Libertarian Paternalism, Information Sharing, and Financial Decision-Making[*]

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Abstract

We develop a theoretical model to study the welfare effects of libertarian paternalism on information acquisition, social learning, and financial decision-making. Individuals in our model are permitted to appreciate and use the information content in the default options set by a social planner. We show that in some circumstances the presence of default options can decrease welfare by slowing information propagation in the economy. An extension of the model shows that partial information disclosures by the social planner can increase individuals' incentives for gathering and sharing information, but that this does not affect the set of circumstances in which the absence of default options is optimal. Our analysis also considers a setting in which individuals can sell their information to others. We show that default options cause the quality (and price) of advice to decrease, which may lower social welfare. Finally, we study the effects of procrastination and excessive trust in the social planner on our analysis.

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1 Introduction

Financial sophistication has lagged behind the growing complexity of retail markets (e.g., NASD Literacy Survey, 2003).[1] This not only degrades personal welfare, but also affects the real economy.[2] What to do about this disparity between complexity and sophistication has received much attention, but the optimal solution remains hotly debated. Whereas some are proponents of increasing awareness through education (e.g., Lusardi and Mitchell, 2007), others favor improving peoples' choices by offering well thought-out default options. Indeed, libertarian paternalism, as posed by Thaler and Sunstein (2003, 2008), makes sense in many venues and has been shown to improve some of the financial decisions that people make (Thaler and Benartzi, 2004).

Libertarian paternalism is provocative because it links two ideas that are on the surface contradictory, but may indeed be an uncompromising compromise. In theory, it allows a social planner to direct individuals through default options without imposing her will, so that everyone may enjoy the best of both worlds: guidance without the tax of obtrusion. This policy needs to be implemented judiciously, however, rather than as a blanket policy. Glaeser (2006) suggests that in some contexts libertarian paternalism may be hard to publicly monitor and may lead to hard paternalism.[3] Mitchell (2005) questions the redistributive consequences of libertarian paternalism. Korobkin (2009) argues that, because libertarian paternalism ignores the externalities that individuals create for each other, its policies may not maximize collective welfare even though they induce individuals to make optimal decisions for themselves. These observations raise an obvious question: Given its propensity for inducing or exacerbating externalities, when do we expect libertarian paternalism to be welfare improving?

To explore this, we analyze an important dimension of this problem: the effect of libertarian paternalism on the acquisition of financial information and social learning. Madrian and Shea (2001) show that 401(k) default options provide information to market participants, which changes both their perceptions and resultant investment decisions.[4] Individuals frequently interpret default op-

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[1]See Carlin (2009) and Carlin and Manso (2010) for further discussion.

[2]For example, Ausubel (1991), Mitchell et al. (1999), Baye and Morgan (2001), Brown and Goolsbee (2002), Christoffersen and Musto (2002), Hortaçsu and Syverson (2004), Green (2007), and Green et al. (2007) show that financial sophistication (or the lack of it) has important pricing effects in various contexts. Campbell (2006) and Calvet et al. (2006) discuss the significant welfare repercussions that this can have. Finally, other effects of financial sophistication are analyzed by Capon et al. (1996), Alexander et al. (1998), Sirri and Tufano (1998), Wilcox (2003), Barber et al. (2005), Agnew and Szykman (2005), and Choi et al. (2009).

[3]See also Rostbøll (2005), and Whitman and Rizzo (2007) for similar arguments.

[4]Madrian and Shea (2001) reach this conclusion from the empirical observation that existing employees systematically change their participation and investment decisions after a change in the defaults provided to new employees. Mitchell et al. (2009) reach a similar conclusion in their study of the mutual funds used by retirement plan participants.

tions as the recommended course of action (Brown and Krishna, 2004; McKenzie et al., 2006), which may decrease their willingness to acquire further information. At the same time, social learning is an important mechanism by which individuals acquire knowledge, especially in settings in which default options are considered (Duflo and Saez, 2002, 2003; Sorensen, 2006; and Beshears et al., 2009). When the use of default options reduces information acquisition by individuals, this may negatively impact social learning. If in turn knowledge deteriorates sufficiently when people are guided by a social planner, whether they are forced to make choices or not, total welfare may decrease. This implies that in some circumstances it may be optimal to either implement a limited form of libertarian paternalism or to leave market participants alone, even if some people's choices end up regrettably suboptimal.

We develop a theoretical model to analyze the effect of libertarian paternalism on information acquisition, social learning, and financial decision-making. We characterize settings in which providing default options may decrease welfare because information acquisition and aggregation slows. We do this both when information percolates according to a social learning technology (e.g., Ellison and Fudenberg, 1993 and 1995; Manski, 2004; Duffie and Manso, 2007) and in a setting in which uninformed individuals can purchase information from informed ones (i.e., an advice market).

In the base model that we analyze, each individual must make a financial decision whose payoff depends on his unknown type. The social planner knows a characteristic that is common across all the individuals in the market. She must decide between two policies: (i) institute a default option that implicitly discloses her information; (ii) hold on to the information and let individuals make their own choices without guidance from a default. Individuals can exert costly effort to find out their own type, which includes the planner's information, so that they make an even better decision. Higher aggregate effort also increases the probability that any one individual becomes informed. This form of social learning provides an externality where one individual's effort affects other people's welfare and vice versa.

We derive conditions under which default options are optimal and describe when they destroy social surplus. The tradeoff revolves around the fact that the information contained in the default option provided by the social planner reduces each individual's incentive to gather and share any additional information. Thus, although the information in the default is useful to any one individual, it reduces the positive externalities associated with social learning. When the information-sharing technology is sufficiently effective, the cost of information acquisition is low, and/or the individual-specific information is more valuable, providing a default option is suboptimal. Under

2

these conditions, a social planner maximizes welfare by letting market participants fend for themselves and allowing social learning to take place. Alternatively, if the information known by the planner is relatively more valuable and these other conditions do not hold, then default options add value.

This sheds light on when libertarian paternalism is likely to add value. For example, default options are likely to be welfare-improving when individuals are sufficiently homogeneous. Consider the default option of a low-fee life cycle fund that automatically reallocates wealth to fixed income assets as investors age. It is unlikely that there is much variation in preferences for such age-dependent reallocations. Yet, people's ability to access this information for themselves is limited. Therefore, in this case, providing a default option is likely to add value. However, default options are unlikely to increase social welfare when people's needs are more heterogeneous or when the information acquired by individuals is relatively valuable compared to the information contained in the default option. An example of this might be a decision as to whether or not to purchase a life annuity. People's needs for these retirement vehicles are quite variable (e.g., simple life versus joint survivorship) and given the degree of adverse selection associated with such choices, these decisions are difficult to reverse ex post. Getting the choice right on the first attempt is valuable: if providing defaults for this decision decreases some people's incentives to become savvy, this may lead to a drop in welfare.

We proceed to consider the possibility that the social planner acquires imperfect information about its constituents. In this case, systematic errors decrease the accuracy for people who use the default options, but increase the effort that individuals employ to acquire and aggregate information. We show that the latter effect dominates the former in that issuing no default is more likely to be of value when the planner's information is imperfect. Our analysis thus confirms an objection raised by Glaeser (2006) that social planners are not immune from making errors or having biases.

Given this, we then ask whether the social planner would ever want to issue an imperfect default even though she has perfect information. We show this not to be the case. That is, despite being given a broader action space including noisy defaults, the planner's optimal choice is binary: either issue a fully informative default option or leave individuals to fend for themselves. The same comparative statics still hold as before, supporting the generality of our findings.

We then characterize an economy in which information sales (i.e., advice) are allowed to take place. A fraction of the individuals are recognized as information gatherers, whereas the remainder rely on advice markets for guidance. The social planner faces the same problem as before, and

information gatherers decide how much costly effort to employ in accumulating knowledge. The difference here is that the social learning technology takes the form of information exchanges between information gatherers and the rest of the public.[5] In this version of the model, the presence of a default option decreases the value of advice. That is, since fewer information gatherers will become knowledgeable, the quality of advice in the market suffers. As in the base model, not offering a default option sometimes dominates issuing a default option, especially if the cost of effort is low and the value of individual-specific (social planner) information is high (low).

Finally, we explore the effect of two behavioral considerations on our analysis. First, we consider procrastination by embedding our model in a framework that is similar to that of Carroll et al. (2009). We determine when it is optimal for the social planner to offer an accurate default (i.e., a centered default), an offset default that increases information-gathering incentives, or force its constituents to make active decisions. Besides showing that the information content of the default options remains a robust consideration when adding a procrastination component to the model, we obtain several additional results. Specifically, we show that the optimal magnitude of an offset default option is decreasing in the degree to which information is shared. That is, when social learning is more potent, the social planner does not need to induce people to acquire information as much. As a result, even people who do not opt out of the default option are better off: even though they do not participate in the learning or information-sharing process, the offset required in the default is lower, which gives them a better outcome when they remain in the default. In other words, social learning affects the redistributive properties of libertarian paternalism.[6]

Second, we reconsider our analysis when individuals put too much trust in the social planner. Specifically, as suggested by the empirical work of Madrian and Shea (2001), we investigate a situation in which individuals overweight the importance of the social planner's information. Our analysis shows that over-dependency on the social planner makes individuals follow the path of least resistance and herd into the defaults, as documented by Choi et al. (2002) and Johnson and Goldstein (2003).[7] This further leads to suboptimal information acquisition and social learning, causing the benefits of default options to erode. As a result, default options are less likely to increase welfare than in our base model.

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[5]Because individuals learn to make better decisions by interacting with their skilled peers, our approach is similar in spirit to work by Glaeser (1999) and Glaeser and Maré (2001) in which agents become more productive when working with others who are skilled.

[6]For a discussion of the redistributive effects of libertarian paternalism, see Mitchell (2005) and Zanitelli (2009).

[7]Similarly, Korobkin (1998) argues that contract defaults rules often lead to herding and suboptimal contractual terms as a result of a status quo bias.

Social interactions have been shown to affect a variety of decisions that have a significant impact on the financial well-being of individuals and households: their decisions to participate in markets (Hong et al., 2004; Brown et al., 2008; Kaustia and Knüpfer, 2009), to enroll in retirement plans (Madrian and Shea, 2001; Beshears et al., 2009), to buy stocks (Shiller and Pound, 1989), to select health plans (Sorensen, 2006), to purchase cars (Grinblatt et al., 2008), and to use welfare programs (Bertrand et al., 2000).[8] Based on our analysis, given that individuals learn from their peers when they make important financial decisions, a systematic implementation of default options to all of these (and other) domains may not be optimal. In particular, as implied by Arrow's (1994) arguments about social knowledge, it is important to weigh the social multiplier effects of learning (e.g., Glaeser et al., 2003) when considering the design of default options or more generally the adoption of policies based on libertarian paternalism.[9]

The remainder of the paper is organized as follows. Section 2 outlines our basic model and determines when it is optimal to use default options. Specifically, Section 2.1 analyzes the case when the social planner can only issue fully informative default options, whereas Section 2.2 allows for imperfect default options. In Section 3, we turn to information sales to endogenize the mechanism underlying information propagation. Section 4 explores the effects of behavioral biases on our analysis. Finally, Section 5 provides some concluding remarks. All proofs are in the appendix.

2   Social Learning

2.1   Basic Model

The market is composed of a social planner and a continuum (a non-atomic finite measure space $(I, \mathcal{I}, \gamma)$) of heterogeneous, rational individuals who all face a significant financial decision. Examples of such a decision might be an investment-consumption choice, a capital allocation decision, or a choice of insurance. For simplicity, but without loss of generality, we set the total measure $\gamma(I)$ of individuals to 1 (i.e., a unit mass).

The ex post utility from the decision for each individual $i \in I$ is given by

$$\tilde{U}_i(x_i) = -(\tilde{\tau}_i - x_i)^2, \tag{1}$$

where $x_i \in \mathbb{R}$ is a choice variable and $\tilde{\tau}_i$ is the individual's true (but unknown) type. The type $\tilde{\tau}_i$ is the sum of a component $\tilde{g}$ that is common to all individuals and an idiosyncratic component $\tilde{t}_i$ that

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[8]For a survey of the literature on social interactions, see Manski (2000).

[9]Similarly, Ahdieh (2009) stresses the importance for any public intervention aimed at individuals to internalize the social dynamics that it may affect. Also, Camerer et al. (2003) propose a form of asymmetric paternalism aimed at minimizing the externality distortions of regulation.

is specific to individual i. We assume that $\tilde{g}$ and $\tilde{t}_i$ are two independent normally distributed random variables, each with zero mean and respective variances Σ_g and Σ_t, and that $\text{Cov}(\tilde{t}_i, \tilde{t}_j) = \rho \Sigma_t$, with $\rho \in [0, 1)$, for any $\{i, j\} \in I^2$ with $i \neq j$.[10] Thus, for each individual i, $\tilde{\tau}_i$ is normally distributed with a mean of zero and a variance of $\Sigma_\tau \equiv \Sigma_g + \Sigma_t$. As (1) is a quadratic loss function, the goal of each individual is to choose x_i to be as close to $\tilde{\tau}_i$ as possible in order to minimize his expected loss.

Before choosing x_i, each individual i can exert some effort in order to improve the probability that he finds out about his own type. An individual's effort of $e_i \in [0, 1]$ comes with a personal utility cost of

$$C(e_i) = \frac{c}{2} e_i^2, \tag{2}$$

where c is a positive constant. An individual who selects an effort level e_i observes his true type $\tilde{\tau}_i$ (i.e., receives an informative signal) with probability

$$e_i + \alpha \bar{e}, \tag{3}$$

where $\bar{e} \equiv \int_I e_i d\gamma$ and $\alpha \in [0, 1)$, and observes nothing otherwise. Individuals know when they did not receive an informative signal. Given that $\bar{e}$ represents the average effort exerted by individuals in the population, the signal specification in (3) implies that an individual is more likely to learn his own type when many individuals seek to learn theirs. This positive externality of effort captures the idea that as more people exert effort and more of the population becomes informed, their interactions lead to more spillovers in the learning process; this ultimately makes it easier for anyone to learn about the financial decision that they have to make. While not specifically modeled, the micro-foundation for this setup might be a model of search in which individuals are more likely to learn from each other as more of the population is informed. Section 3 provides an alternative micro-foundation in which the information externality comes from the exchange of information between skilled and unskilled individuals. In this base model, the parameter α measures the degree of this information externality.

The social planner costlessly observes the common component $\tilde{g}$ of the individuals' types. For example, this could correspond to the planner having an informed opinion about the optimal average savings rate for a group of individuals. The planner then chooses whether to set a default option that takes $\tilde{g}$ into account or to leave individuals to their own devices.[11] The planner's goal

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[10]Note that the positive correlation across the idiosyncratic component t_i of individuals' types does not play a role until we allow for information sales, in Section 3.

[11]Note that, because individuals are rational and do not face any cost for choosing x_i, the social planner could

in this choice is to maximize total welfare. Since individuals are rational, they are able to glean information about $\tilde{g}$ from a default option if it is offered.[12] This in turn will affect their choice of effort in gathering further information.

Let $\mathcal{S}_i$ denote the information set of an individual i at the time he must make his decision x_i. This set is equal to $\{\tilde{\tau}_i\}$ if the individual observes his true type, whether or not the social planner sets a default option.[13] When there is a default option and the individual does not observe his type, $\mathcal{S}_i = \{\tilde{g}\}$. Finally, when there is no default option and the individual does not observe his type, $\mathcal{S}_i = \varnothing$. The following lemma defines the optimal choice of x_i, given the information set $\mathcal{S}_i$.

Lemma 1. *The optimal choice of x_i for individual i is* $\mathrm{E}\big[\tilde{\tau}_i \,|\, \mathcal{S}_i\big]$.

With a default option, each individual i who observes an informative signal opts out of the default and chooses $x_i = \tilde{\tau}_i$, whereas any individual who remains uninformed does not opt out, i.e., chooses $x_i = \tilde{g}$, as prescribed by the social planner. If no default option is offered by the planner, any individual i who becomes informed still chooses $x_i = \tilde{\tau}_i$, and chooses $x_i = 0$ if he does not get to observe an informative signal. Consistent with Madrian and Shea's (2001) empirical findings, there is information content in the default options that the social planner provides, as uninformed individuals optimally (and rationally) choose to use it.

Before choosing x_i but after the social planner's decision to announce a default option, each individual i chooses the effort level e_i that maximizes his expected utility. This choice takes into account the fact that he will subsequently choose x_i according to Lemma 1. It also depends on individual i's information set $\mathcal{S}_i^0$, which is then $\tilde{g}$ if the planner makes a default option available and is empty otherwise. The following lemma summarizes and simplifies this maximization problem.

Lemma 2. *Individual i chooses his effort level e_i to maximize*

$$\mathrm{E}\Big[\tilde{U}_i(x_i) - C(e_i) \,|\, \mathcal{S}_i^0\Big] = -(1 - e_i - \alpha\bar{e})\Big[(1-\delta)\Sigma_g + \Sigma_t\Big] - \frac{c}{2}e_i^2, \tag{4}$$

where $\delta = 1$ when a default option $\tilde{g}$ is offered by the social planner and $\delta = 0$ when people are left to their own devices.

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equivalently announce an uninformative default or force individuals into a decision. The distinction between these policies will become more important when we add procrastination to our model, in Section 4.1.

[12]As long as the planner's choice for the default option is one-to-one with $\tilde{g}$, every individual can infer $\tilde{g}$ perfectly. Thus, it is without loss of generality that we assume in what follows that the planner announces $\tilde{g}$ as the default option when she makes such an option available.

[13]Technically speaking, the information set is $\{\tilde{g}, \tilde{\tau}_i\}$ when the social planner announces a default option and individual i observes his own type, but the additional information provided by $\tilde{g}$ (i.e., knowing $\tilde{g}$ and $\tilde{\tau}_i$ separately) is not useful for any of the decisions that this individual must make.

This result highlights the tradeoff faced by each individual. Effort is costly (second term in (4)) but it reduces the variance that the individual is subject to (first term in (4)). At the same time, the concerted effort of every individual creates a public good, $\bar{e}$, that reduces the variance for everyone. Going forward, we make the following assumption, which guarantees an interior solution to the effort problem but does not affect the economics of the analysis.

Assumption 1. *The cost parameter c is such that $c > 2(\Sigma_g + \Sigma_t)$.*

The following proposition characterizes the effort choice of individuals, with and without a default option.

Proposition 1. *If the social planner adopts a default option, each individual chooses effort*

$$e_i = \frac{\Sigma_t}{c} \equiv e^{\mathrm{D}}, \tag{5}$$

whereas if the social planner does not adopt a default option, each individual chooses effort

$$e_i = \frac{\Sigma_g + \Sigma_t}{c} \equiv e^{\mathrm{N}}. \tag{6}$$

Inspection of (5) and (6) shows that individuals exert more effort with higher Σ_t and lower c. That is, the more variance about an individual's type that is resolved when an informative signal is obtained and the lower the cost of acquisition, the more effort each individual is willing to employ. Importantly, it is also the case that

$$e^{\mathrm{N}} = e^{\mathrm{D}} + \frac{\Sigma_g}{c}.$$

This implies that people exert more effort without a default option, and that the difference between e^{N} and e^{D} increases as Σ_g gets larger and as c gets smaller. Since the positive externality $\bar{e}$ comes from the average effort of individuals in the economy, it follows that there are greater opportunities for people to learn from each other when default options are not provided by the social planner. In this sense, whether a default option is welfare improving depends on the strength of the learning externality relative to the value of the information that the social planner has in her possession.

Given Proposition 1 and Lemma 2, we can compute the total welfare with a default option as

$$W^{\mathrm{D}} = -\Sigma_t + \frac{(1 + 2\alpha)\Sigma_t^2}{2c}, \tag{7}$$

and the total welfare without a default option as

$$W^{\mathrm{N}} = -(\Sigma_g + \Sigma_t) + \frac{(1 + 2\alpha)(\Sigma_g + \Sigma_t)^2}{2c}. \tag{8}$$

The next proposition compares welfare with and without a default option.

Proposition 2. *The total welfare W^{N} without a default option is higher than the total welfare W^{D} with a default option if the cost parameter c is in the following region:*

$$2(\Sigma_g + \Sigma_t) < c < (\Sigma_g + 2\Sigma_t)\frac{1 + 2\alpha}{2}. \tag{9}$$

This region is non-empty if and only if

$$\Gamma \equiv \frac{\Sigma_g}{\Sigma_g + \Sigma_t} < \frac{2(2\alpha - 1)}{1 + 2\alpha}. \tag{10}$$

According to Proposition 2, welfare without a default option may be higher than welfare with a default option. This arises because the presence of a default option reduces people's incentives to learn about the economic problem they face, which in turn slows the pace of information propagation throughout the economy. In other words the very presence of a default option creates an incentive for the population to herd into it, a damaging effect when people can learn a lot from each other (i.e., when α is greater than $\frac{1}{2}$ and large), and when the cost of information acquisition is low (i.e., when c is small). As shown in (10), the availability of a default option is more likely to be detrimental if the portion Γ of the volatility that the social planner can eliminate with her information about $\tilde{g}$ is small relative to the extent of information externalities.

To gain further insight into this result, let us use (7) and (8) and define the difference

$$\Delta W \equiv W^{\mathrm{N}} - W^{\mathrm{D}} = -\Sigma_g + \frac{(1 + 2\alpha)\Sigma_g(\Sigma_g + 2\Sigma_t)}{2c}. \tag{11}$$

Notice that, since $\Sigma_g = \Gamma\Sigma_\tau$ and $\Sigma_t = (1 - \Gamma)\Sigma_\tau$, we can rewrite this expression as

$$\Delta W = -\Gamma\Sigma_\tau + \frac{(1 + 2\alpha)\Gamma(2 - \Gamma)\Sigma_\tau^2}{2c}. \tag{12}$$

It is easy to verify that, holding the total variance Σ_τ fixed, we have

$$\frac{\partial(\Delta W)}{\partial\Gamma} = -\Sigma_\tau + \frac{(1 + 2\alpha)(1 - \Gamma)\Sigma_\tau^2}{c}, \tag{13}$$

and this quantity is positive if and only if

$$\Gamma < 1 - \frac{c}{(1 + 2\alpha)\Sigma_\tau}.$$

That is, an increase in the ability of the social planner to curb variance by revealing its knowledge of $\tilde{g}$ through a default option makes this option relatively less appealing when Γ is small or the total variance Σ_τ is large. In other words, when important information about individuals is unobservable to the social planner (small Γ) or when there is a lot of uncertainty about the individuals' financial

9

decision (large Σ_τ), increasing the precision of this information makes default options less appealing, as such options then have a particularly detrimental effect on information gathering incentives, and in turn on information sharing.

Similarly, after fixing the proportion Γ of the total variance that the social planner can control, we have

$$\frac{\partial(\Delta W)}{\partial \Sigma_\tau} = -\Gamma + \frac{(1+2\alpha)\Gamma(2-\Gamma)\Sigma_\tau}{c}, \tag{14}$$

which is positive if and only if

$$\Sigma_\tau > \frac{c}{(1+2\alpha)(2-\Gamma)}.$$

Thus an increase in overall uncertainty renders the presence of default options detrimental to welfare when this uncertainty is large to begin with (large Σ_τ) and when the social planner's ability to reduce uncertainty is limited (small Γ). The former effect has two potential interpretations. First, Σ_τ might proxy for the amount of heterogeneity in the population: when people's needs or attributes differ a lot, default options are more likely to be suboptimal. Second, Σ_τ might also proxy for the economic value at risk in each individual's decision: when decisions are more important, the social planner should refrain from issuing a default in order to promote learning and information sharing by individuals. The latter effect is directly related to the information gathering incentives of individuals: an increase in Σ_τ makes the default option damaging when Γ is small because the importance of the information that individuals forego by exerting less effort to gather it, $(1-\Gamma)\Sigma_\tau$, is large relative to the precision of the information they learn from the default option, $\Gamma\Sigma_\tau$. Together, these comparative statics suggest venues in which default options are likely to add value. For instance, default options are more likely to add value when there is little cross-sectional variation in the population than when this variation is higher.

By inspection of (11), the relationship between ΔW and Σ_g is non-monotonic. Similarly, our analysis of (13) shows that ΔW is non-monotonically affected by changes in Γ. Based on this, it is feasible that the social planner can optimize welfare by limiting her information collection to an imperfect signal and by offering to the population a default option that is not perfectly correlated with $\tilde{g}$. We explore this next.

2.2 Imperfect Social Planner

One of Glaeser's (2006) objections to the optimality of libertarian paternalism is that the social planner may, like individuals, make errors in judgement and decision-making. For example, the planner may have limited precision when gathering information about its constituents. In this case,

default options reveal an imperfect, yet unbiased, signal about $\tilde{g}$.[14] Alternatively, the planner may gather perfect information about $\tilde{g}$, but wish to disclose an imperfect signal of this information through a default option. Characterizing these issues is the purpose of this section.

Suppose that the social planner only observes a noisy signal $\tilde{s} = \tilde{g} + \tilde{\epsilon}$, where $\tilde{\epsilon}$ is normally distributed with mean zero and variance Σ_ϵ, and is independent from $\tilde{g}$ and $\tilde{t}_i$ for all $i \in I$. As before, each individual i can exert effort e_i for a cost given by (2) and learns his type $\tilde{\tau}_i$ with probability $e_i + \alpha \bar{e}$. If the planner issues a default option that conveys her noisy signal, rational individuals will take this into account when choosing how much information to acquire and share. We characterize this effect in the following proposition.

Proposition 3. *If the social planner implements an imperfect default option with noise Σ_ϵ, each individual i chooses effort*

$$e_i = \frac{(1-\delta)\Sigma_g + \Sigma_t}{c}, \tag{15}$$

where $\delta \equiv \frac{\Sigma_g}{\Sigma_g + \Sigma_\epsilon}$. An individual i who observes a fully informative signal opts out of the default option and chooses $x_i = \tilde{\tau}_i = \tilde{g} + \tilde{t}_i$. An individual i who does not become informed chooses $x_i = \delta \tilde{s} = \delta(\tilde{g} + \tilde{\epsilon})$, the default option offered by the social planner.

As in Proposition 1, the optimal choice of effort is decreasing in c and increasing in Σ_t and Σ_g. Additionally, as the amount of noise in the default increases (higher Σ_ϵ, and thus lower δ), the higher is the effort that each individual is willing to exert to learn about $\tilde{\tau}_i$. Therefore, the precision of information contained in the default option drives the incentives of individuals to acquire information, which in turn affects how much is learned via information sharing.

Given Proposition 3, we can compute the total welfare with a noisy default option as

$$
\begin{aligned}
W^{\mathrm{D}}(\Sigma_\epsilon) &= -\left[(1-\delta)\Sigma_g + \Sigma_t\right] + \frac{\left[(1-\delta)\Sigma_g + \Sigma_t\right]^2}{2c}(1 + 2\alpha) \\
&= -\left(\frac{\Sigma_\epsilon \Sigma_g}{\Sigma_g + \Sigma_\epsilon} + \Sigma_t\right) + \frac{\left(\frac{\Sigma_\epsilon \Sigma_g}{\Sigma_g + \Sigma_\epsilon} + \Sigma_t\right)^2}{2c}(1 + 2\alpha).
\end{aligned} \tag{16}
$$

The next proposition compares welfare with and without a default option when the social planner's information is imperfect.

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[14]Such mistakes might also result from a systematic bias in the social planner's information gathering process. Of course, since individuals in our model are fully rational, they would correctly interpret the information contained in default options and remove the effects of these systematic biases. With an unbiased but noisy signal about $\tilde{g}$, improving precision is not possible but does induce individuals to employ more effort in acquiring their own information. Therefore, the model as posed could include a systematic bias, but this would not change the economics of our results. Only if individuals could not understand and adjust for the planner's biases would such mistakes change the analysis and lead to lower welfare.

Proposition 4. *The total welfare W^{N} without a default option is higher than the total welfare $W^{\mathrm{D}}(\Sigma_\epsilon)$ with a noisy default option if the cost parameter c is in the following region:*

$$2(\Sigma_g + \Sigma_t) < c < \left(\frac{2\Sigma_\epsilon + \Sigma_g}{\Sigma_\epsilon + \Sigma_g} \Sigma_g + 2\Sigma_t \right) \frac{1 + 2\alpha}{2}. \tag{17}$$

This region is non-empty if and only if

$$\Gamma\Phi < \frac{2(2\alpha - 1)}{1 + 2\alpha}, \tag{18}$$

where $\Gamma = \frac{\Sigma_g}{\Sigma_g + \Sigma_t}$ and $\Phi = \frac{\Sigma_g}{\Sigma_g + \Sigma_\epsilon}$.

Comparing the result in Proposition 4 with that in Proposition 2, the region in which no default dominates default is larger when the social planner's information is imprecise. In fact, Proposition 4 shows that this region gets larger as Σ_ϵ increases (and Φ decreases). This result is not obvious: an imprecise default hurts individuals who decide take the default option, but also provides incentives for individuals to search more intensively, which improves information sharing. Comparison of Propositions 2 and 4 shows that the first effect dominates the second, confirming Glaeser's (2006) conjecture that the case for libertarian paternalism is weaker if the social planner makes errors in judgement or has imprecise information.

Clearly, this motivates an analysis of whether the social planner would optimally choose to issue a noisy default, even when she has free access to perfect information about $\tilde{g}$. Thus, let us consider a broader action space for the social planner in which she can issue default options that do not convey a precise signal regarding $\tilde{g}$. As such, the planner could still choose to issue a default option that conveys $\tilde{g}$ perfectly, but we now allow the planner to instead issue a default option that conveys $\tilde{g} + \tilde{\epsilon}$, in which she chooses the variance $\Sigma_\epsilon > 0$ of $\tilde{\epsilon}$. If a finite Σ_ϵ is chosen, individuals can learn some (i.e., incomplete) information about their decision from the default. Of course, as before, the planner can still make the default option perfectly informative about $\tilde{g}$ by choosing $\Sigma_\epsilon = 0$, and effectively refrain from making a default option available by choosing $\Sigma_\epsilon = \infty$.

Given our previous discussion, the social planner's choice of Σ_ϵ affects welfare through two channels. A higher precision improves the choices that individuals make when they do not observe an informative signal, but it decreases the incentives of individuals to collect and share information in the first place. Taking these two forces into account, the next proposition characterizes the social planner's optimal default policy.

Proposition 5. *The optimal choice of noisy default policy is given by*

$$\Sigma_\epsilon^* = \begin{cases} 0, & \text{if } c > (\Sigma_g + 2\Sigma_t)\frac{1+2\alpha}{2} \\ \infty, & \text{otherwise.} \end{cases} \tag{19}$$

Proposition 5 implies that our analysis in Section 2.1 holds even when we consider a broader action space for the social planner. That is, the planner's decision is effectively binary: she either chooses a fully informative default option or offers no default whatsoever. Again, if the cost of information acquisition is sufficiently high (high c), the size of the variation or value at risk is sufficiently low (low $\Sigma_g + \Sigma_t$), or the information sharing technology is sufficiently weak (low α), the social planner issues a fully informative default option (i.e., $\Sigma_\epsilon = 0$). Otherwise, the planner lets individuals fend for themselves (i.e., $\Sigma_\epsilon = \infty$).

3 Information Sales

So far, our model shows that the adoption of default options is costly and potentially suboptimal when individuals in the economy can help each other learn about their own type. In this section, we show that the externality need not be of the form specified in Section 2. In particular, we show that allowing individuals to sell their information to uninformed individuals can generate similar results. That is, the presence of default options reduces the incentive for individuals to gather and resell their information, potentially leading to an overall reduction of information in the economy and to lower welfare. In essence, formal exchanges of information across individuals in the economy, as modeled in this section, provide a micro-foundation for our base model.

To establish our results, we adapt the basic model of Section 2 to a context in which some individuals can (and will) purchase information from other individuals in the economy. More specifically, we assume that a subset $I_\mu \in I$, with $\gamma(I_\mu) = \mu$, of individuals are skilled in the sense that they can gather information about their type with the same technology as before, except that we set $\alpha = 0$ in (3) to emphasize the fact that externalities derive purely from information sales. That is, for a cost of $C(e_i) = \frac{c}{2} e_i^2$, individual $i \in I_\mu$ receives a signal that reveals his type $\tilde{g} + \tilde{t}_i$ with probability e_i. The other individuals $j \in I \setminus I_\mu$ are unskilled in that gathering information about their own type is prohibitively costly.

Instead, these unskilled individuals can purchase information from skilled individuals. Although everyone's skill is publicly observable, the private information of any one skilled individual is not. That is, no one can tell if individual i learned $\tilde{g} + \tilde{t}_i$ or not. Thus, for a price p (to be determined shortly), an unskilled individual j can purchase a signal from a skilled individual i, but does not know if he learns $\tilde{g} + \tilde{t}_i$ (which is correlated with his own type $\tilde{g} + \tilde{t}_j$) or noise (which is not) in the process.[15] Throughout this section, we go back to the assumption that the social planner's

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[15]We assume that skilled individuals who do not learn their own type sell an uninformative signal that is randomly

default option is perfect (i.e., equal to $\tilde{g}$) when it is made available; that is, we refrain from showing as in Section 2.2 that this choice is optimal even if the planner can choose the precision of her information. The following lemma characterizes the value derived from the information by an unskilled individual who consults a randomly selected skilled individual.

Lemma 3. *If the social planner does not adopt a default option, the maximum amount that an unskilled individual is willing to pay for the information sold by a randomly selected skilled individual is*

$$\nu_0 = \frac{(\Sigma_g + \rho\Sigma_t)^2}{\Sigma_g + \Sigma_t}\bar{e}_\mu = \left[\Gamma + \rho(1-\Gamma)\right]^2\Sigma_\tau\bar{e}_\mu, \tag{20}$$

where $\bar{e}_\mu \equiv \frac{1}{\mu}\int_{I_\mu} e_i d\gamma$, $\Sigma_\tau = \Sigma_g + \Sigma_t$, and $\Gamma = \frac{\Sigma_g}{\Sigma_g + \Sigma_t}$. If the social planner adopts a default option, the maximum amount that an unskilled individual is willing to pay for the information sold by a randomly selected skilled individual is

$$\nu_1 = \rho^2\Sigma_t\bar{e}_\mu = \rho^2(1-\Gamma)\Sigma_\tau\bar{e}_\mu. \tag{21}$$

Unskilled individuals are willing to pay more to learn a skilled individual's type when they know that skilled individuals exert a lot of effort to learn their own type, i.e., ν_0 and ν_1 are both increasing in $\bar{e}_\mu$. This makes sense as a fraction $\bar{e}_\mu$ of the μ skilled individuals will be informed in equilibrium, while the other $(1-\bar{e}_\mu)\mu$ skilled individuals sell useless noise. From (20) and (21), we can also see that unskilled individuals are willing to pay a higher price for a skilled individual's information when their type is highly variable (large Σ_τ) and when it is more highly correlated with that of other individuals (large ρ). This last result is consistent with the fact that, keeping Σ_τ fixed, ν_0 is increasing in Γ, as types are more correlated when the common component $\tilde{g}$ accounts for a larger portion of each individual's type. This is also consistent with ν_1 being decreasing in Γ as, when the social planner announces $\tilde{g}$, the unknown portion of an individual's type correlates with someone else's type only to the extent that the default option leaves uncertainty regarding $\tilde{t}_i$. In fact, using (20) and (21), it is straightforward to verify that $\nu_0 > \nu_1$ for a given total variance Σ_τ and aggregate level of effort $\bar{e}_\mu$. Indeed, because types are more correlated across individuals when $\tilde{g}$ is unknown, it is the case that unskilled individuals are willing to pay more to learn a skilled individual's type when there is no default option offered. As we shall see below, this difference between ν_0 and ν_1 is exacerbated by the fact that the equilibrium effort level of skilled individuals is greater in the absence of a default option.

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drawn from a normal distribution with a mean of zero and a variance of $\Sigma_g + \Sigma_t$, which makes it impossible for information buyers to tell noise from real information. The skilled individuals have nothing to gain from doing anything else.

The price that a skilled individual will end up charging for his information will in general depend on how much competition he faces from other information sellers or, alternatively, on how easy it is for unskilled individuals to consult another skilled individual. To capture these possibilities in a tractable manner, we assume that each unskilled individual meets with one randomly selected skilled individual, and that the economic surplus from their transaction is split as a Nash bargaining outcome. More specifically, we assume that a skilled individual charges $p = \theta \nu_\delta$ for the information he sells to an unskilled individual, where $\theta \in [0,1]$ and $\delta = 1$ if a default option is made available ($\delta = 0$ otherwise). When $\theta = 1$ ($\theta = 0$), the skilled (unskilled) individual extracts all the surplus from the transaction.[16] Setting $\theta \in (0,1)$ allows us to capture any intermediate market power scenario. As the following analysis shows, our results are unaffected by the size of θ, as money exchanges between individuals cancel out in the total welfare function that the social planner seeks to maximize. We start with the following result, which describes the equilibrium in the absence of a default option.

Proposition 6. *If the social planner does not adopt a default option, then each skilled individual $i \in I_\mu$ chooses an effort level $e_i = \frac{\Sigma_g + \Sigma_t}{c} = \frac{\Sigma_\tau}{c}$, and chooses $x_i = \tilde{\tau}_i$ or $x_i = 0$, depending on whether or not he observes $\tilde{\tau}_i$. Each unskilled individual $j \in I \setminus I_\mu$ purchases a signal $\tilde{s}_j$ (which is $\tilde{\tau}_{\tilde{i}}$ or noise) from a randomly selected skilled individual $\tilde{i} \in I_\mu$ for a price $p = \theta \nu_0$, with ν_0 given by (20), and chooses*

$$x_j = \frac{\Sigma_g + \rho \Sigma_t}{\Sigma_g + \Sigma_t} \bar{e}_\mu \tilde{s}_j = \big[\Gamma + \rho(1-\Gamma)\big] \bar{e}_\mu \tilde{s}_j. \tag{22}$$

The skilled individuals' behavior is the same as in Section 2.1. In particular, their behavior is not affected by the possibility of reselling their information to unskilled individuals. This is due to the fact that unskilled individuals cannot distinguish between skilled individuals who learn their type and skilled individuals who do not. That is, they pay $\theta \nu_0$ to the one skilled individual they encounter, informed or not. As we see from (22), the extent to which unskilled individuals rely on the information they purchase depends on its correlation with their type, as increases in ρ, Γ and $\bar{e}_\mu$ all ultimately lead to a higher correlation between $\tilde{s}_j$ and $\tilde{\tau}_j$. The following result is the analogue of Proposition 6 when the social planner makes a default option $\tilde{g}$ available.

Proposition 7. *If the social planner adopts a default option, then each skilled individual $i \in I_\mu$ chooses an effort level $e_i = \frac{\Sigma_t}{c} = \frac{(1-\Gamma)\Sigma_\tau}{c}$, and chooses $x_i = \tilde{\tau}_i$ or $x_i = \tilde{g}$, depending on whether or*

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[16]Note that when $\theta = 0$, the transaction can be interpreted as a free information exchange between two individuals with different skills. For example, this captures the situation in which a new employee asks an existing employee of the same firm about his choices in the company's 401(k) plan.

not he observes $\tilde{\tau}_i$. Each unskilled individual $j \in I \setminus I_\mu$ purchases a signal $\tilde{s}_j$ (which is $\tilde{\tau}_{\tilde{i}}$ or noise) from a randomly selected skilled individual $\tilde{i} \in I_\mu$ for a price $p = \theta\nu_1$, with ν_1 given by (21), and chooses

$$x_j = \tilde{g} + \rho\bar{e}_\mu(\tilde{s}_j - \tilde{g}). \tag{23}$$

The comparative statics on the individuals' choices with respect to Σ_τ, ρ and $\bar{e}_\mu$ are similar to those in Proposition 6: more risk (large Σ_τ) leads to more effort, and more correlation (large ρ and $\bar{e}_\mu$) leads to heavier reliance on purchased information. When Γ is large, skilled individuals do not gain much from learning their type perfectly, as the default option already reveals a large portion of their type. As such, they work less. Although Γ affects the price of information (as shown in Lemma 3), it does not affect the weight that unskilled individuals put on the information they acquire from skilled individuals. Instead, they use the default option to remove the common component included in the signal and place weight only on the idiosyncratic component. Finally, note that as in Proposition 1, the skilled individuals exert a higher level of effort in the absence of a default option since the incentive to gather information is stronger when they do not have a default option to fall back on. This in turn causes the quality of their advice to decrease, and further amplifies the previously discussed difference between ν_0 and ν_1. That is, unskilled individuals do not benefit as much from a skilled individual's information, and are thus inclined to pay less for it.

As in Section 2, to assess the pros and cons of the planner's default option, we compare total welfare with and without this option. In this case, welfare must be aggregated over skilled and unskilled individuals. This is done in the following lemma.

Lemma 4. *The total welfare without a default option is*

$$W^{\mathrm{N}} = -(\Sigma_g + \Sigma_t) + \frac{\mu}{2c}(\Sigma_g + \Sigma_t)^2 + \frac{1-\mu}{c}(\Sigma_g + \rho\Sigma_t)^2. \tag{24}$$

The total welfare with a default option is

$$W^{\mathrm{D}} = -\Sigma_t + \frac{\mu}{2c}\Sigma_t^2 + \frac{1-\mu}{c}\rho^2\Sigma_t^2. \tag{25}$$

In Section 2, an increase in α enhances overall welfare through the larger information gathering externalities that individuals have on each other. We can now see from (24) and (25) that increases in ρ have a similar effect in the presence of information sales. More precisely, straightforward differentiation of these two expressions with respect to ρ lead to

$$\frac{\partial W^{\mathrm{N}}}{\partial \rho} = \frac{2(1-\mu)}{c}(\Sigma_g + \rho\Sigma_t)\Sigma_t > 0 \tag{26}$$

and
$$\frac{\partial W^{\mathrm{D}}}{\partial \rho} = \frac{2(1-\mu)}{c}\rho\Sigma_t^2 > 0. \tag{27}$$

That is, a larger correlation across individuals' types leads to more welfare when a formal advice channel, like information sales, is incorporated. We can also see that the increase in welfare accommodated by this advice channel is more important when a sizeable fraction of the population is unskilled (i.e., $1-\mu$ is large). Finally, it is clear that (26) is greater than (27): the advice channel is more crucial and the role of ρ greater when the social planner refrains from making a default option available, as unskilled individuals can then rely only on the skilled individuals' information for their decisions.

The next proposition is the analogue of Proposition 2 when we allow for information sales.

Proposition 8. *The total welfare W^{N} without a default option is higher than the total welfare W^{D} with a default option if the cost parameter c is in the following region:*

$$\Sigma_g + \Sigma_t < c < \left(1 - \frac{\mu}{2}\right)\Sigma_g + \left[\mu + 2(1-\mu)\rho\right]\Sigma_t. \tag{28}$$

This region is non-empty if and only if $\rho > \frac{1}{2}$ and

$$\frac{\Sigma_g}{\Sigma_t} < \frac{2(1-\mu)}{\mu}(2\rho - 1). \tag{29}$$

As mentioned above, ρ plays an especially important welfare role in information sales when the social planner does not make a default option available. Proposition 8 formalizes this by showing that $\rho \leq \frac{1}{2}$ always makes the availability of a default option optimal. That is, unskilled individuals are better off learning the common component of their type perfectly from the social planner when the information that can be acquired from other individuals is not all that useful. This implies that default options are especially valuable when the needs of an individual are unlikely to be similar to those of his peers, including the ones who can advise him.

We can also see from (29) that default options are less valuable when Σ_t is large and Σ_g is small, which is similar to our findings in Section 2. The extent to which the social planner can resolve the uncertainty faced by the population is still an important determinant of the usefulness of default option. Interestingly, however, default options are more valuable when a larger fraction of the population is skilled (large μ), even when ρ is large. This arises because the information externalities that skilled individuals bring to the economy through information sales is limited: the small number of unskilled individuals leads to a small number of information sales, and so the effort choices of skilled individuals with and without a default option (as derived in Proposition 7) do not lead to significantly different externalities.

4 Behavioral Considerations

4.1 Procrastination

The default option models developed by Choi et al. (2003) and Carroll et al. (2009) revolve around the idea that individuals tend to procrastinate when they have to make decisions. In these models, procrastination derives from hyperbolic discounting preferences by which individuals do not value the future benefits of optimal financial decisions as much as the current utility cost of making these decisions. That is, as suggested by Akerlof (1991), making decisions today appears more painful and costly than the future losses that result from postponing these decisions. As we show in this section, the same procrastination forces can be accommodated in our model without affecting our conclusions regarding the information content of default options. In this sense, our model complements these existing models by adding informational considerations to the set of tradeoffs involved in the optimal design of default options.

To illustrate our point, we return to the model of Section 2 and assume that in order to make an active decision each individual i faces an additional cost

$$\tilde{\kappa}_i = \begin{cases} 0, & \text{prob. } \phi \\ k, & \text{prob. } 1 - \phi, \end{cases} \tag{30}$$

where $\phi \in (0, 1]$ and $k > 0$. This cost is observable by individual i at the outset, but is potentially misinterpreted by him. In particular, every individual i thinks that his cost is $\tilde{\kappa}_i + b$, where $b \geq 0$. That is, although this individual will experience a cost of $\tilde{\kappa}_i$ when he chooses to make an active decision, he thinks that doing so will cost him more. As a result, he is naturally inclined to postpone active decision-making and instead rely on the default set by the social planner. Therefore, as with hyperbolic discounting, individuals are mistaken by the cost of making a decision today relative to the future gains that come with this decision.

As before, the social planner chooses her default option policy in order to maximize total welfare. As in Carroll et al. (2009), if the planner does not provide a default option, each individual i must actively make a decision and therefore incur the cost κ_i. Alternatively, the planner can announce a default option that individuals can adhere to without incurring any costs, or change at their will. Because the change entails a utility cost for each person, the planner's choice of default now serves two purposes. First, as before, it serves to communicate the information that the planner has about $\tilde{g}$. Second, as in the work of Choi et al. (2003) and Carroll et al. (2009), it serves to affect individuals' incentive to exert effort. Specifically, the planner can now choose a center default of $\tilde{g}$ or an offset default of $\tilde{g} - \gamma$ where, without loss of generality, $\gamma > 0$. In both cases, the default

communicates $\tilde{g}$ to the population. When γ is large, however, the offset default leads to worse outcomes on average and to lower expected utility for an individual i who elects not to change his decision away from the default. This in turn creates an incentive for each individual i to pay the cost of active decision-making, gather information and change x_i based on this information.[17]

We restrict our analysis to the situation in which it is socially optimal for the high-cost types not to exert effort. For this to be the case, it is sufficient to assume that $k > \frac{(1+2\alpha)(\Sigma_g + \Sigma_t)^2}{2c}$, as will become clear from our analysis below. Also, to capture the idea that procrastination is socially costly, we assume that $b > \frac{(1+2\alpha\phi)\Sigma_t^2}{2c}$ which, as we show later, implies that low-cost types prefer to stay with the default option when it is set at $x_i = \tilde{g}$ by the social planner. We also assume that b is not so large that the perceived fixed cost of active decision-making always prevents all individuals from gathering any information. In particular, for reasons to be made clear later, we assume that $b < \frac{(1+2\alpha\phi)\Sigma_t^2}{2c(1-\phi)}$. In short, the socially optimal situation in which only low-cost types exert some information-gathering effort is impossible to implement using the center default option of previous sections.

If the social planner does not adopt a default option and forces individuals to make their own decision, it is optimal for everyone to exert the same effort as in (6) from Proposition 1; that is, $e_i = \frac{\Sigma_g + \Sigma_t}{c}$ for all $i \in I$. In particular, the fixed cost $\tilde{\kappa}_i$ is sunk by the time individual i chooses e_i and so does not affect his effort choice. As a result, total welfare is given by (8) minus the cost k that $1 - \phi$ of the individuals must pay:

$$W^{\mathrm{N}} = -(\Sigma_g + \Sigma_t) + \frac{(1 + 2\alpha)(\Sigma_g + \Sigma_t)^2}{2c} - (1 - \phi)k. \tag{31}$$

Now suppose that the social planner sets a default option of $x_i = \tilde{g}$. The following lemma establishes that no individual finds it optimal to change x_i from its default value. As a result, every individual's expected utility is $-\Sigma_t$, which then also trivially measures total welfare.

Lemma 5. *If the social planner sets a center default option of $x_i = \tilde{g}$, every individual in the economy sticks with the default option. Total welfare is*

$$W^{\mathrm{CD}} = -\Sigma_t. \tag{32}$$

As in previous sections, the optimality of offering a default involves a comparison of total welfare across the two policies, i.e., between (31) and (32). The following proposition summarizes the results.

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[17]Any default option that is a one-to-one function with $\tilde{g}$ has the same information content as the center and offset defaults, but does not improve the utility of any one individual electing to stick with the default. As such, we do not entertain these other default policies.

Proposition 9. *The total welfare W^{N} without a default option is higher than the total welfare W^{CD} with a center default option if the cost parameter c is in the following region:*

$$2(\Sigma_g + \Sigma_t) < c < \frac{(\Sigma_g + \Sigma_t)^2 (1 + 2\alpha)}{2[\Sigma_g + (1 - \phi)k]}. \tag{33}$$

This region is non-empty if and only if

$$\Gamma \equiv \frac{\Sigma_g}{\Sigma_g + \Sigma_t} < \frac{1}{4}(1 + 2\alpha) - \frac{(1 - \phi)k}{\Sigma_g + \Sigma_t}. \tag{34}$$

Since the right-hand side of (34) is increasing in α, it is the case as before that the presence of a default option is less likely to improve total welfare when information sharing improves. This tradeoff is affected by the second term in (34), which increases with ϕ and decreases with k. A larger fraction $1 - \phi$ of individuals who must incur a large fixed cost k reduces the overall benefit of active decision-making.

Finally, let us consider the possibility that the social planner sets the default option to $x_i = \tilde{g} - \gamma$. If γ is sufficiently small, it is clear from Lemma 5 that all individuals will stick with the default option. Indeed, their utility from doing so is

$$\mathrm{E}\big[\tilde{U}_i(\tilde{g} - \gamma) \,|\, \tilde{g}\big] = -\Sigma_t - \gamma^2,$$

which is close to W^{CD} for γ small. Thus both low-cost and high-cost types still refuse to pay the perceived fixed cost of making active decisions (b for the former, $k + b$ for the latter), as the gain from changing x_i to a more optimal value is relatively small. This implies that it is never optimal for the social planner to set γ to a value so small that nobody changes their decision. That is, only larger values of γ that induce low-cost types to exert effort should be entertained by the social planner. The following lemma derives the planner's optimal choice of γ when she chooses an offset default that encourages only low-cost types to exert information-gathering effort.

Lemma 6. *If the social planner sets an offset default option of $x_i = \tilde{g} + \gamma$, then it is optimal to set*

$$\gamma = \sqrt{b - \frac{(1 + 2\alpha\phi)\Sigma_t^2}{2c}}. \tag{35}$$

Then, there is an equilibrium in which low-cost individuals choose $e_i = \frac{\Sigma_t}{c}$, and high-cost individuals stick with the default option.[18] *Total welfare is given by*

$$W^{\mathrm{OD}} = -\Sigma_t + \frac{(1 + 2\alpha\phi)\Sigma_t^2}{2c} - (1 - \phi)b. \tag{36}$$

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[18]It is worth noting that another equilibrium in which nobody exerts effort also exists. However, with our previous assumptions on b, it can be shown that this no-effort equilibrium is always dominated in terms of total welfare.

The fraction ϕ of low-cost individuals affects W^{OD} in two ways. First, because only the low-cost individuals exert effort, the positive externality that people have on each other's information-gathering process is only ϕ of the externality when everyone exerts effort; that is,

$$\alpha \bar{e} = \alpha \left[\phi \frac{\Sigma_t}{c} + (1 - \phi)(0) \right] = \phi \alpha \frac{\Sigma_t}{c}.$$

Second, because externalities are larger when ϕ is large, the offset γ that is required to motivate the low-cost individuals to exert effort is smaller (i.e., (35) is decreasing in ϕ). This further implies that high-cost individuals are better off even if they keep using the default; this also increases welfare.[19] In fact, the extent of the bias b of individuals about their fixed cost of making active decisions has the opposite effect: because it makes the required offset γ larger, it has a negative impact on W^{OD}. Whether the offset default option improves welfare necessitates a comparison between (31) and (36). This is our next result.

Proposition 10. *The total welfare W^{N} without a default option is higher than the total welfare W^{OD} with an offset default option if the cost parameter c is in the following region:*

$$2(\Sigma_g + \Sigma_t) < c < \frac{(\Sigma_g + \Sigma_t)^2 (1 + 2\alpha) - \Sigma_t^2 (1 + 2\alpha\phi)}{2 \big[\Sigma_g + (1 - \phi)(k - b) \big]}. \tag{37}$$

This region is non-empty if and only if

$$\Gamma \equiv \frac{\Sigma_g}{\Sigma_g + \Sigma_t} < \bar{\Gamma}, \tag{38}$$

where $\bar{\Gamma}$ solves

$$(1 + 2\alpha\phi)(1 - \bar{\Gamma})^2 - 4(1 - \bar{\Gamma}) + (3 - 2\alpha) + 4(1 - \phi)\frac{k - b}{\Sigma_g + \Sigma_t} = 0. \tag{39}$$

It is straightforward to show, by implicit differentiation of (39), that $\bar{\Gamma}$ is increasing in α. As before, it is optimal for the social planner to let individuals make their own decisions, without providing them with any information, when their opportunities for information sharing improve. It is also straightforward to show that $\bar{\Gamma}$ is increasing in b. When individuals are heavily biased, the impact of today's decisions on future outcomes appears small compared to their cost. Instead of offsetting the default to such an extent that it becomes optimal for some people (i.e., the low-cost types) to exert effort, it is more efficient to simply force everyone to make the financial decisions they face right away. That is, when biases are too costly to realign, active decisions with no informational help from the social planner become socially optimal.

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[19]The offset γ and the information sharing parameter α are substitutes in this case. This results from our distributional assumption on $\tilde{\kappa}_i$. For some other distributions (e.g., uniform distribution), γ and α are complements: however, it is easy to show that there does not exist an optimal γ in this case. That is, an offset default is never optimal in the first place.

4.2 Trusting the Social Planner

Madrian and Shea (2001) suggest that the overreliance of 401(k) participants on the defaults provided by their employers may be due to a misinterpretation of the information contained in these defaults. Similarly, McKenzie and Nelson (2003) and Sher and McKenzie (2006) find that the designers of default options are often able to affect the information communicated to individuals by varying the frame through which the same defaults are presented. Thus, the result that individuals herd into the defaults provided by policy designers could be due to these individuals interpreting the defaults as advice that is not as valuable as they think. Our model of the information content of defaults naturally lends itself to a study of this possibility.

To investigate this question, let us again return to the model of Section 2 and now assume that each individual i misperceives the precision and value of the default provided by the social planner. In particular, let us assume that every individual i mistakenly thinks that Σ_g is $\hat{\Sigma}_g \equiv \Sigma_g + \beta\Sigma_\tau$ and that Σ_t is $\hat{\Sigma}_t \equiv \Sigma_t - \beta\Sigma_\tau$, where $\beta \in \left[0, \frac{\Sigma_t}{\Sigma_\tau}\right]$. So, although individual i still correctly assesses the unconditional variance of $\tilde{\tau}_i$ to be $\hat{\Sigma}_g + \hat{\Sigma}_t = \Sigma_g + \Sigma_t = \Sigma_\tau$, he puts too much weight on the variance reduction that the social planner's default provides, i.e., individuals believe that the social planner understands their economic problem better than she really does.

Without a default option by the social planner, individuals solve exactly the same problem as in section 2.1. Indeed, because $\hat{\Sigma}_g + \hat{\Sigma}_g = \Sigma_g + \Sigma_t$, they choose an effort level of $e_i = \frac{\hat{\Sigma}_g + \hat{\Sigma}_t}{c} = \frac{\Sigma_g + \Sigma_t}{c}$, which is identical to (6). As such, total welfare is the same as derived in (8):

$$W^{\mathrm{N}} = -(\Sigma_g + \Sigma_t) + \frac{(1 + 2\alpha)(\Sigma_g + \Sigma_t)^2}{2c}. \tag{40}$$

When the social planner offers a default option $x_i = \tilde{g}$, however, individuals believe the variance reduction to be larger than it really is. Their effort choice is then as in (5), except that it is based on the underestimated residual variance: $e_i = \frac{\hat{\Sigma}_t}{c} = \frac{\Sigma_t - \beta\Sigma_\tau}{c}$. The reduction in effort that comes with the individuals' over-reliance on the social planner is detrimental to welfare not only because individuals reach the wrong level of effort when they solve their own maximization problem, but also because the lower effort reduces the information-sharing externality. The following proposition derives the total welfare that comes with the social planner's default option as well as the conditions for individuals being better off without it.

Proposition 11. *The total welfare with a default option is given by*

$$W^{\mathrm{D}} = -\Sigma_t + \frac{(1 + 2\alpha)\Sigma_t^2}{2c} - \frac{\beta\Sigma_\tau(2\alpha\Sigma_t + \beta\Sigma_\tau)}{2c}. \tag{41}$$

22

The total welfare W^{N} without a default option is higher than the total welfare W^{D} with a default option if the cost parameter c is in the following region:

$$2(\Sigma_g + \Sigma_t) < c < \frac{(1 + 2\alpha)\Sigma_g(\Sigma_g + 2\Sigma_t)}{2c} + \frac{\beta\Sigma_\tau(2\alpha\Sigma_t + \beta\Sigma_\tau)}{2c}. \tag{42}$$

This region is non-empty if and only if

$$\Gamma \equiv \frac{\Sigma_g}{\Sigma_g + \Sigma_t} < \frac{2(2\alpha - 1) + \beta(2\alpha + 1)}{1 + 2\alpha(1 + \beta)}. \tag{43}$$

It is easy to verify that the inequalities in (42) and (43) are weaker than the inequalities in (9) and (10) and that they get weaker as β increases. That is, individuals' bias about the ability of the social planner to inform their decisions through the default option leads them to adopt the default more often than they should. As documented by Choi et al. (2002) and Johnson and Goldstein (2003), they follow the path of least resistance. When information sharing is affected by individuals' dedication to learning about their economic situation, the welfare consequences of this misperception can be quite important. Not providing default options then becomes an even better option for the social planner.

5   Concluding Remarks

Individuals have difficulty making financial decisions. Several proposals have been made to assist individuals in financial decision-making. Among these proposals, libertarian paternalism, through the use of default options, is an alluring idea because it combines two policies that appear incompatible at first glance, but work well together in many settings. However, one needs to be cautious when implementing the ideals of such a policy in practice. As we show in our analysis, it is not necessarily the paternalistic partner in this union that causes problems in the relationship. Rather, the freedom that participants exercise in the market may lead to side effects that decrease social welfare.

Indeed, as its name suggests, libertarian paternalism preserves the rights of individuals to act in their own best interest, benefit from each other's effort provision, and shirk in their own responsibilities. In the face of non-cooperative incentives, libertarian paternalism may induce or worsen externalities that decrease welfare, even though it does not explicitly force people to act in a prescribed manner.

In the paper, we analyze a theoretical model to characterize one such distortion: information acquisition and social learning. As documented by Madrian and Shea (2001) in the context of

401(k) plan choice, default options have information content, which participants may take into consideration when making key decisions. Importantly, this may affect incentives to gather further information, which in turn may alter the success of information aggregation, either through social learning or information exchanges.

We characterize the situations in which libertarian paternalism is more or less likely to add value given this externality. We show that default options are more likely to improve social welfare when acquiring information is costly, information is not easily shared across individuals, and people are more heterogeneous in their attributes or needs. Based on our model, default options will likely decrease welfare when the social planner knows less about its constituents, when people are heterogeneous, and when the value at stake in the decision is large.

Our analysis adds to previous theoretical work on default options by Choi et al. (2003) and Carroll et al. (2009) and, as such, increases our understanding of these policies. More generally, our theory adds an important tradeoff in the optimal implementation of libertarian paternalism through public recommendations and advice. Further study of the externalities induced by libertarian paternalism are the subject of future research, which appears warranted given the potential welfare import of this policy.

Appendix

Proof of Lemma 1

Individual i must choose x_i in order to maximize

$$\mathrm{E}\big[\tilde{U}_i(x_i) \mid \mathcal{S}_i\big] = \mathrm{E}\big[-(\tilde{\tau}_i - x_i)^2 \mid \mathcal{S}_i\big] = -\mathrm{E}\big[\tilde{\tau}_i^2 \mid \mathcal{S}_i\big] + 2x_i \mathrm{E}\big[\tilde{\tau}_i \mid \mathcal{S}_i\big] - x_i^2.$$

By differentiating this expression with respect to x_i, we obtain the first-order condition for this problem, $2\mathrm{E}\big[\tilde{\tau}_i \mid \mathcal{S}_i\big] - 2x_i = 0$, which yields $x_i = \mathrm{E}\big[\tilde{\tau}_i \mid \mathcal{S}_i\big]$. It is straightforward to verify that the second-order condition is satisfied. ∎

Proof of Lemma 2

Let $\delta = 1$ if the social planner announces a default option $\tilde{g}$ and $\delta = 0$ otherwise. Using Lemma 1, individual i's expected utility is given by

$$
\begin{aligned}
\mathrm{E}\Big[\tilde{U}_i(x_i) \mid \mathcal{S}_i^0\Big] &= \mathrm{E}\Big[-(\tilde{\tau}_i - x_i)^2 \mid \mathcal{S}_i^0\Big] = \mathrm{E}\Big\{\mathrm{E}\big[-(\tilde{\tau}_i - x_i)^2 \mid \mathcal{S}_i\big] \mid \mathcal{S}_i^0\Big\} \\
&= \Pr\big\{\mathcal{S}_i = \{\tilde{\tau}_i\} \mid \mathcal{S}_i^0\big\} \mathrm{E}\big[-(\tilde{\tau}_i - x_i)^2 \mid \tilde{\tau}_i\big] + \Pr\big\{\mathcal{S}_i = \{\tilde{g}\} \mid \mathcal{S}_i^0\big\} \mathrm{E}\big[-(\tilde{\tau}_i - x_i)^2 \mid \tilde{g}\big] \\
&\qquad + \Pr\big\{\mathcal{S}_i = \varnothing \mid \mathcal{S}_i^0\big\} \mathrm{E}\big[-(\tilde{\tau}_i - x_i)^2\big] \\
&= (e_i + \alpha\bar{e})\mathrm{E}\big[-(\tilde{\tau}_i - \tilde{\tau}_i)^2\big] + (1 - e_i - \alpha\bar{e})\delta\mathrm{E}\big[-(\tilde{\tau}_i - \tilde{g})^2\big] + (1 - e_i - \alpha\bar{e})(1 - \delta)\mathrm{E}\big[-(\tilde{\tau}_i - 0)^2\big] \\
&= -(1 - e_i - \alpha\bar{e})\delta\Sigma_t + -(1 - e_i - \alpha\bar{e})(1 - \delta)(\Sigma_g + \Sigma_t) \\
&= -(1 - e_i - \alpha\bar{e})\Big[(1 - \delta)\Sigma_g + \Sigma_t\Big].
\end{aligned}
$$

The result obtains after we subtract the cost of effort $C(e_i)$ for individual i, as given in (2). ∎

Proof of Proposition 1

As shown in Lemma 2, each individual i chooses e_i to maximize

$$-(1 - e_i - \alpha\bar{e})\Big[(1 - \delta)\Sigma_g + \Sigma_t\Big] - \frac{c}{2}e_i^2,$$

where $\delta = 1$ when a default option $\tilde{g}$ is offered by the social planner and $\delta = 0$ otherwise. The first-order condition for this problem is

$$(1 - \delta)\Sigma_g + \Sigma_t - ce_i = 0,$$

which implies that

$$e_i = \frac{(1 - \delta)\Sigma_g + \Sigma_t}{c}.$$

It is easy to see that the second order condition is satisfied and thus the above e_i corresponds to a maximum. The effort levels with and without a default option, (5) and (6), are obtained by setting δ equal to one and zero respectively. ∎

Proof of Proposition 2

A simple comparison of (7) and (8) yields the second inequality in (9). The first inequality in (9) comes from Assumption 1. The region is non-empty if and only if

$$2(\Sigma_g + \Sigma_t) < (\Sigma_g + 2\Sigma_t)\frac{1 + 2\alpha}{2},$$

which simplifies to the condition in (10). ∎

Proof of Proposition 3

Using the projection theorem for normal variables, it is straightforward to show that $\mathrm{E}\big[\tilde{\tau}_i \,|\, \tilde{s}\big] = \frac{\Sigma_g}{\Sigma_g + \Sigma_\epsilon}\tilde{s} = \delta\tilde{s}$ and $\mathrm{Var}\big[\tilde{\tau}_i \,|\, \tilde{s}\big] = \left(1 - \frac{\Sigma_g}{\Sigma_g + \Sigma_\epsilon}\right)\Sigma_g + \Sigma_t = (1-\delta)\Sigma_g + \Sigma_t$, where $\delta = \frac{\Sigma_g}{\Sigma_g + \Sigma_\epsilon}$. Thus, when individual i's information set is $\mathcal{S}_i = \{\tilde{s}\}$ at the time of his decision about x_i, Lemma 1 implies that $x_i = \delta\tilde{s}$. When individual i observes his type and $\mathcal{S}_i = \{\tilde{\tau}_i\}$, then he chooses $x_i = \tilde{\tau}_i$, as before. At the time of his effort decision, individual i's information set is $\mathcal{S}_i^0 = \{\tilde{s}\}$, and thus

$$
\begin{aligned}
\mathrm{E}\Big[\tilde{U}_i(x_i) \,|\, \mathcal{S}_i^0\Big] &= \mathrm{E}\Big[-(\tilde{\tau}_i - x_i)^2 \,|\, \mathcal{S}_i^0\Big] = \mathrm{E}\Big\{\mathrm{E}\big[-(\tilde{\tau}_i - x_i)^2 \,|\, \mathcal{S}_i\big] \,|\, \mathcal{S}_i^0\Big\} \\
&= \mathrm{Pr}\left\{\mathcal{S}_i = \{\tilde{\tau}_i\} \,|\, \mathcal{S}_i^0\right\}\mathrm{E}\big[-(\tilde{\tau}_i - x_i)^2 \,|\, \tilde{\tau}_i\big] + \mathrm{Pr}\left\{\mathcal{S}_i = \{\tilde{s}\} \,|\, \mathcal{S}_i^0\right\}\mathrm{E}\big[-(\tilde{\tau}_i - x_i)^2 \,|\, \tilde{s}\big] \\
&= (e_i + \alpha\bar{e})\mathrm{E}\big[-(\tilde{\tau}_i - \tilde{\tau}_i)^2\big] + (1 - e_i - \alpha\bar{e})\mathrm{E}\big[-(\tilde{\tau}_i - \delta\tilde{s})^2 \,|\, \tilde{s}\big] \\
&= -(1 - e_i - \alpha\bar{e})\mathrm{Var}\big[\tilde{\tau}_i \,|\, \tilde{s}\big] = -(1 - e_i - \alpha\bar{e})\Big[(1 - \delta)\Sigma_g + \Sigma_t\Big].
\end{aligned}
$$

Therefore, each individual i chooses e_i to maximize

$$\mathrm{E}\Big[\tilde{U}_i(x_i) - C(e_i) \,|\, \mathcal{S}_i^0\Big] = -(1 - e_i - \alpha\bar{e})\Big[(1 - \delta)\Sigma_g + \Sigma_t\Big] - \frac{c}{2}e_i^2.$$

The first-order condition for this problem is

$$(1 - \delta)\Sigma_g + \Sigma_t - ce_i = 0,$$

which leads to (15). It is easy to verify that the second-order condition is satisfied. ∎

Proof of Proposition 4

The first inequality in (17) comes from Assumption 1. Let us define $\Delta W(\Sigma_\epsilon) \equiv W^{\mathrm{N}} - W^{\mathrm{D}}(\Sigma_\epsilon)$. Using (8) and (16), it is easy to show that

$$\Delta W(\Sigma_\epsilon) = \frac{\Sigma_g^2 \left\{ (1 + 2\alpha) \left[\Sigma_g(2\Sigma_\epsilon + \Sigma_g) + 2\Sigma_t(\Sigma_\epsilon + \Sigma_g) \right] - 2c(\Sigma_\epsilon + \Sigma_g) \right\}}{2c(\Sigma_\epsilon + \Sigma_g)^2}.$$

This quantity is positive if and only if the second inequality in (17) is satisfied. For the region in (17) to be non-empty, we must have

$$2(\Sigma_g + \Sigma_t) < \left(\frac{2\Sigma_\epsilon + \Sigma_g}{\Sigma_\epsilon + \Sigma_g} \Sigma_g + 2\Sigma_t \right) \frac{1 + 2\alpha}{2},$$

which produces condition (18). ∎

Proof of Proposition 5

As shown in (16), welfare with a noisy default policy is given by

$$W^{\mathrm{D}}(\Sigma_\epsilon) = - \left(\frac{\Sigma_\epsilon \Sigma_g}{\Sigma_g + \Sigma_\epsilon} + \Sigma_t \right) + \frac{\left(\frac{\Sigma_\epsilon \Sigma_g}{\Sigma_g + \Sigma_\epsilon} + \Sigma_t \right)^2}{2c}(1 + 2\alpha).$$

After taking the derivative of this expression with respect to Σ_ϵ and simplifying, we find

$$\frac{\partial W^{\mathrm{D}}(\Sigma_\epsilon)}{\partial \Sigma_\epsilon} = \frac{\Sigma_g^2}{c(\Sigma_g + \Sigma_\epsilon)^3} \left\{ (1 + 2\alpha) \left[\Sigma_g \Sigma_t + \Sigma_\epsilon(\Sigma_g + \Sigma_t) \right] - c(\Sigma_\epsilon + \Sigma_g) \right\}. \tag{44}$$

If $c > (1 + 2\alpha)(\Sigma_g + \Sigma_t)$, this derivative is always negative and it is optimal to set Σ_ϵ as low as possible, that is, $\Sigma_\epsilon^* = 0$. If $c < (1 + 2\alpha)\Sigma_t$, the above derivative is always positive and it is therefore optimal to set Σ_ϵ as high as possible, that is $\Sigma_\epsilon^* = \infty$, which is equivalent to the social planner not offering a default option. Finally, if $(1 + 2\alpha)\Sigma_t < c < (1 + 2\alpha)(\Sigma_g + \Sigma_t)$, then (44) is greater than zero when

$$\Sigma_\epsilon > \frac{c - (1 + 2\alpha)\Sigma_t}{(1 + 2\alpha)(\Sigma_g + \Sigma_t) - c} \Sigma_g,$$

and smaller than zero otherwise. This means that the maximum can only be achieved at $\Sigma_\epsilon = 0$ (i.e., default option without noise) or $\Sigma_\epsilon = \infty$ (i.e., no default option). The optimal default choice must therefore be the same as in Proposition 2, leading to (19). ∎

Proof of Lemma 3

Let $\tilde{s}_j$ denote the information purchased by unskilled individual j from skilled individual i, and let us first consider the case in which the social planner does not make a default option available. If $\tilde{s}_j = \tilde{g} + \tilde{t}_i$, then the reduction in variance experienced by individual j from knowing $\tilde{s}_j$ is given by

$$\mathrm{Var}\big(\tilde{g} + \tilde{t}_j\big) - \mathrm{Var}\big(\tilde{g} + \tilde{t}_j \mid \tilde{g} + \tilde{t}_i\big) = (\Sigma_g + \Sigma_t) - \left[\Sigma_g + \Sigma_t - \frac{(\Sigma_g + \rho\Sigma_t)^2}{\Sigma_g + \Sigma_t}\right] = \frac{(\Sigma_g + \rho\Sigma_t)^2}{\Sigma_g + \Sigma_t},$$

where we use the projection theorem to calculate the expression in square brackets. If $\tilde{s}_j$ is pure noise, then individual j does not experience a reduction in variance. Since a fraction $\bar{e}_\mu$ of the skilled individuals learn their type, the unconditional reduction in variance experienced by individual j from learning individual i's information is $\frac{(\Sigma_g + \rho\Sigma_t)^2}{\Sigma_g + \Sigma_t}\bar{e}_\mu$, which can be rewritten as $\big[\Gamma + \rho(1-\Gamma)\big]^2 \Sigma_\tau \bar{e}_\mu$ using the fact that $\Sigma_g = \Gamma\Sigma_\tau$ and $\Sigma_t = (1 - \Gamma)\Sigma_\tau$. Since this quantity represents the increase in expected utility enjoyed by individual j as a result of knowing $\tilde{s}_j$, this is the maximum price that he is willing to pay for it. The case in which the social planner makes a default option available is similarly derived. ■

Proof of Proposition 6

Let $\tilde{\pi}_i$ denote the profits that a skilled individual $i \in I_\mu$ generates from selling information to unskilled individuals. With an information price $p = \theta\nu_0$, the $1 - \mu$ unskilled individuals will pay a total sum of $(1 - \mu)p = (1 - \mu)\theta\nu_0$ to acquire signals from the μ skilled individuals. Since these skilled individuals are randomly selected, the expected profits from information sales of any one skilled individual i are

$$\mathrm{E}\big[\tilde{\pi}_i\big] = \frac{(1 - \mu)\theta\nu_0}{\mu}.$$

Thus, using the same notation and reasoning as in Lemma 2, this skilled individual i must choose e_i in order to maximize

$$\mathrm{E}\Big[\tilde{U}_i(x_i) - C(e_i) + \tilde{\pi}_i\Big] = -(1 - e_i)(\Sigma_g + \Sigma_t) - \frac{c}{2}e_i^2 + \frac{(1 - \mu)\theta\nu_0}{\mu}.$$

Because the last term in this expression is not affected by this individual's choice of e_i, the first-order and second-order conditions for this maximization problem are identical to those in the proof of Proposition 1, and so lead to $e_i = \frac{\Sigma_g + \Sigma_t}{c}$. After purchasing $\tilde{s}_j$ from a skilled individual, unskilled individual j must choose x_j in order to maximize $\mathrm{E}\big[-(\tilde{g} + \tilde{t}_j - x_j)^2 \mid \tilde{s}_j\big]$. By Lemma 1, this individual chooses

$$x_j = \mathrm{E}\big[\tilde{g} + \tilde{t}_j \mid \tilde{s}_j\big] = \bar{e}_\mu \mathrm{E}\big[\tilde{g} + \tilde{t}_j \mid \tilde{s}_j = \tilde{g} + \tilde{t}_i\big] + (1 - \bar{e}_\mu)\underbrace{\mathrm{E}\big[\tilde{g} + \tilde{t}_j\big]}_{=0} = \bar{e}_\mu \frac{\Sigma_g + \rho\Sigma_t}{\Sigma_g + \Sigma_t}\tilde{s}_j,$$

28

where the last equality is obtained using the projection theorem. Using the fact that $\Sigma_g = \Gamma\Sigma_\tau$ and $\Sigma_t = (1 - \Gamma)\Sigma_\tau$, we can rewrite this last expression as $x_j = [\Gamma + \rho(1 - \Gamma)]\bar{e}_\mu\tilde{s}_j$. ∎

Proof of Proposition 7

Let $\tilde{\pi}_i$ denote the profits that a skilled individual $i \in I_\mu$ generates from selling information to unskilled individuals. With an information price $p = \theta\nu_1$, the $1 - \mu$ unskilled individuals will pay a total sum of $(1 - \mu)p = (1 - \mu)\theta\nu_1$ to acquire signals from the μ skilled individuals. Since these skilled individuals are randomly selected, the expected profits from information sales of any one skilled individual i are

$$\mathrm{E}\big[\tilde{\pi}_i\big] = \frac{(1 - \mu)\theta\nu_1}{\mu}.$$

Thus, using the same notation and reasoning as in Lemma 2, this skilled individual i must choose e_i in order to maximize

$$\mathrm{E}\Big[\tilde{U}_i(x_i) - C(e_i) + \tilde{\pi}_i \,\big|\, \tilde{g}\Big] = -(1 - e_i)\Sigma_t - \frac{c}{2}e_i^2 + \frac{(1 - \mu)\theta\nu_1}{\mu}.$$

Because the last term in this expression is not affected by this individual's choice of e_i, the first-order and second-order conditions for this maximization problem are identical to those in the proof of Proposition 1, and so lead to $e_i = \frac{\Sigma_t}{c}$. After purchasing $\tilde{s}_j$ from a skilled individual, unskilled individual j must choose x_j in order to maximize $\mathrm{E}\big[-(\tilde{g} + \tilde{t}_j - x_j)^2 \,|\, \tilde{g}, \tilde{s}_j\big]$. By Lemma 1, this individual chooses

$$x_j = \mathrm{E}\big[\tilde{g} + \tilde{t}_j \,|\, \tilde{g}, \tilde{s}_j\big] = \tilde{g} + \bar{e}_\mu\mathrm{E}\big[\tilde{t}_j \,|\, \tilde{g}, \tilde{s}_j = \tilde{g} + \tilde{t}_i\big] + (1 - \bar{e}_\mu)\underbrace{\mathrm{E}\big[\tilde{t}_j \,|\, \tilde{g}\big]}_{=0} = \tilde{g} + \bar{e}_\mu\rho(\tilde{s}_j - \tilde{g}),$$

where the last equality is obtained using the projection theorem. ∎

Proof of Lemma 4

Suppose first that there is no default option. From the proof of Proposition 6, we know that the welfare of any one skilled individual $i \in I_\mu$ is given by

$$W_i^{\mathrm{N}} = -(1 - e_i)(\Sigma_g + \Sigma_t) - \frac{c}{2}e_i^2 + \frac{(1 - \mu)p}{\mu}.$$

The welfare of any one unskilled individual $i \in I \setminus I_\mu$ is given by

$$W_i^{\mathrm{N}} = -(\Sigma_g + \Sigma_t) + \nu_0 - p,$$

and so total welfare is

$$W^{\mathrm{N}} \equiv \int_I W_i^{\mathrm{N}} d\gamma = \int_{I_\mu}\Big[-(1-e_i)(\Sigma_g + \Sigma_t) - \frac{c}{2}e_i^2\Big]d\gamma + \int_{I\backslash I_\mu}\Big[-(\Sigma_g + \Sigma_t) + \nu_0\Big]d\gamma$$

$$= -(\Sigma_g + \Sigma_t) + \int_{I_\mu}\Big[e_i(\Sigma_g + \Sigma_t) - \frac{c}{2}e_i^2\Big]d\gamma + (1-\mu)\nu_0.$$

In equilibrium, we know from Proposition 6 that $e_i = \bar{e}_\mu = \frac{\Sigma_g + \Sigma_t}{c}$, $p = \theta\nu_0$, and $\nu_0 = \frac{(\Sigma_g + \rho\Sigma_t)^2}{\Sigma_g + \Sigma_t}\bar{e}_\mu$. After using these expressions in the total welfare function above, we get

$$W^{\mathrm{N}} = -(\Sigma_g + \Sigma_t) + \mu\Big[\bar{e}_\mu(\Sigma_g + \Sigma_t) - \frac{c}{2}\bar{e}_\mu^2\Big] + (1-\mu)\frac{(\Sigma_g + \rho\Sigma_t)^2}{\Sigma_g + \Sigma_t}\bar{e}_\mu,$$

which simplifies to (24). The calculations are similar with the default option. ∎

Proof of Proposition 8

A simple comparison of (24) and (25) yields the second inequality in (28). The first inequality in (28) comes from Assumption 1. The region is non-empty if and only if

$$\Sigma_g + \Sigma_t < \Big(1 - \frac{\mu}{2}\Big)\Sigma_g + \big[\mu + 2(1-\mu)\rho\big]\Sigma_t,$$

which simplifies to the condition in (29). ∎

Proof of Lemma 5

Suppose that there is an equilibrium in which every low-cost (high-cost) type i follows the following mixed strategy: change x_i with probability $\theta_0 \in [0,1]$ ($\theta_k \in [0,1]$), and stick with the default option $x_i = \tilde{g}$ with probability $1 - \theta_0$ ($1 - \theta_k$). In what follows, we show that the only possible equilibrium values for θ_0 and θ_k are zero.

Individuals choose $x_i = \tilde{\tau}_i$ when they learn their type and, given that $\tilde{g}$ becomes known through the provider's default option, they choose $x_i = \tilde{g}$ when they do not. Since the fixed cost of making active decisions does not affect the optimal choice of effort, everyone chooses their effort level as in Proposition 1: $e_i = \frac{\Sigma_t}{c}$. Thus, under the conjectured equilibrium, we have

$$\bar{e} = \big[\phi\theta_0 + (1-\phi)\theta_k\big]\frac{\Sigma_t}{c}.$$

Let us start with the perspective of a high-cost individual. His (biased) expected utility from gathering information about τ_i is

$$\hat{W}_k^{\mathrm{I}} = -(1 - e_i - \alpha\bar{e})\Sigma_t - \frac{c}{2}e_i^2 - (k+b) = -\Sigma_t + \Big\{1 + 2\alpha\big[\phi\theta_0 + (1-\phi)\theta_k\big]\Big\}\frac{\Sigma_t^2}{2c} - (k+b).$$

30

If instead this individual sticks with the default option, his expected utility is $W_k^{\mathrm{CD}} = -\Sigma_t$. Thus individual i strictly prefers to go with the default option if $k + b > \left\{ 1 + 2\alpha\left[\phi\theta_0 + (1-\phi)\theta_k\right] \right\}\frac{\Sigma_t^2}{2c}$, which is clearly the case since

$$k + b > k > \frac{(1+2\alpha)(\Sigma_g + \Sigma_t)^2}{2c} > \frac{(1+2\alpha)\Sigma_t^2}{2c} > \left\{ 1 + 2\alpha\left[\phi\theta_0 + (1-\phi)\theta_k\right]\right\}\frac{\Sigma_t^2}{2c}.$$

This implies that $\theta_k = 0$, and that $\bar{e} = \phi\theta_0\frac{\Sigma_t}{c}$. Let us now analyze the problem of a low-cost individual. His (biased) expected utility from gathering information about τ_i is

$$\hat{W}_0^{\mathrm{I}} = -(1 - e_i - \alpha\bar{e})\Sigma_t - \frac{c}{2}e_i^2 - b = -\Sigma_t + (1 + 2\alpha\phi\theta_0)\frac{\Sigma_t^2}{2c} - b.$$

If instead this individual sticks with the default option, his expected utility is $W_0^{\mathrm{CD}} = -\Sigma_t$. Thus individual i strictly prefers to go with the default option if $b > \frac{(1+2\alpha\phi\theta_0)\Sigma_t^2}{2c}$, which is clearly the case since

$$b > \frac{(1 + 2\alpha\phi)\Sigma_t^2}{2c} > \frac{(1 + 2\alpha\phi\theta_0)\Sigma_t^2}{2c}.$$

Thus we have $\theta_0 = 0$. Total welfare is then $W^{\mathrm{CD}} = \phi W_0^{\mathrm{CD}} + (1-\phi)W_k^{\mathrm{CD}} = -\Sigma_t$. This completes the proof. ∎

Proof of Proposition 9

A simple comparison of (31) and (32) yields the second inequality in (33). The first inequality in (33) comes from Assumption 1. The region is non-empty if and only if

$$2(\Sigma_g + \Sigma_t) < \frac{(\Sigma_g + \Sigma_t)^2(1 + 2\alpha)}{2\left[\Sigma_g + (1-\phi)k\right]},$$

which simplifies to the condition in (34). ∎

Proof of Lemma 6

When the default option offered by the social planner is offset by $\gamma > 0$, the expected utility of any individual who chooses to stick to this default option is

$$W_\kappa^{\mathrm{OD}} = \mathrm{E}\left[\tilde{U}_i(\tilde{g} - \gamma)\right] = \mathrm{E}\left[-(\tilde{\tau}_i - \tilde{g} + \gamma)^2\right] = \mathrm{E}\left[-(\tilde{t}_i + \gamma)^2\right] = -\Sigma_t - \gamma^2,$$

where $\kappa \in \{0, k\}$ denotes low-cost and high-cost types. Since this quantity is decreasing in γ, it is never optimal for the social planner to increase γ when the increase does not affect any individual's decision to acquire information about their type. This implies that the only positive value of γ that potentially increases welfare is the lowest possible γ that makes low-cost individuals switch from using the default option to gathering information about their type and choosing their own x_i.

Suppose that the equilibrium is for low-cost individuals to gather information about their type. As in Lemma 5, they choose $x_i = \tilde{\tau}_i$ when they learn their type and $x_i = \tilde{g}$ when they do not, and they choose $e_i = \frac{\Sigma_t}{c}$. Thus, under the conjectured equilibrium, we have $\bar{e} = \phi \frac{\Sigma_t}{c}$. In this equilibrium, the low-cost individuals' perceived expected utility is given by

$$\hat{W}_0^{\mathrm{I}} = -(1 - e_i - \alpha \bar{e})\Sigma_t - \frac{c}{2}e_i^2 - b = -\Sigma_t + (1 + 2\alpha\phi)\frac{\Sigma_t^2}{2c} - b.$$

Thus, the social planner can motivate low-cost individuals to gather information by setting γ to a value that makes $\hat{W}_0^{\mathrm{I}}$ equal to W_0^{OD}. This is the value given by (35). The low-cost individuals' utility is $\hat{W}_0^{\mathrm{I}}$ with $b = 0$, that is,

$$W_0^{\mathrm{I}} = -\Sigma_t + (1 + 2\alpha\phi)\frac{\Sigma_t^2}{2c}.$$

Total welfare is then $W^{\mathrm{OD}} = \phi W_0^{\mathrm{I}} + (1 - \phi)W_k^{\mathrm{OD}}$ which, after replacing γ by its expression in (35), simplifies to (36). ∎

Proof of Proposition 10

A simple comparison of (31) and (36) yields the second inequality in (37). The first inequality in (37) comes from Assumption 1. The region is non-empty if and only if

$$2(\Sigma_g + \Sigma_t) < \frac{(\Sigma_g + \Sigma_t)^2 (1 + 2\alpha) - \Sigma_t^2(1 + 2\alpha\phi)}{2[\Sigma_g + (1 - \phi)(k - b)]},$$

which simplifies to the region described by (38) and (39). ∎

Proof of Proposition 11

When the social planner sets the default option at $x_i = \tilde{g}$, every individual i's effort is $e_i = \frac{\Sigma_t - \beta\Sigma_\tau}{c}$, and so $\bar{e} = \frac{\Sigma_t - \beta\Sigma_\tau}{c}$. As such, total welfare is given by

$$W^{\mathrm{D}} = -(1 - e_i - \alpha\bar{e})\Sigma_t - \frac{c}{2}e_i^2 = -\Sigma_t + (1 + \alpha)\frac{(\Sigma_t - \beta\Sigma_\tau)\Sigma_t}{c} - \frac{c}{2}\left(\frac{\Sigma_t - \beta\Sigma_\tau}{c}\right)^2,$$

which simplifies to (41).

A simple comparison of (40) and (41) yields the second inequality in (42). The first inequality in (42) comes from Assumption 1. The region is non-empty if and only if

$$2(\Sigma_g + \Sigma_t) < \frac{(1 + 2\alpha)\Sigma_g(\Sigma_g + 2\Sigma_t)}{2c} + \frac{\beta\Sigma_\tau(2\alpha\Sigma_t + \beta\Sigma_\tau)}{2c},$$

which simplifies to the region described by (43). ∎

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