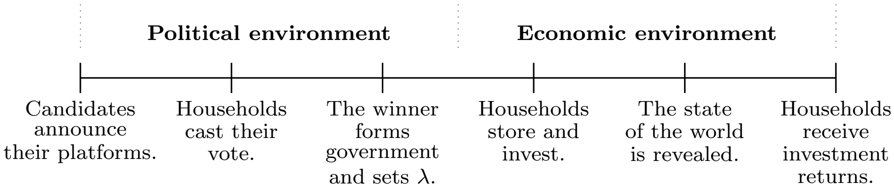


Figure 1: Timeline

The timeline of events is summed up by Figure 1. There are two types of decisions a household needs to make: (i) to cast its vote, and (ii) to allocate its initial endowment between investing and storing. Out of the former, the collective decision on the election outcome arises and the policy variable λ is set. As a result of the latter, the capital allocation in the economy arises. The formation of λ in this political economic environment is the focal point of the analysis that follows.

4 Analysis

We solve the problem backwards. We first characterize the competitive equilibrium considering that the electoral outcome—and therefore the winning platform λ—is given. We then characterize the preferences of households-voters being aware of the impact of any λ on their investment decisions. Finally, we investigate the equilibrium of the electoral competition.

4.1 Competitive Equilibrium

Household i solves

$$\max_{\kappa_r^i;\lambda \text{ given}} \quad U^i = g(\lambda) + p \cdot \ln\left(1 + \kappa_r^i(\gamma(h^i(\lambda))R - 1)\right) + (1-p) \cdot \ln\left(1 - \kappa_r^i\right) \tag{7}$$

$$\text{s.t.} \quad 0 \leq \kappa_r^i \leq 1, \tag{8}$$

where U^i is obtained from (3)-(5), and λ is chosen by the candidate that won the election.

Proposition 1. *Let λ be fixed. Household i invests*

$$\kappa_r^i = \max\left\{0, \frac{\gamma pR - 1}{\gamma R - 1}\right\}, \tag{9}$$

and stores $\kappa_s^i = 1 - \kappa_r^i$. Therefore, there exists threshold $\dot{h}$ that satisfies $\gamma(\dot{h}) = (pR)^{-1}$ with $0 < \dot{h} < 1$ such that the household i invests if and only if $h^i = \eta^i + \alpha\lambda W > \dot{h}$; otherwise, $\kappa_r^i = 0$ and $\kappa_s^i = 1$.

The proof of Proposition 1 is given in the Appendix. The competitive equilibrium informs the voter about the impact of any λ on his financial skills and ultimately on his investment decisions. What does he learn? That λ can determine *whether* he participates in the financial markets, and if so, it can also determine the *extent* of this participation.

Specifically, participation in the financial markets requires a minimum level of financial skills, namely, $h^i = \eta^i + \alpha\lambda W > \dot{h}$, and financial literacy, namely, $\gamma(h^i) > \gamma(\dot{h})$. This means that for households with $\eta^i < \dot{h}$, the policy λ is crucial as to whether they participate, or not.[10] The policy λ may also impact the extent of participation: As long as $h^i \in (\dot{h}, 1)$, higher λ makes investing more efficient due to higher financial literacy level $\gamma(h^i)$, which, in turn, increases investment κ_r^i and decreases storage κ_s^i.[11] Otherwise, the policy does not impact the extent of participation—either because the household does not participate anyway ($h^i < \dot{h}$), or because there is no room for further improvement ($h^i \geq 1$). The intuition that drives Proposition 1 resonates with empirical evidence (see, among others, Haliassos and Bertaut (1995), Calvet et al. (2007), Rooij et al. (2011), Kacperczyk et al. (2019)) that directly relates financial literacy and access to higher investment returns.

[10]Notably, higher pR implies lower $\dot{h}$. This means that less households' participation hinges on the policy λ in more advanced-resilient economies.

[11]Indeed, $\frac{\partial}{\partial\lambda}\left(\frac{\gamma pR - 1}{\gamma R - 1}\right) = \frac{\alpha W R \gamma'(1-p)}{(\gamma R - 1)^2} > 0$.

4.2 Preferences

Being aware of the impact of λ on his investment decisions, as described by Proposition 1, the voter forms his policy preferences. Formally, to cast his vote, the household-voter i solves

$$\max_{\lambda} \quad U^i = g(\lambda) + p \cdot \ln\big(1 + \kappa_r^i(\gamma(h^i(\lambda))R - 1)\big) + (1-p) \cdot \ln\big(1 - \kappa_r^i\big) \tag{10}$$

$$\text{s.t.} \quad 0 \leq \lambda \leq 1, \tag{11}$$

where κ_r^i is given by (9).

Proposition 2. *There exists a threshold $\bar{A}$ with $\bar{A} > 0$ so that $\partial U^i/\partial\lambda \leq 0$ for every $\lambda \in [0,1]$ and every $i \in I$ if and only if $\frac{\beta}{\alpha} \geq \bar{A}$. Otherwise, i.e., for every $\frac{\beta}{\alpha} < \bar{A}$, there exist thresholds $\bar{h}$ and $\check{h}$ with $\dot{h} < \bar{h} < \check{h} < 1$ so that $\partial U^i/\partial\lambda < 0$ for every household i with $h^i \in [0, \bar{h}) \cup (\check{h}, +\infty)$, whereas $\partial U^i/\partial\lambda > 0$ for every household i with $h^i \in (\bar{h}, \check{h})$.*

The proof of Proposition 2 is given in the Appendix.[12]

We first notice that if the effectiveness of the public good is sufficiently high, and/or the effectiveness of a financial literacy national strategy is sufficiently low, i.e., $\beta/\alpha \geq \bar{A}$, then all households are worst off by diverting any amount of public endowment W to promoting financial literacy. In such a case, a public investment for promoting financial literacy is obviously unwanted since it harms more beneficial policies.[13] To rule out solutions in which all households trivially denounce any funding for a financial literacy strategy, we consider constellations with $\beta/\alpha < \bar{A}$ in the remainder of the paper.[14]

[12]The proof makes use of the assumption that $\gamma''' < 0$ to rule out constellations with a strictly greater than two and even number of solutions of $\partial U^i/\partial\lambda = 0$, and, accordingly, strictly greater than one solution of $\partial^2 U^i/\partial\lambda^2 = 0$. As shown by the numerical example depicted by Figure 2, our results still hold for a reasonable specification of γ with $\gamma''' > 0$.

[13]Empirical evidence in the same spirit is presented by Jappelli and Padula (2013) and Lusardi et al. (2017), who show a negative relationship between individual investments in financial literacy and social security benefits.

[14]Obviously, estimations that attach a low value to α render our paper redundant. While,

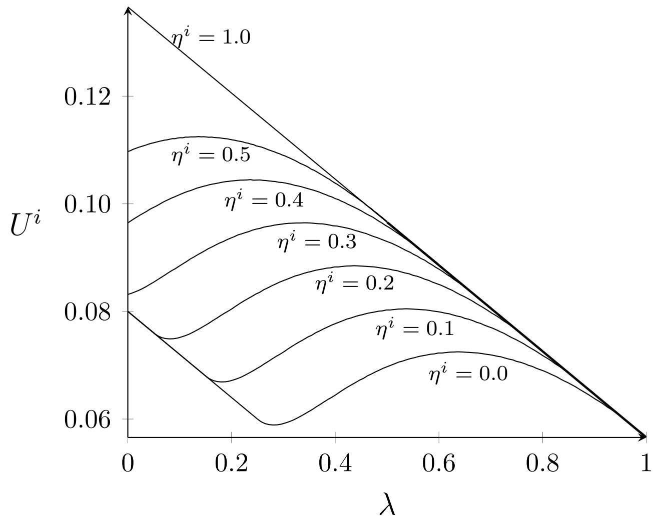


Figure 2: Graphical illustration of the utility of households with different intrinsic skills under the following specification: $\gamma(h^i) = 2\sqrt{h^i} - h^i \; \forall h^i \in [0,1)$ and $\gamma(h^i) = 1 \; \forall h^i \geq 1$, $R = 2$, $p = 2/3$, $W = 1$, $\alpha = 1$ and $\beta = 0.08$. Every household with $\eta^i \geq 0.27$ has single-peaked preferences, regardless of αW. Otherwise, αW matters. For example, a household with $\eta^i = 0.1$ has single-peaked preferences if $\alpha W \leq 0.17$, but has no single-peaked preferences if the public endowment is sufficiently large, i.e., $\alpha W > 0.17$.

Such constellations admit an ends-against-the-middle feature of policy preferences in that households with too small or too high financial skills have the same negative stance towards funding the financial literacy strategy. A graphical illustration of policy preferences is given by Figure 2. Reading the graph vertically for relatively small values of λ, we observe that indeed households with moderate intrinsic skills have an increasing utility with respect to λ, whereas households with too low or too high intrinsic skills have a decreasing utility with respect to λ.

Ends-against-the-middle policy preferences are not uncommon. See, for example, the work by Epple and Romano (1996a) and Glomm and Ravikumar (1998) where households, who fund—via taxes—public provision of a private good, can opt out of the public service to chase better quality from private services. In what follows, we detail the mechanism at work in our context, where households utilize both private and public sources of financial skills, namely, intrinsic skills η^i and

as stated in Subsection 3.1, we take no stance on the estimation of α, we understand that the political economy of financial literacy is *de facto* relevant as long as the issue made it into the policy debate (see, for example, Cundy (2021)).

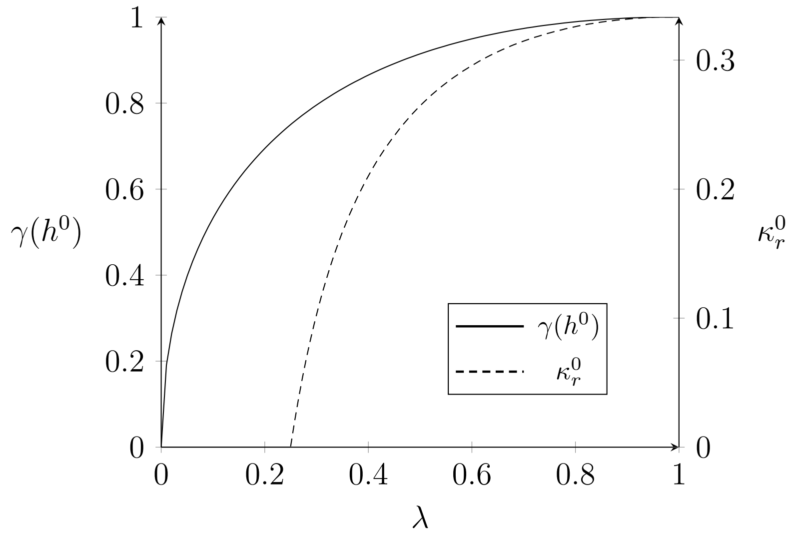


Figure 3: Graphical illustration of the financial literacy and market exposure of the household with no intrinsic skills under the specification of Figure 2. Despite the substantial increase of its financial literacy for small λ, this household does not participate in the market, and thus does not materialize its financial literacy improvement, unless at least 0.25 of the public endowment is devoted to the national strategy.

skills from the national strategy $\alpha\lambda W$.

Members of both ends dislike funding the financial literacy strategy because their gains from higher skills are less than the opportunity cost of lower public good. Yet, the causes of this same stance are distinct for the two ends. Highly skilled households have little to gain because their skills are already substantial, and, therefore, the marginal increase of their financial literacy level from any further increase of financial skills is too small. On the contrary, an increase in λ causes a substantial increase of financial literacy for households with low skills—because of the concavity of γ. However, these households either do not participate in the financial market at all, i.e., $h^i < \dot{h}$, or they participate to an insignificant degree, i.e., $\dot{h} \leq h^i < \bar{h}$. As a result, their income from the financial market accounts for a small part of their utility—which also stems from storage and the public good—and therefore, an increase of returns—though substantial—still does not exceed the respective opportunity cost. As Figure 3 shows for the household with the lowest intrinsic skills, a large fraction of the public endowment needs to be devoted to the national strategy for this household to translate its financial literacy improvement into material benefit. This causes the decreasing utility of household with $\eta^i = 0$ in Figure 2 for small values of λ.

Since $h^i = \eta^i + \lambda\alpha W$, households move towards higher financial skills as λ increases. A potential shift of a household from the lower end—where $\frac{\partial U^i}{\partial \lambda} < 0$—to the middle—where $\frac{\partial U^i}{\partial \lambda} > 0$—is of particular interest with respect to the property of single-peaked preferences because any such shift violates the property. Therefore, a household with $\eta^i < \bar{h}$ has non-single-peaked preferences as long as the potential of a national strategy to add to its intrinsic skills exceeds the difference $\bar{h} - \eta^i$, namely, as long as $\alpha W > \bar{h} - \eta^i$. Reading Figure 2 horizontally, we observe the violation of the property of single-peaked preferences for households with $\eta^i \in (\max\{0, \bar{h} - \alpha W\}, \bar{h})$. At the same time, it is straightforward that a shift from the lower end to the middle cannot be the case for any household with $\eta^i \geq \bar{h}$. These households can only shift from the middle to the higher end, which, in turn, means that they can only undergo a sign change of $\frac{\partial U^i}{\partial \lambda}$ from positive to negative, thus preserving the property of single-peaked preferences. This result stems directly from Proposition 2 and is summarized as follows:

Corollary 1. *A household i has single-peaked preferences over λ, if and only if $\eta^i \leq \max\{0, \bar{h} - \alpha W\}$ or $\eta^i \geq \bar{h}$.*

Does the lack of single-peaked preferences for some households also interferes with the concavity of the total utility in the society? We obtain

Lemma 1. *Let $u \equiv \int_I U^i di$. Then $\frac{\partial^2 u}{\partial \lambda^2} \leq 0$ for every $\lambda \in [0, 1]$ with $\lambda^* = \arg\max_{\lambda \in [0,1]} u$.*

The proof of Lemma 1 is given in the Appendix. This result indicates that there exists a policy that an efficiency-driven authority would choose. We call this policy, i.e., λ^*, as the *efficient* policy.

4.3 Political Equilibrium

We are now ready to investigate the equilibrium of the electoral competition. Since the candidates' fixed characteristics are exogenously determined, we are looking for an equilibrium that is defined as follows:

Definition 1. *An equilibrium is a pair of financial literacy funding levels* (λ^L, λ^R) *that constitute a Nash equilibrium in the game between the two candidates.*

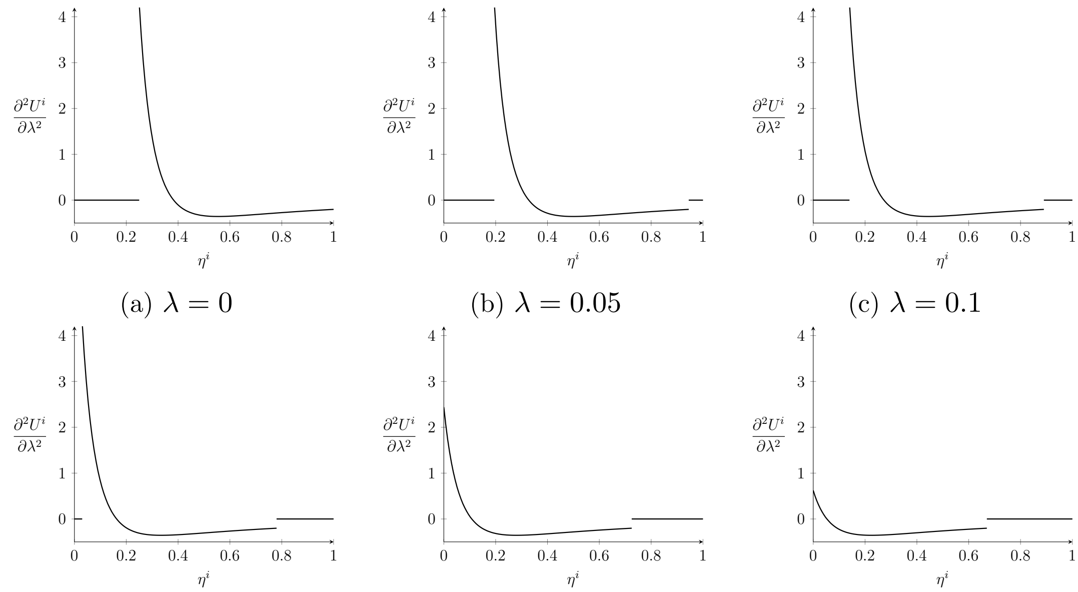
We obtain

Theorem 1. *When candidates are sufficiently differentiated in fixed characteristics (or the issue of financial literacy is 'secondary' enough), then the game admits a unique equilibrium that is moreover efficient. Formally, there exists* $\bar{d} > 0$ $(\bar{w} > 0)$ *such that for every* $d \geq \bar{d}$ $(w \leq \bar{w})$ *there exists a unique equilibrium that involves policies* $\lambda^L = \lambda^R = \lambda^*$.

The proof is given in the Appendix. This result shows that financial literacy can be handled well in a representative democracy: It does not contribute to political polarization since candidates converge to the same policy, and the policy chosen by candidates is the one that an efficiency-driven authority would chose. In what follows we discuss novel aspects of this finding, and elaborate on the plausibility of the required conditions.

5 Discussion

The lack of well-behaved preferences for some households in our setting makes the existence of an equilibrium anything but trivial. Therefore, our analysis contributes to the theoretical understanding of general electoral competition models between differentiated candidates by establishing that existence and efficiency of political equilibria do not require single-peaked preferences on behalf of all voters (as assumed by Dziubiński and Roy (2011), Krasa and Polborn (2012), Krasa and



(a) $\lambda = 0$ (b) $\lambda = 0.05$ (c) $\lambda = 0.1$

(d) $\lambda = 0.2$ (e) $\lambda = 0.25$ (f) $\lambda = 0.3$

Figure 4: Second derivative of households' utility under the following specification: $\gamma(h^i) = 2\sqrt{h^i} - h^i \ \forall h^i \in [0,1)$ and $\gamma(h^i) = 1 \ \forall h^i \geq 1$, $R = 2$, $p = 2/3$, $W = 1.1$, $\alpha = 1$, $\beta = 0.08$ and $\eta^i \sim \mathcal{U}(0,1)$.

Polborn (2014), Xefteris (2017)), but utilities being on 'average' concave in policy is a sufficient condition. That is, for enough candidate differentiation the representative democracy converges to the policy that yields the unique local and global maximum of total utility, as long as such a policy exists.

Lemma 1, which shows that preferences are concave on aggregate, holds in a setting where intrinsic skills are distributed uniformly with support $[0,1]$. Is this the only constellation that ensures concavity on aggregate, and therefore, the existence of an equilibrium for enough candidate differentiation? To address this question, we refer first to Figure 4 to elaborate on why the uniform distribution with support $[0,1]$ supports the aforementioned condition. As we know from the proof of Lemma 1, the area that is bounded by $\partial^2 U^i/\partial\lambda^2$ and lies above the x-axis is at most equal to the area that is bounded by $\partial^2 U^i/\partial\lambda^2$ and lies below the x-axis. At the same time, since the distribution is uniform, as λ increases the mass of households entering the interval that results in a positive $\partial^2 U^i/\partial\lambda^2$ is at most equal to the mass of households entering the interval that results in a negative $\partial^2 U^i/\partial\lambda^2$. As a result,

$\frac{\partial^2 u}{\partial \lambda^2}$ is at most zero for every $\lambda \in [0, 1]$.

Let us now consider any continuous distribution with probability density function f and support $[\underline{\eta}, \overline{\eta}]$ with $\underline{\eta} < \overline{\eta}$. Because we know from the proof of Proposition 2 that $\frac{\partial^2 U^i}{\partial \lambda^2} > 0$ for every $h^i \in [\dot{h}, \hat{h}]$ where $\hat{h}$ is a threshold that satisfies $\dot{h} < \bar{h} < \hat{h} < \check{h} < 1$, we readily obtain

Lemma 2. *If $\underline{\eta} \geq \hat{h}$ or $\overline{\eta} < \dot{h} - \alpha W$, then Lemma 1 holds for every density function f.*

This implies that Theorem 1 holds for a wide range of distributions, as long as the skills of the more skilled household do not exceed a threshold, or the skills of the less skilled household exceed a (higher) threshold.[15]

Once concavity on aggregate holds, Theorem 1 states that an equilibrium, which is also efficient, exists under the condition that candidates are differentiated enough ($d \geq \bar{d}$). This condition is arguably plausible in many settings; as in several elections with two main candidates, the contestants differ substantially in fixed characteristics, like long-standing policy stances, e.g. redistribution or government size, or non-policy attributes, e.g. race or religion. Importantly, for the equilibrium to exist, one can consider any given level of candidates' differentiation, and require that the issue of financial literacy is 'secondary' enough during the electoral campaign ($w \leq \bar{w}$).

This delineates how our work complements existing papers (Epple and Romano (1996a), Epple and Romano (1996b), Glomm and Ravikumar (1998), Epple and Romano (2014), Epple et al. (2018)) that solve the problem of an equilibrium existence with ends-against-the-middle preferences considering that the policy at hand is unique, or the most prominent. Deviating from these papers, our analysis acknowledges that financial literacy policies can hardly be the focal point of an

[15] Accordingly, if we still consider a support $[0, 1]$, i.e., $\underline{\eta} = 0$ and $\overline{\eta} = 1$, Lemma 1 and Theorem 1 survive by imposing some structure on the density function f. Namely, by requiring that the distribution is right- or left-skewed enough so that there is no $\lambda \in [0, 1]$ that will bring a substantial mass of households in the interval $h^i \in [\dot{h}, \hat{h}]$.

election. As a result, these policies are formed in a political environment where candidates have ideological positions on other issues and take a stance on λ to maximize their vote share. But nonetheless, what if candidates are identical, or preferences over candidates' fixed characteristics are perfectly correlated, or the issue of financial literacy becomes much more significant than the candidates' fixed characteristics?

In all these cases, which technically are equivalent, the property of single-peaked preferences is required for an equilibrium to exist in line with the median-voter theorem (Downs (1957)). As we know from our analysis, this is not the case as long as intrinsic skills are distributed with support $[0,1]$. However, we readily obtain from Proposition 2 that in a setting where households' skills do not cross $\bar{h}$, the property of single-peaked preferences is preserved. Formally, we obtain

Lemma 3. *If $\underline{\eta} \geq \bar{h}$ or $\overline{\eta} < \bar{h} - \alpha W$, then every household $i \in I$ has single-peaked preferences over $\lambda \in [0,1]$ for every density function f.*

In these cases, the standard median-voter theorem can apply.

Observing that there are overlaps among the intervals specified by Lemmata 2 and 3, we obtain our second main result as follows:

Theorem 2. *If $\underline{\eta} \geq \hat{h}$, or $\overline{\eta} \leq \bar{h} - \alpha W$, then there exist two classes of equilibria:*

(i) $\lambda^L = \lambda^R = \lambda^{0.5}$ *if* $d = 0$ $(w \to +\infty)$ *with* $\lambda^{0.5} \equiv \arg\max_{\lambda \in [0,1]} U^{0.5}$;

(ii) $\lambda^L = \lambda^R = \lambda^*$ *for every* $d \geq \bar{d}$ $(w \leq \bar{w})$ *where* $\bar{d}$ *and* $\bar{w}$ *are positive thresholds.*

The proof of Theorem 2 is given in the Appendix. This result states that whether financial literacy is of primary importance during the campaign (i.e., $d = 0$), or not (i.e., $d > 0$), is crucial since the median-voter's optimal policy $\lambda^{0.5}$ may or may not coincide with the efficient policy λ^*. The case with sufficient candidate differentiation yields the efficient policy, thus making mechanism design questions irrelevant; the case with $d = 0$ may call for considerations of policy formation via channels other than a representative democracy since its equilibrium need not be efficient.

Special cases of Theorem 2 in which the two equilibria classes coincide occur when all households belong to either of the two ends.

Corollary 2. *If* $\bar{\eta} \leq \bar{h} - \alpha W$ *or* $\underline{\eta} \geq \check{h}$*, then* $\lambda^L = \lambda^R = \lambda^* = \lambda^{0.5} = 0$ *for every* $w, d \geq 0$ *and every density function* f*.*

This leads to a strong policy prediction according to which a financial literacy national strategy is deprived of any funding in a democracy where households' intrinsic skills fall in the lower or the upper end for every funding level. To the extent intrinsic skills are a proxy of households' capability to cope with financial complexity by themselves, this result indicates that promoting financial literacy is contingent on regulating financial complexity: As long as financial products are so complicated that households' own skills are far from allowing them to benefit from the financial market, policies that promote financial literacy will remain unwanted in a well-functioning democracy.

6 Conclusions

Our work reveals the position of the financial literacy issue in the political debate as a crucial determinant of a representative democracy's performance in funding a financial literacy strategy: If financial literacy is 'secondary' enough during the electoral campaign, then a representative democracy can deliver an equilibrium policy that is the same as the one an efficiency-driven authority would choose. Otherwise, i.e., if the financial literacy has a central position in the political debate, a median-voter driven result holds, which may or may not be efficient. Allowing for the financial literacy to be of 'secondary' political importance does not mean that we overlook its economic importance. In fact, our model preserves the financial literacy's decisive role for each household's financial performance, as empirical evidence suggests, and at the same time, acknowledges that other—likely more prominent—issues preoccupy voters and politicians. To the extent this is a plausible setting, our work may trigger further research, both empirical and theoretical, on the political economy of financial literacy. It can also be employed for the study of other economic policies that, though consequential for voters' welfare, attract less political attention.

Appendix

Proof of Proposition 1

From the First-Order Condition (FOC) of (7), we obtain

$$\frac{p}{1-p} \cdot (\gamma R - 1) = \frac{\overline{c}^i}{\underline{c}^i} \tag{12}$$

where $\overline{c}^i$ and $\underline{c}^i$ are given by (4) and (5), respectively. Solving (12) with respect to κ_r^i, we find that its root reads

$$\frac{\gamma(h^i(\lambda))pR - 1}{\gamma(h^i(\lambda))R - 1}. \tag{13}$$

Because γ is strictly concave in the interval $[0, 1)$, with $\gamma(0) = 0$ and $\gamma(1) = 1$, and because we only consider constellations with $pR > 1$ as explained in Subsection 3.1, we obtain that there exists threshold $\dot{h}$ with $0 < \dot{h} < 1$ that satisfies $\gamma(\dot{h}) = (pR)^{-1}$. We also observe that (13) becomes negative for every $\gamma(\dot{h}) < (pR)^{-1}$ and is not defined at $\gamma = 1/R$. Therefore, and taking the feasibility constraint (8) into consideration, we obtain (9). □

Proof of Proposition 2

We obtain from (10) that

$$\frac{\partial U^i}{\partial \lambda} = W \cdot \left(-\beta + \alpha \frac{\kappa_r^i}{\overline{c}^i} pR\gamma' \right) + \frac{\partial \kappa_r^i}{\partial \lambda} \cdot \left(\frac{p(\gamma R - 1)}{\overline{c}^i} - \frac{1-p}{\underline{c}^i} \right) \tag{14}$$

where $\gamma' \equiv \dfrac{\partial \gamma}{\partial h^i}$. Let $\eta^i = 0$ and $W > 1$. This allows us to capture all possible constellations. Generalization for $\eta^i \in [0, 1]$ and $W \leq 1$ will be straightforward because η^i is an added term in the argument of γ thus not impacting $\frac{\partial \gamma}{\partial \lambda}$ whereas W impacts all households in the same manner. Because $\gamma' > 0$ for every $h^i \in [0, 1)$, we know that there exist $\underline{\underline{\lambda}}$ and $\overline{\overline{\lambda}}$ with $0 < \underline{\underline{\lambda}} < \overline{\overline{\lambda}} < 1$ such that $0 + \underline{\underline{\lambda}}W = \dot{h}$, i.e., $\gamma(0 + \underline{\underline{\lambda}}W) = (pR)^{-1}$ and $0 + \overline{\overline{\lambda}}W = 1$, i.e., $\gamma(0 + \overline{\overline{\lambda}}W) = 1$. Since $\kappa_r^i = 0$, and therefore $\frac{\partial \kappa_r^i}{\partial \lambda} = 0$, for any $\gamma \leq (pR)^{-1}$, we know that $\dfrac{\partial U^i}{\partial \lambda} = -\beta W < 0$ for all $\lambda \leq \underline{\underline{\lambda}}$. Since $\gamma' = 0$, and therefore $\frac{\partial \kappa_r^i}{\partial \lambda} = 0$, for any $\lambda \geq \overline{\overline{\lambda}}$, we know that $\dfrac{\partial U^i}{\partial \lambda} = -\beta W < 0$ for all $\lambda \geq \overline{\overline{\lambda}}$. Otherwise, i.e., for all $\lambda \in (\underline{\underline{\lambda}}, \overline{\overline{\lambda}})$, (12) holds. Solving (12) with respect to $\underline{c}^i$ and substituting in (14), we obtain that its second term becomes zero. Substituting for $\overline{c}^i$ and κ_r^i from (4) and (9), respectively, into (14), we obtain

$$\frac{\partial U^i}{\partial \lambda} = \alpha W \cdot \left(-\frac{\beta}{\alpha} + \frac{\gamma pR - 1}{\gamma R - 1} \cdot \frac{\gamma'}{\gamma} \right) \qquad \forall \lambda \in (\underline{\underline{\lambda}}, \overline{\overline{\lambda}}). \tag{15}$$

For ease of exposition we define

$$A \equiv \frac{\gamma pR - 1}{\gamma R - 1} \cdot \frac{\gamma'}{\gamma}. \tag{16}$$

If $A > \beta/\alpha$, then $\dfrac{\partial U^i}{\partial \lambda} > 0$; if $A < \beta/\alpha$, then $\dfrac{\partial U^i}{\partial \lambda} < 0$; if $A = \beta/\alpha$, then $\dfrac{\partial U^i}{\partial \lambda} = 0$. We also note that $A > 0$ for all $\lambda \in (\underline{\underline{\lambda}}, \overline{\overline{\lambda}})$, and that as λ approaches $\underline{\underline{\lambda}}$ from right, γ approaches $(pR)^{-1}$ from right and therefore A approaches zero. Moreover, as λ approaches $\overline{\overline{\lambda}}$ from left, γ' approaches zero and therefore A approaches zero as well.

We also obtain

$$\frac{\partial^2 U^i}{\partial \lambda^2} = \frac{\alpha^2 W^2}{\gamma(\gamma R - 1)} \cdot \left((\gamma p R - 1) \cdot \left(\gamma'' - \frac{\gamma'\gamma'}{\gamma} \right) + \gamma'\gamma' \cdot \frac{(1-p)R}{\gamma R - 1} \right). \tag{17}$$

We note that as λ approaches $\underline{\underline{\lambda}}$ from right, γ approaches $(pR)^{-1}$ from right and therefore $\partial^2 U^i/\partial\lambda^2 > 0$ because $\gamma' > 0$. As λ approaches $\overline{\overline{\lambda}}$ from left, γ' approaches zero and therefore $\partial^2 U^i/\partial\lambda^2 < 0$ because $\gamma'' < 0$. By continuity in the interval $(\underline{\underline{\lambda}}, \overline{\overline{\lambda}})$, the above means that there is at least one $\lambda \in (\underline{\underline{\lambda}}, \overline{\overline{\lambda}})$ that sustains $\partial^2 U^i/\partial\lambda^2 = 0$. This also means that

$$\gamma'' = \gamma'\gamma' \cdot \left(\frac{1}{\gamma} - \frac{(1-p)R}{(\gamma R - 1)\cdot(\gamma p R - 1)} \right) \tag{18}$$

has at least one solution in the interval $(\underline{\underline{\lambda}}, \overline{\overline{\lambda}})$. Because $\gamma' > 0$ and $\gamma'' < 0$, we know that

$$\frac{1}{\gamma} < \frac{(1-p)R}{(\gamma R - 1)\cdot(\gamma p R - 1)} \tag{19}$$

in order for $\partial^2 U^i/\partial\lambda^2 = 0$. Let lhs and rhs denote the left-hand side and right-hand side of (18), respectively. We obtain

$$\frac{\partial lhs}{\partial \lambda} = \alpha W \cdot \gamma'''; \tag{20}$$

$$\begin{aligned} \frac{\partial rhs}{\partial \lambda} &= \alpha W 2\gamma'\gamma'' \left(\frac{1}{\gamma} - \frac{(1-p)R}{(\gamma R - 1)(\gamma p R - 1)} \right) \\ &\quad - \alpha W \gamma'\gamma'\gamma' \left(\frac{1}{\gamma}\frac{1}{\gamma} - \frac{(1-p)R}{(\gamma R - 1)\cdot(\gamma p R - 1)} \cdot \frac{2\gamma p R^2 - R(1+p)}{(\gamma R - 1)\cdot(\gamma p R - 1)} \right). \end{aligned} \tag{21}$$

Because $\gamma' > 0$ and $\gamma'' < 0$ and taking (19) into consideration, we know that the first term of (21) is positive for any λ that sustains $\partial^2 U^i/\partial\lambda^2 = 0$. Moreover, because $\frac{1}{\gamma} < \frac{\gamma 2pR^2 - R(1+p)}{(\gamma R - 1)\cdot(\gamma p R - 1)}$ for all $\lambda \in (\underline{\underline{\lambda}}, \overline{\overline{\lambda}})$, and taking (19) into consideration, we know that the second term of (21) is also positive for any λ that sustains $\partial^2 U^i/\partial\lambda^2 = 0$. Finally, because $\gamma''' < 0$, we know that lhs of (18) is decreasing in λ. Since rhs is increasing for any λ that solves $\partial^2 U^i/\partial\lambda^2 = 0$, while lhs is decreasing for all $\lambda \in (\underline{\underline{\lambda}}, \overline{\overline{\lambda}})$, we know that there is a unique $\lambda \in (\underline{\underline{\lambda}}, \overline{\overline{\lambda}})$ that solves $\partial^2 U^i/\partial\lambda^2 = 0$ and therefore there exists a threshold $\hat{h}$ such that $\partial^2 U^i/\partial\lambda^2 = 0$ if $h^i(\lambda) = \hat{h}$. It then follows directly that there exists a strictly positive threshold $\bar{A}$ that solves $\partial^2 U^i/\partial\lambda^2 = 0$ with $\beta/\alpha = \bar{A}$ and $h^i = \hat{h}$. Therefore, for any $\beta/\alpha < \bar{A}$, there exist only two solutions, i.e., $h^i(\lambda) = \bar{h}$ and $h^i(\lambda) = \check{h}$, with $\dot{h} < \bar{h} < \hat{h} < \check{h} < 1$, that solve $\partial U^i/\partial\lambda = 0$ so that $\partial U^i/\partial\lambda < 0$ for any $h^i \in [0, \bar{h}) \cup (\check{h}, +\infty)$, $\partial U^i/\partial\lambda = 0$ for any $h^i(\lambda) = \bar{h}$ or $h^i(\lambda) = \check{h}$, and $\partial U^i/\partial\lambda > 0$ for any $h^i(\lambda) \in (\bar{h}, \check{h})$. This means that whether or not household i favors a marginal increase of λ depends on the position of $h^i = \eta^i + \alpha\lambda W$ with respect to the thresholds $\bar{h}$, $\hat{h}$ and $\check{h}$. □

Proof of Lemma 1

We know from Proposition 2 that households with $h^i(\lambda) < \dot{h}$ or $h^i(\lambda) > 1$ feature $\partial^2 U^i/\partial\lambda^2 = 0$. Therefore, and because $\partial^2 U^i/\partial\lambda^2 = \partial^2 U^i/\partial {h^i}^2 \alpha W$,

$$\int_I \frac{\partial^2 U^i}{\partial\lambda^2} di = \alpha W \cdot \int_I \frac{\partial^2 U^i}{\partial {h^i}^2} di \tag{22}$$

for every $\lambda \in [0, 1]$. Because of the fundamental theorem of calculus, (22) reads

$$\alpha W \cdot \int_I \frac{\partial^2 U^i}{\partial {h^i}^2} di = \alpha W \cdot \left(\frac{\partial U^i(1)}{\partial h^i} - \frac{\partial U^i(\dot{h})}{\partial h^i} \right), \tag{23}$$

where $\partial U^i/\partial h^i = 1/(\alpha W) \cdot \partial U^i/\partial\lambda$ and $\partial U^i/\partial\lambda$ is given by (15). We know that $\partial U^i(1)/\partial h^i = -\beta/\alpha$ because $\gamma'(1) = 0$, and $\partial U^i(\dot{h})/\partial h^i = -\beta/\alpha$ because $\gamma(\dot{h}) = (pR)^{-1}$. This, and because we know from Proposition 2 that a household with $h^i(\lambda) \in [\dot{h}, \hat{h})$ features $\partial^2 U^i/\partial\lambda^2 > 0$ and a household with $h^i(\lambda) \in (\hat{h}, 1]$ features $\partial^2 U^i/\partial\lambda^2 < 0$, suffices to show that $\int_I \frac{\partial^2 U^i}{\partial\lambda^2} di = 0$ for every $\lambda \in [0, 1]$ if $\alpha W \leq \dot{h}$, whereas $\int_I \frac{\partial^2 U^i}{\partial\lambda^2} di = 0$ for every $\lambda \in [0, \dot{h}/(\alpha W)]$ and $\int_I \frac{\partial^2 U^i}{\partial\lambda^2} di < 0$ for every $\lambda \in (\dot{h}/(\alpha W), 1]$ if $\alpha W > \dot{h}$. □

Proof of Theorem 1

For each pair of platforms, (x^L, λ^L) and (x^R, λ^R), a household i prefers candidate L to candidate R if and only if

$$v(x^L, \lambda^L|x^i, \eta^i) > v(x^R, \lambda^R|x^i, \eta^i) \Longleftrightarrow x^i < \frac{w[U^i(\eta^i|\lambda^L) - U^i(\eta^i|\lambda^R)]}{2d}. \tag{24}$$

If we denote by G the CDF of the uniform distribution on $[-q, q]$, for any pair of funding levels $(\lambda^L, \lambda^R) \in [0,1]^2$ the expected vote-share of candidate L, $z(\lambda^L, \lambda^R)$, is equal to

$$z(\lambda^L, \lambda^R) = \int_I G(\frac{w[U^i(\eta^i|\lambda^L) - U^i(\eta^i|\lambda^R)]}{2d})di, \tag{25}$$

while the expected vote-share of candidate R is given by $1 - z(\lambda^L, \lambda^R)$. Since $U^i(\eta^i|\lambda)$ is bounded with respect to $\lambda \in [0,1]$ for every η^i, it follows that when d is sufficiently large, then $\frac{w[U^i(\eta^i|\lambda^L) - U^i(\eta^i|\lambda^R)]}{2d} \in (-q, q)$ for every $(\lambda^L, \lambda^R) \in [0,1]^2$ and every $\eta^i \in [0,1]$. For such values of d we have

$$\frac{\partial^2 z(\lambda^L, \lambda^R)}{\partial(\lambda^L)^2} = \frac{w^2}{8qd}\int_I \frac{\partial^2 U^i(\eta^i|\lambda^L)}{\partial(\lambda^L)^2}di < 0 \text{ for every } (\lambda^L, \lambda^R) \in [0,1]^2, \tag{26}$$

where we used Lemma 1.

By Debreu (1952) it follows that the game admits an equilibrium in pure strategies. By the fact that the game is zero-sum it follows further that if there exists $(\tilde{\lambda}^L, \tilde{\lambda}^R) \in [0,1]^2$ such that

$$\frac{\partial z(\lambda^L, \lambda^R)}{\partial \lambda^L}|_{(\lambda^L,\lambda^R)=(\tilde{\lambda}^L,\tilde{\lambda}^R)} = \frac{\partial z(\lambda^L, \lambda^R)}{\partial \lambda^R}|_{(\lambda^L,\lambda^R)=(\tilde{\lambda}^L,\tilde{\lambda}^R)} = 0 \tag{27}$$

it has to be the case that $(\tilde{\lambda}^L, \tilde{\lambda}^R) \in [0,1]^2$ is the unique pair of minimaximizers for the two players; i.e. the unique Nash equilibrium of the game. For the same values of d for which the above calculation of $\frac{\partial^2 z(\lambda^L,\lambda^R)}{\partial(\lambda^L)^2}$ holds, we get that

$$\frac{\partial z(\lambda^L,\lambda^R)}{\partial \lambda^L}|_{(\lambda^L,\lambda^R)=(\lambda,\lambda)} = \frac{\partial z(\lambda^L,\lambda^R)}{\partial \lambda^R}|_{(\lambda^L,\lambda^R)=(\lambda,\lambda)} = 0 \tag{28}$$

if and only if

$$\frac{w}{qd}\int_I \frac{\partial U^i(\eta^i|\lambda)}{\partial \lambda} di = 0, \tag{29}$$

that is, if and only if $\lambda = \lambda^*$, which concludes the argument. □

Proof of Theorem 2

If $\underline{\eta} \geq \hat{h}$ or $\overline{\eta} \leq \bar{h} - \alpha W$, we know from Lemma 3, since $\bar{h} < \hat{h}$, that all households have single-peaked preferences, and therefore the standard median-voter theorem (Downs (1957)) applies, which corresponds to setting $d = 0$ in our model. We also know from Lemma 2 that if $\underline{\eta} \geq \hat{h}$, preferences are concave on average which allows us to establish the existence, uniqueness and efficiency of equilibrium following the steps as in Theorem 1. If $\overline{\eta} \leq \bar{h} - \alpha W$, all households have a decreasing utility with respect to λ which trivially implies that $\lambda^L = \lambda^R = \lambda^* = \lambda^{0.5} = 0$ for every $d \geq 0$—which belongs to the special cases depicted in Corollary 2. □

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