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Are Donors Afraid of Charities' Core Costs? Scale Economies in Non-profit Provision and Charity Selection*

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ABSTRACT

We study contestability in non-profit markets where non-commercial providers supply a homogeneous collective good or service through increasing-returns-to-scale technologies. Unlike in the case of for-profit markets, in the non-profit case the absence of price-based sales contracts between providers and donors means that fixed costs are directly relevant to donors, and that they can translate into an entry barrier, protecting the position of an inefficient incumbent; or that, conversely, they can make it possible for inefficient newcomers to contest the position of a more efficient incumbent. Evidence from laboratory experiments show that fixed cost driven trade-offs between payoff dominance and perceived risk can lead to inefficient selection.

KEY WORDS: Not-for-profit Organizations, Entry, Core Funding

JEL CLASSIFICATION: L1, L3

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Abstract

We study contestability in non-profit markets where non-commercial providers supply a homogeneous collective good or service through increasing-returns-to-scale technologies. Unlike in the case of for-profit markets, in the non-profit case the absence of price-based sales contracts between providers and donors means that fixed costs are directly relevant to donors, and that they can translate into an entry barrier, protecting the position of an inefficient incumbent; or that, conversely, they can make it possible for inefficient newcomers to contest the position of a more efficient incumbent. Evidence from laboratory experiments show that fixed cost driven trade-offs between payoff dominance and perceived risk can lead to inefficient selection.

As first pointed out by Baumol and Willig (1981), the presence of fixed, non-sunk costs need not impede entry and efficient selection of for-profit producers. By analogy, one might conjecture that the same conclusion should apply to non-profit firms: provided that donors are fully informed about charities' performance, unfettered competition between charities will enable those charities that deliver the highest value for donors to attract the most funding, making them best positioned to meet their fixed costs; less efficient charities that cannot cover their fixed costs will then be (efficiently) selected out.

In this paper, we show that this analogy does not apply: unlike in the case of for-profit firms, the presence of fixed costs can impede competition between non-commercial, non-profit providers, and can give rise to inefficient selection. In the for-profit case, adopting high fixed cost technologies can potentially give rise to losses for for-profit providers if demand falls short of the scale of production that warrants incurring those fixed costs; but, by relying on price-based sale contracts and thus acting as residual claimants for any surplus or shortfall resulting from the adoption of any given technology, competing for-profit providers can make uncoordinated deviations to lower cost providers worthwhile for individual consumers and thus ensure efficient coordination and efficient selection even when there are fixed, non-sunk costs. In contrast, in the non-profit case the absence of price-based sale contracts between providers and donors means that deviations by individual donors can result in output loss unless the switch is coordinated across donors. As a result, non-cooperative contributions equilibria – as characterized by Bergstrom, Blume and Varian (1986) – can result in inefficient selection.[1]

The fact that, absent a price mechanism, efficient charity selection involves a donor coordination problem means that the models that are routinely deployed to study competition and entry in the for-profit sector – typically variants of Chamberlin's (1933) monopolistic competition model – cannot be mechanically adapted to characterize non-profit competition simply by positing that non-profit organization pursue objectives other than profit maximization; and it means that studying inter-charity competition in the presence of scale economies involves similar questions and arguments to those that have been examined in the literature on coordination games – questions and arguments that are of little relevance when looking at competition between for-profit providers. What is unique to the donor coordination problem, in comparison to other kinds of coordination problems, however, is that its structure can be mapped from technological conditions; and that, additionally, it can shape prior entry and exit decisions by providers.

Borrowing constructs from the experimental literature on coordination games, we characterize contribution choices and selection outcomes in situations where there are multiple providers with different cost characteristics and where donor coordination on a provider is (or is perceived to be) noisy – for example, because donors view other donors' actions as boundedly-rational. We show that failure by donors to select the most efficient provider directly relates to a comparison between fixed costs of different providers; specifically, donor coordination on charities that adopt comparatively more efficient technologies with comparatively higher fixed costs may be successfully undermined by the availability of less efficient charities facing lower fixed costs. This weakens the ability of more efficient, higher fixed cost providers to successfully compete against lower fixed cost providers, and can thus translate into an inefficient barrier to entry that protects the position of less efficient incumbents against challenges by more efficient challengers; or into an inefficient "entry breach" that allows less efficient challengers to successfully contest the position of a more efficient incumbent. Although these conclusions follow quite naturally from the structure of the interaction between donors who face competing charities, they have not been identified before in the literature.

We then design and conduct a series of laboratory experiments in order to explore the

[1]The fact that non-profit providers do not use price-based contracts can in turn be rationalized in terms of the statutory non-distribution constraint that non-profit providers face. This constraint means that any surplus or shortfall experienced by a non-profit provider must be reflected in its (long-run) level of provision rather than in its residual profit claims – non-profits may incur a surplus or a loss in a given period, but costs and revenues must balance out in the long-run. Non-commercial charities cannot therefore commit to supply goods or services for a given price, if doing so could result a loss out of equilibrium; accordingly, they cannot price their provision, but instead receive donations that they must convert into output.

efficiency/fixed-cost trade-offs described above. Our theoretical results are confirmed experimentally: fixed cost driven trade-offs generate significant coordination failures, and such failures are anticipated by competitors, affecting entry choices.

Our conclusions and experimental findings are reflected in the prominence given by charities to core funding strategies. There is indeed ample anecdotal evidence suggesting that scale economies/fixed costs present special challenges to the not-for profit sector. Charities often lament that donors are typically unwilling to fund core costs[2] – making it difficult for newcomer charities to get off the ground and for more established incumbent charities to cover management and general administration costs – and consistently lobby government to step in with grants to cover their fixed operating costs.[3] The arguments we develop set out a pro-competitive based rationale for why government funding of fixed costs may be called for in the case of non-commercial, non-profit providers, and suggests that this correlation and these arrangements may reflect an acknowledgement of the way that scale economies in provision can adversely affect entry and technology adoption incentives in the non-profit sector.

Our paper contributes to the debate on conduct and performance in the non-profit sector vis-à-vis the for-profit sector. This has focused mainly on the implications of organizational form for internal performance along various dimensions – information and agency costs (Alchian and Demsetz, 1972; Hansmann, 1980; Easley and O'Hara, 1983; Glaeser and Schleifer, 2001; Brown and Slivinski, 2006), differential regulatory and tax regimes (Lakdawalla and Philipson, 2006), access to pro-socially motivated workforce (Ghatak and Mueller, 2009); the implications of organizational form for inter-charity competition and industry structure have received less attention.[4] It also contributes to the experimental

[2] As Rosemary McCarney, CEO of Plan Canada, put it, "There's an idea out there that a charity is good if it only spends 20% on administration and fundraising and 80% on program costs, and if you're out of that approximate range, somehow you're bad or inefficient." Often the ratio of variable to fixed costs is taken as an indicator of provision efficiency (see, for example, the charity rating system adopted by MoneySense, a not-for-profit Canadian consumer advocacy organization).

[3] The difficulties that charities face in persuading donors (especially small ones) to make donations that are not earmarked towards project costs and can be used to fund core costs leads charities to formulate specific core funding strategies. See, for example, Scott (2003) and Institute for Philanthropy (2009).

[4] A recent exception is Philipson and Posner (2009), who study – as we do here – competition between providers that pursue non-profit objectives. Their focus, however, is different from ours, as they consider markets that are not contestable, i.e. where there are barriers to entry, concluding that, as in the case of for-profit firms, antitrust regulation may be called for. Their arguments hinge on the incentives that non-profit firms have to defend their incumbency position even when it is not socially efficient to do so. In contrast, the sources of inefficiency we identify here stem from the relationship between private donors' decisions on the one hand and entry and technology adoption decisions on the other in the presence of fixed costs. While antitrust measures are not well suited to tackle the kinds of failure we identify here, public support of core funding needs may be able to alleviate it.

literature on voluntary giving – although our experiments do not involve a public good game, deliberately focusing instead on the coordination of given donations to alternative fixed-cost providers. In that stream of literature, research primarily concentrates on public good games (e.g., Isaac *et al.*, 1984), on group goals and social motives in individual decision making (e.g., Krantz and Kunreuther, 2007) or on group membership and identity (Charness *et al.*, 2007; Chen and Li, 2009); but the question of how donors select a public good provider under conditions of competition has so far remained unexplored.

The remainder of the paper is structured as follows. Section 1 describes the donor coordination problem in the presence of fixed costs and formalizes the ideas of "fixed-cost bias" and "incumbency bias" in the context of a behavioural model of donor choice. Section 2 discusses implications for selection and entry. Section 3 presents experimental evidence, also deriving structural estimates of parameters for the behavioural model. Section 4 concludes and discusses extensions.

1 Uncoordinated contributions to increasing-returns, non-profit providers

Consider N donors with exogenous income y. Each donor contributes one dollar towards the provision of a homogeneous collective good. The technology for producing the collective good is such that one dollar can be transformed into one unit of the public good.

The collective good is provided by two non-commercial, not-for-profit suppliers, $j \in \{1, 2\}$. Both face a non-distribution constraint, i.e. their profits must be zero.[5] This constraint can be viewed as an endogenous response to the presence of output verification constraints – an idea that has been discussed extensively in the literature going back to Hansmann (1980). That is, if service delivery is not verifiable in contractual arrangements, providers facing a zero profit constraint would outperform for profit providers, and consequently the non-profit organizational form would be selected.[6]

[5] In a dynamic framework short-run profits can be positive or negative even when a non-distribution constraint is present, but profits must be zero in the long run. However, in our static framework, a non-distribution constraint translates directly into a zero-profit constraint.

[6] With collective consumption, overall output may be difficult to verify even when deliveries to individual purchasers are fully verifiable. This makes the verification problem comparatively more likely to occur in the case of collective goods, as the following example illustrates. Suppose that two individuals each contribute an overall amount v towards provision of a purely collective service with marginal cost $c = 1$; even if each contributor is able to verify that an amount v is provided as a direct consequence of her own individual contribution, she may be unable to verify that an additional amount v is also provided as a result of the other individual's contribution. In this case, the provider may be able to supply a total amount v (rather than an amount $2v$) and still satisfy its contractual obligations with each of the two contributors.

The production of the collective good occurs through increasing returns technologies that involve a marginal cost c_j, and a fixed, non-sunk cost F_j, $j \in \{1,2\} \equiv J$. In the remainder of our discussion, we shall assume $F_j \in [1, N-1]$, i.e. that donations by a single donor are not sufficient to cover fixed costs, but that donations by $N-1$ donors always are. The provider with the more efficient technology – the *low-cost charity* – will thus be the one that delivers the higher level of output (at the lower average cost) when all contributions are directed towards it, i.e.

$$\arg\max_{j \in J} \ \frac{N - F_j}{c_j}. \tag{1}$$

The low-cost charity may well be the one with the higher fixed costs, as exploiting scale economies typically requires incurring larger fixed costs in order to reduce variable costs.

Absent pricing decisions, charities are passive recipients of donations, i.e. there is no choice they have to make (we will later touch on providers' entry and technology adoption decisions that may precede the contribution game we are studying here). In this framework, where donation levels are exogenously given, the component of the donors' payoff that is relevant to the problem coincides with the level of total provision, and the only choice donors have to make is which charity to give their dollar to.

1.1 Non-cooperative contribution equilibria

As donation decisions are taken independently by individuals, the relevant equilibrium concept is that of a non-cooperative (Nash) equilibrium. The presence of fixed costs translates into the possibility of multiple non-cooperative equilibria:

Proposition 1 *When two non-commercial charities providing collective goods face identical fixed costs that are not sunk and entry and exit are costless, all provision will be carried out by a single provider, which can be either the high-cost provider or the low-cost provider, and the low-cost equilibrium will payoff dominate the high-cost equilibrium.*

PROOF: If $N_1 < N$ donors give to charity 1 and $N_2 = N - N_1 < N$ give to charity 2, total provision will be $\max\{(N_1 - F_1)/c_1, 0\} + \max\{(N_2 - F_2)/c_2, 0\}$.[7] An outcome with N_1 strictly between 0 and N cannot be an equilibrium: if $0 < N_1 < F_1$, then any donor giving to charity 1 could bring about an increase in output (and thus in her payoff) by redirecting her donation to charity 2; analogously,

[7] We therefore assume that provision cannot become negative – or equivalently, that if the difference between donations received and f is negative, this difference can be funded in some way (privately or by the government). An alternative assumption that leads to the same conclusion is that whenever a charity receives donations that fall short of f, it does not directly engage in provision and instead diverts the donations it receives towards another charity.

if $0 < N - N_1 < F_2$, i.e. $N_1 > N - F_2$, any donor giving to charity 2 could bring about an increase in output by redirecting her donation to charity 1; if $F_1 \leq N_1 \leq N - F_2$, then if $c_1 < c_2$ a donor giving to charity 2 could raise output by switching to charity 1, and, vice-versa, if $c_2 < c_1$ a donor giving to charity 1 could raise output by switching to charity 2. So, the only possible pure-strategy (Nash) equilibria are $N_1 = 0$ and $N_1 = N$. There always also exists a "knife-edge" mixed-strategy equilibrium where players mix between the two charities. This equilibrium, however, is dominated by either of the pure-strategy equilibria, and can be ruled out by standard refinements – such as trembling-hand perfection (Selten, 1975) or evolutionary stability (Smith and Price, 1973). $\square$

It is useful to contrast this result with the conclusion that applies to an analogous commercial, for-profit scenario. Consider the following sequence of moves: (i) firms 1 and 2 simultaneously select prices p_1 and p_2; (ii) consumers select a supplier. In the second stage consumers will select the supplier that charges the lower price, and so profits for firm j will be equal to $N(p_j - c_j)(1/p_j) - f = N(1 - c_j/p_j) - f$ if $p_j < p_{-j}$, to $(N/2)(p_j - c_j)(1/p_j) - F_j$ if $p_j = p_{-j}$ (assuming an equal split of the market for equal prices), and to zero if $p_j > p_{-j}$. The best response for firm j is then to strictly undercut its rival as long as doing so results in a non-negative profit. Then, supposing 1 is the low-cost firm, a non-cooperative equilibrium will involve the high-cost firm, 2, selecting $p_2 = Nc_2/(N - F_2)$ and the low-cost firm, 1, selecting a price p_1 that is only marginally less than p_2; this will result in zero profits for the high-cost firm and a positive level of profits for the low-cost firm; in this outcome, neither firm 1 nor firm 2 will be able to obtain a higher profit by unilaterally increasing or decreasing the price it charges, and so all production will be carried out by the lower-cost producer.

The difference between the non-commercial, not-for-profit case and the commercial, for-profit case is that coordination between donors towards efficient charities is more difficult to achieve than coordination of consumers towards efficient firms, because in the case of for-profit firms consumers can be "herded" effectively through price competition – firm 2 can undercut firm 1 and induce all consumers to switch. Firm 2 can do this credibly as consumers need not concern themselves about whether the firm will succeed in meeting its objectives; i.e. if firm 2 were not to succeed in attracting buyers, it would make a loss but the price a consumer has paid for its services would not be revisited. This is not the case for non-commercial charities: charity 2 is unable to make a corresponding binding offer to all donors that it will provide more for each dollar received than charity 1 does. This is because charity 2 is a not-for-profit entity with no residual claimants, and thus devotes all of its resources to provision. Accordingly, a failure to successfully contest the position of charity 1 will be reflected in its level of provision rather than its profits. Thus, donors would only switch to charity 2 if they believed that other donors would also choose charity

2 – and, as a consequence, no donor will switch.[8]

The above analysis only tells us that multiple Pareto rankable equilibria are possible, but it does not tell us which one is more likely to prevail. While Pareto dominance may be an appealing theoretical criterion for equilibrium selection, it has little behavioural content – even though it might play a role in how people behave. If we want to model and study how donors choose between different increasing returns providers, we need to look elsewhere.

In what follows, we will develop arguments and predictions concerning competition and entry focusing on two effects, which we term "incumbency bias" and "low-fixed cost bias". The first refers to the simple idea that donors may view coordination on the incumbent as focal, giving the incumbent an advantage. The second relates to the fact that, with higher fixed costs, coordination mistakes on the part of donors – as we define them more precisely below – are more likely to lead to provision failure. We elaborate on these concepts below.

1.2 Noisy play and incumbency

As noted above, the Nash equilibrium concept is predictively weak when applied to the question of which charity will be selected in the problem we are studying – there can be multiple equilibria, and the Nash equilibrium concept on its own does not point to one over the other. On the other hand, by deploying constructs and ideas from the experimental literature on coordination games to characterize behaviour, we can give substance to the ideas of incumbency bias and low-fixed cost bias.

Starting from the latter, if donors conjecture that the actions of other donors might be either based on uninformed beliefs – meaning that some donors might not best respond to the actions of other more informed donors and may thus fail to coordinate to a given equilibrium – or be noisy, i.e. actions might result from choices that systematically depart from optimizing choices, then higher fixed costs make coordination on the more efficient, higher-fixed cost provider more "risky".

To model this idea it is useful to focus first on a framework where optimizing donors conjecture that other donors' actions may be noisy, or, equivalently, that other donors might fail to optimize themselves. In formal terms, consider a scenario where each player can be one of two types, fully rational (R), or fully irrational (C), with the latter choosing one charity at random, i.e. each with a probability $1/2$; and suppose that a donor's type is

[8] Ghatak and Mueller (2009) show how a for-profit manager, acting as residual claimant, may be comparatively better positioned to engage pro-socially motivated workers in incentive contracts. This somewhat parallels the conclusion here that, in the presence of fixed costs, the residual-claimant position of for-profit start-ups can make it comparatively easier for them to divert revenues away from incumbents.

private information. If the N donors are drawn at random from a large population where a fraction ζ of donors are of type C (and a fraction $1-\zeta$ are of type R), with ζ being the common belief amongst all donors, the probability (as seen from another player) of an individual donor being of type R – and thus selecting a charity on the basis of a payoff-maximizing response to the choices of other players – is $1-\zeta$, while the probability of an individual donor being of type C – and thus randomizing between the two – is ζ.[9]

For the remainder of our analysis, we shall restrict attention to scenarios where charity 1 is both the low-cost and the high-fixed cost charity, and use replace the labels the labels 1 and 2 respectively with H and L. We also normalize parameters so that the full-coordination payoff for charity L – the low-fixed cost, inefficient provider – equals unity, while the full-coordination payoff for charity H – the higher-fixed cost, more efficient charity – equals $\delta > 1$. The fixed cost level of charity H is expressed as

$$F_H = F, \tag{2}$$

(dropping the subscript), and the fixed cost level of charity L as

$$F_L = \frac{F_H}{1+\phi}, \qquad \phi \geq 0. \tag{3}$$

Given this normalization, the remaining cost parameters can then be expressed as

$$c_H = \frac{N-F}{1+\delta}; \tag{4}$$

$$c_L = N - \frac{F}{1+\phi}. \tag{5}$$

Note that, under this normalization, a change in ϕ only affects the ratio of fixed costs, not the comparison of the full-coordination payoffs for the two options. We shall refer to δ as the *dominance premium* and to ϕ as the *fixed cost premium*.

Additionally, we shall restrict attention to scenarios where donations by a single individuals to a charity are incapable of induce positive provision by either charity, i.e., where both F_H and F_L are greater than unity; in turn, given our parameterization, and since $F_H = F \geq F_L = F/(1+\phi)$, this requires $F/(1+\phi) \geq 1$ and thus

$$F \geq 1+\phi. \tag{6}$$

[9]The resulting game is a game of incomplete information and the relevant equilibrium concept is Bayes-Nash equilibrium. However, we use this construct here to build intuition with respect to the dominance ranking, not as a way of characterizing equilibria. To the latter end, in Section 1.3 we shall invoke the concept of Quantile Response Equilibrium (QRE, McKelvey and Palfrey, 1995), which is a technically more suitable (if perhaps less intuitive) solution concept in this context. The above construct can also be viewed as a special case of a level-k reasoning framework, (Stahl and Wilson, 1994), where level-0 players randomize between the two charities and level-1 players best-respond to an assumed distribution of level-0 and level-1 players in proportions ζ and $1-\zeta$.

We can then characterize expected payoffs for individuals of type R if they all select charity H and if they all select charity L as follows. Consider first an outcome where all players of type R coordinate on charity H, i.e. they all choose to give all of their cash to H (with each player having one unit of cash). Then, the probability that a given donor actually chooses charity H is $(1-\zeta)+\zeta/2 = 1-\zeta/2 \equiv 1-\gamma$ (i.e. $\gamma = \zeta/2$), and the expected payoff for a risk-neutral representative donor of type R (choosing H), if risk-neutral, is

$$E\big[Q_H + Q_L \mid N_H = N,\, N_L = 0\big]$$
$$= \sum_{x=1}^{N} \binom{N-1}{x-1} \gamma^{N-x} (1-\gamma)^{x-1} \Big(Q_H(x) + Q_L(N-x)\Big) \equiv EQ_H, \tag{7}$$

where

$$Q_j(x) \equiv \max\Big\{\big(x - F_j\big)/c_j, 0\Big\}, \qquad j \in \{H, L\}, \tag{8}$$

and where $\binom{N-1}{x-1}$ is the binomial coefficient (the number of distinct combinations of $x-1$ element from a set of $N-1$ elements). Note that this is the same as the payoff obtained from a specification where individual donors conjecture that all players are best-responding to other players' choices but where the actions of each of them may be overturned by chance with probability $1-\gamma = \zeta/2$. Analogously, if all players of type R coordinate on charity L, the expected payoff for a representative donor of type R (also choosing L) is

$$E\big[Q_H + Q_L \mid N_H = 0,\, N_L = N\big]$$
$$= \sum_{x=1}^{N} \binom{N-1}{x-1} \gamma^{N-x} (1-\gamma)^{x-1} \Big(Q_H(N-x) + Q_L(x)\Big) \equiv EQ_L. \tag{9}$$

Donors' conjectures of noisy choices by other donors have implications for the dominance ranking of expected payoffs. Specifically, when pure-strategy coordination on charity H and pure-strategy coordination on charity L are both equilibria, and there are differences in fixed costs between the dominant and dominated option, noisy choices can affect the dominance ranking of equilibria in terms of their expected, full-coordination payoffs:

Proposition 2 *When the conjectured probability of mistakes, γ, is sufficiently small, an increase in γ lowers the ratio of the expected payoff for full-coordination on the dominant, high fixed cost option to the expected payoff for full-coordination on the dominated, low fixed cost option. For $\gamma > 0$, an increase in the fixed cost premium, ϕ, also lowers this ratio.*

PROOF: Let

$$\Psi(x,\gamma) \equiv \binom{N-1}{x-1} \gamma^{N-x} (1-\gamma)^{x-1}, \qquad \sum_{x=1}^{N} \Psi(x,\gamma) = 1. \tag{10}$$

The ratio EQ_H/EQ_L equals $1+\delta$ for $\gamma = 0$, and its derivative with respect to γ agrees with the sign of the difference

$$\frac{\partial EQ_H/\partial\gamma}{EQ_H} - \frac{\partial EQ_L/\partial\gamma}{EQ_L} \equiv \Omega. \tag{11}$$

The partial derivatives of $\Psi(x,\gamma)$ with respect to γ, when evaluated at $\gamma = 0$, equal $-(N-1)$ for $x = N$, $N-1$ for $x = N-1$, and zero for $x < N-1$. We can thus write,

$$\left|\Omega\right|_{\gamma=0} = -(N-1)\left(\frac{Q_H(N) - Q_H(N-1) - Q_L(1)}{EQ_H} - \frac{Q_L(N) - Q_L(N-1) - Q_H(1)}{EQ_L}\right). \tag{12}$$

For $N-1 \geq F \geq 1$, substituting the relevant expressions for $Q_H(.)$ and $Q_L(.)$, letting $EQ_H = 1+\delta$ and $EQ_L = 1$, and using (6), the above expression can be simplified to

$$\left|\Omega\right|_{\gamma=0} = -(N-1)\,\frac{\phi F/(1+\phi)}{(N-F)\big(N-F/(1+\phi)\big)} < 0. \tag{13}$$

Since $\Psi(x,\gamma)$ is continuous and repeatedly differentiable in γ for all x, by continuity there exists a right-hand neighbourhood $\{0,\gamma^*\}$ of $\gamma = 0$ where the ratio EQ_H/EQ_L is decreasing in γ. Moreover, since

$$\left|d\Omega/d\phi\right|_{\gamma=0} = -(N-1)\,\frac{F/(1+\phi)}{\big(N-F/(1+\phi)\big)^2} < 0, \tag{14}$$

by continuity, in a right-hand neighbourhood of $\gamma = 0$, the ratio EQ_H/EQ_L is decreasing in ϕ. $\square$

If choices are (conjectured to be) sufficiently noisy, the dominance ranking of equilibria in terms of their expected, full-coordination payoffs, can be overturned in favour of the lower-fixed cost option, as the following example shows. Payoff levels as a function of $x = N_H$ (the number of donors giving to charity H) are shown in Figure 1 for the case $N = 3$, $F = 2$, $\delta = 1/10$, $\phi = 1/3$, while Figure 2 shows how the ratio EQ_H/EQ_L changes with γ for the same parameterization. In this case, for $\gamma = 1/9$ the full-coordination payoff for the dominant option is approximately equal to 0.87, whereas the corresponding payoff for the dominated option is approximately $0.86 < 0.87$; for $\gamma = 1/5$ the ranking is reversed: 0.72 for the dominant option versus $0.75 > 0.72$ for the dominated option. The effects of an increase in ϕ on the dominance ranking is illustrated in Figure 2, with reference to the example introduced earlier. Raising ϕ – which, by construction, leaves full-coordination payoffs unchanged – lowers the ratio EQ_H/EQ_L for any $\gamma \in (0, 1/2]$, and can therefore overturn the ranking of expected payoffs. For example, for $\gamma = 1/9$, raising the fixed-cost premium to $\phi = 1$, makes the full-coordination payoff for the dominant option is approximately equal to 0.88, and that for the dominated option approximately equal to $0.89 > 0.88$.

These conclusions apply despite us having assumed that donors are risk-neutral. Risk aversion, if present, only works to strengthen the risk implications of fixed costs. In the

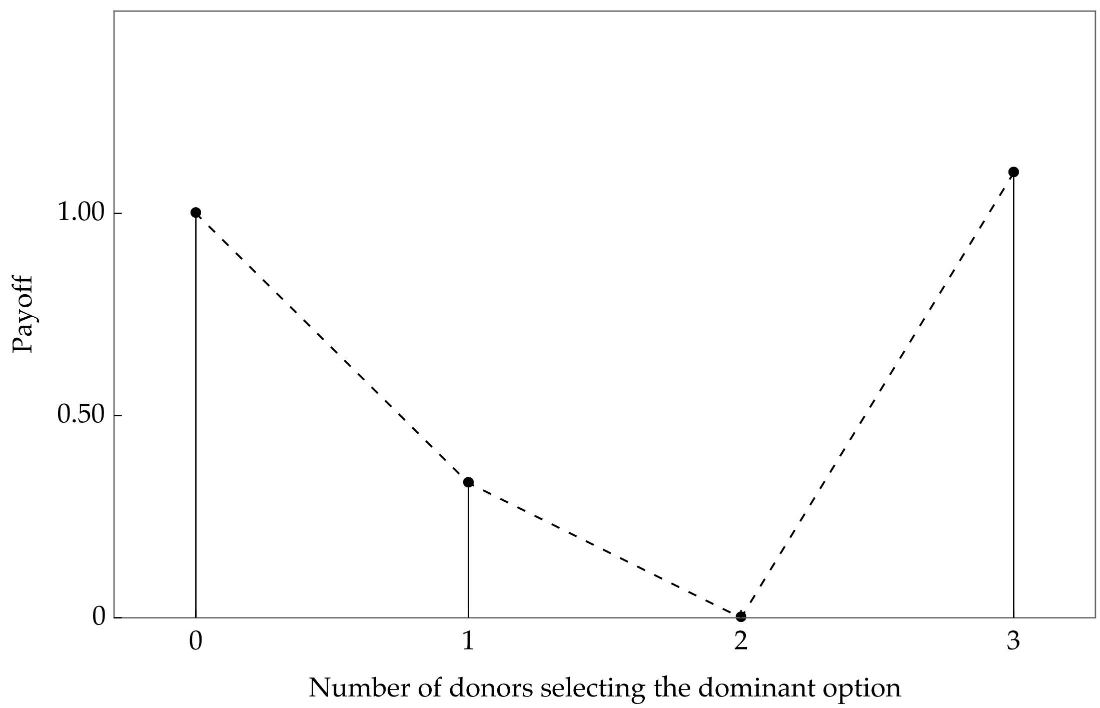

Figure 1: Payoffs as a function of number of donors selecting charity H
$\delta = 1/10,\ F = 2,\ \phi = 1/3$

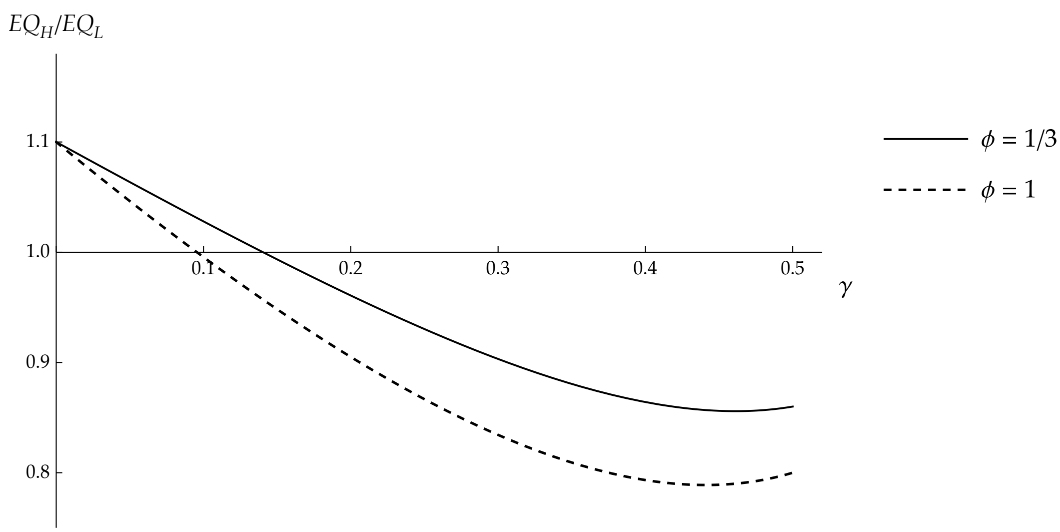

Figure 2: Ratio of expected payoffs under full coordination
$\delta = 1/10,\ F = 2$

above example, for $\gamma = 1/9$, the ratio EQ_H/EQ_L is greater than unity under risk neutrality; if, however, output, Q, in each realization is valued according to the Bernoulli utility function $u(Q) = \ln(1+Q)$, we obtain $E[u(Q)]_H = 0.6$ and $E[u(Q)]_L = 0.605 > 0.6$, i.e. a lower γ is sufficient to overturn dominance.

The idea behind the notion of incumbency bias is simple: in the presence of multiple equilibria, pre-existing coordination on any given choice makes that choice a natural choice (Samuelson and Zeckhauser, 1988). An incumbency bias/status quo bias effect such as this might thus provide protection to an incumbent charity against a challenger. The incumbent charity may be charity L (the high-cost, low-fixed cost charity) – in which case incumbency would work to protect L against a more efficient, dominant challenger, i.e. incumbency would offset dominance; or it may be H (the low-cost, high-fixed cost charity) – in which case incumbency would work to protect H against a less efficient, lower-fixed cost challenger, i.e. incumbency would offset the fixed cost-related risk advantage of charity L.

Incumbency bias can be formally incorporated into a framework with noisy actions as a systematic departure by players of type C from a fifty-fifty choice rule, i.e. by assuming that players of type C select the incumbent charity with probability $(1+\mu)/(2+\mu) > 1/2$ ($\mu > 0$) and the challenger with probability $1/(2+\mu)$. Thus if any given charity is the incumbent, and if players of type R coordinate on that charity, that charity will be selected by each of the other players with probability $(1-\zeta) + \zeta(1+\mu)/(2+\mu) = 1 - \zeta/(2+\mu) \equiv 1 - \gamma_I$; whereas if players of type R coordinate on the non-incumbent charity, it will be selected by each of the other players with probability $(1-\zeta) + \zeta/(2+\mu) = 1 - \zeta(1+\mu)/(2+\mu) \equiv 1 - \gamma_N$; and so $\gamma_N = \gamma(1+\mu)/(1+\mu/2) > \gamma > \gamma_I = \gamma/(1+\mu/2)$. In other words, incumbency introduces an asymmetry between L and H in the perceived probability of mistakes, which in turn alters the comparison of full-coordination expected payoffs in favour of the incumbent.

We can then derive the following result:

Proposition 3 *An increase in the incumbency bias (μ) alters the ratio of the expected payoff for full-coordination on the dominant option to the expected payoff for full-coordination on the dominated option in favour of the incumbent option.*

PROOF: Proceeding along analogous lines as in the proof of the previous proposition, we can establish that, in a neighbourhood of $\gamma = 0$, an increase in μ raises the ratio EQ_H/EQ_L if H is the incumbent and lowers it if L is the incumbent. $\square$

With reference to our earlier example, the effect of incumbency bias on the expected payoff ratio EQ_H/EQ_L for different values of γ is illustrated in Figure 3, for a scenario where the dominated option, L, is the incumbent option.

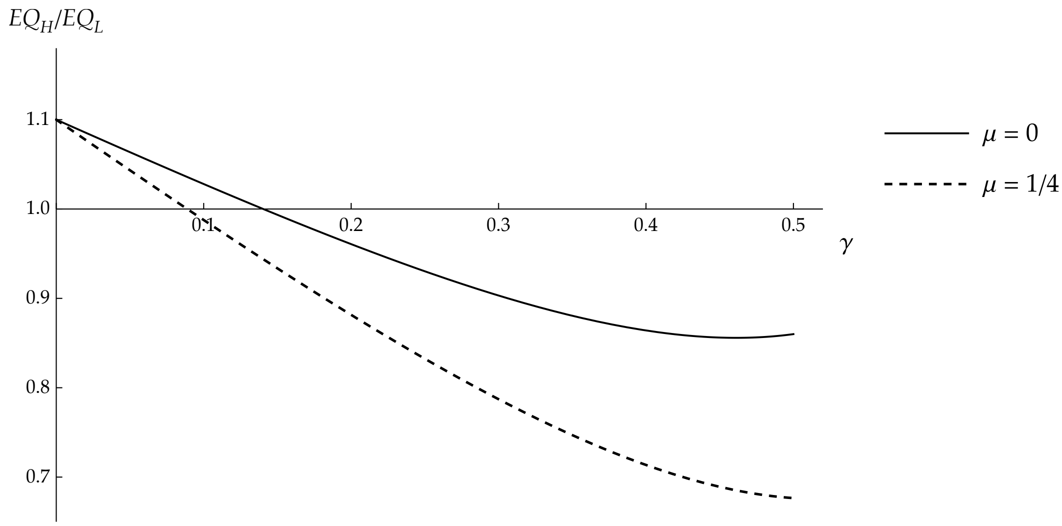

Figure 3: Ratio of expected payoffs under full coordination – incumbency effects
$\delta = 1/10$, $F = 2$, $\phi = 1/3$, charity L is the incumbent

1.3 Quantal response equilibrium

The above construct has allowed us to introduce the idea of noisy actions and to derive results about the "riskiness" of alternative choices in a simple and intuitive way. Whilst dominance is a theoretically appealing criterion for equilibrium selection, it cannot predict play, even if we cast it in terms of expected payoffs with noisy play. Whether or not players will respond to changes in expected payoff dominance in their actual play is ultimately an empirical question – a question which we explore in Section 3 using experimental methods. Nor does dominance translate into a formal characterization of equilibrium play – it just provides a ranking of alternative, pure-strategy equilibria from the point of view of fully-rational players based on the notion that some other players are fully irrational.

A popular way of modelling deliberate mixed-strategy equilibrium play – and thus rationalizing observed outcomes where different boundedly-rational players make different choices – is to posit that players adopt "approximate" best responses, specifically, that the actual best-response correspondence adopted by the players is a smoothed version of the theoretical, fully-rational best-response. By doing this, behavioural mistakes are incorporated and reflected in the mixed strategy choices of players, which, in a well-behaved mixed strategy equilibrium, arise endogenously as an approximate best response to the strategies of other players. This idea gives rise to the the concept of quantal response equilibrium (QRE, McKelvey and Palfrey, 1995), a construct that has been widely adopted in the applied literature as a way of rationalizing and interpreting experimental data.

If the smoothed best response is assumed equal to the best response based on perturbed payoffs according to a logit error structure, the fixed-point equilibrium condition for equilibrium mixed strategies in a symmetric Logit QRE (LQRE) equilibrium, with reference to the problem we are studying, is identified by

$$q^H = \frac{\exp\Big(\lambda E[Q \,|\, q_{-i} = q,\, q_i = 1]\Big)}{\exp\Big(\lambda E[Q \,|\, q_{-i} = q,\, q_i = 0]\Big) + \exp\Big(\lambda E[Q \,|\, q_{-i} = q,\, q_i = 1]\Big)}; \tag{15}$$

where q^H is the equilibrium probability of a player selecting charity H (with $1 - q^H$ being the equilibrium probability of a donor selecting charity L); and where

$$\begin{aligned} &E[Q \,|\, q^H_{-i} = q^H,\, q^H_i = 0] \\ &\qquad \equiv \sum_{x=1}^{N} \binom{N-1}{x-1} (q^H)^{x-1} (1-q^H)^{N-x} \Big(Q_H(x-1) + Q_L(N-x+1)\Big); \end{aligned} \tag{16}$$

$$\begin{aligned} &E[Q \,|\, q^H_{-i} = q^H,\, q^H_i = 1] \\ &\qquad \equiv \sum_{x=1}^{N} \binom{N-1}{x-1} (q^H)^{x-1} (1-q^H)^{N-x} \Big(Q_H(x) + Q_L(N-x)\Big). \end{aligned} \tag{17}$$

The degree to which players engage in fully rational play is reflected in the parameter λ: for $\lambda = 0$, the mixed strategy choice is always $1/2$ (tossing a coin), whereas for λ approaching infinity, the QRE concept coincides with that of Nash Equilibrium.[10]

It can be shown that, other things equal, high fixed costs can negatively affect the equilibrium probability of selecting the dominant, high fixed cost providers in a quantal response equilibrium:

Proposition 4 *In a left-hand neighbourhood of $q^H = 1$, the level of q^H in a stable equilibrium is a non-increasing function of the fixed cost premium, ϕ.*

PROOF: Let $\widehat{EQ}^H = E[Q \,|\, q^H_{-i} = q^H,\, q^H_i = 1]$ and $\widehat{EQ}^L = E[Q \,|\, q^H_{-i} = q^H,\, q^H_i = 0]$. The fixed-point condition for a QR equilibrium can be written as

$$q^H - \frac{1}{1 + \widehat{EQ}^L / \widehat{EQ}^H} \equiv \Omega(q^H, \phi) = 0. \tag{18}$$

[10] Accordingly, for λ approaching infinity, the game admits two stable pure-strategy equilibria and an unstable mixed-strategy equilibrium. For λ finite, different equilibrium set typologies can arise: (i) multiple equilibria of which only the pure strategy ones are stable (for λ large); (ii) multiple mixed-strategy equilibria of which some are stable (as λ becomes smaller); (iii) a single, stable mixed-strategy stable equilibrium (as λ becomes even smaller).

Stability of the above fixed point requires that Ω_{q^H} (the partial derivative of $\Omega(q^H, \phi)$ with respect to q^H) be positive. The comparative statics effects of a change in ϕ on q^H are obtained as

$$\frac{\mathrm{d}\, q^H}{\mathrm{d}\, \phi} = -\frac{\Omega_\phi}{\Omega_{q^H}}. \tag{19}$$

Since $\Omega_{q^H} > 0$ is required for stability, the sign of $\mathrm{d}q^H/\mathrm{d}\phi$ is opposite to the sign of Ω_ϕ, which agrees with the sign of $\partial\left(\widehat{EQ}^H - \widehat{EQ}^L\right)/\partial\phi$. Thus, q is decreasing in ϕ if and only if $\widehat{EQ}^H - \widehat{EQ}^L$ is increasing in ϕ.

To establish how the difference $\widehat{EQ}^H - \widehat{EQ}^L$ changes with ϕ for $q^H < 1$ in a neighbourhood of $q^H = 1$, we can focus on

$$\lim_{q^H \to 1} \frac{\partial^2\left(\widehat{EQ}^H - \widehat{EQ}^L\right)}{\partial\phi\,\partial q^H} = \frac{\partial}{\partial\phi}\left(\lim_{q \to 1} \frac{\partial\left(\widehat{EQ}^H - \widehat{EQ}^L\right)}{\partial q^H}\right). \tag{20}$$

This equals $(N-1)(N-2)F/(N(1+\phi)-F)^2 \geq 0$ if $F < 2(1+\phi)$ and is zero if $F \geq 2(1+\phi)$, which, by continuity, implies that, for q^H sufficiently close to unity, the difference $\left(\widehat{EQ}^H - \widehat{EQ}^L\right)$ is (weakly) increasing in ϕ and therefore q^H is (weakly) decreasing in ϕ. □

Thus, for q^H high enough, an increase in the fixed cost gap between the two options, *holding the full-coordination payoffs of two options constant*, (weakly) lowers the probability of individual players selecting the high fixed cost, efficient option.[11] Intuitively, a lower fixed cost gap can make the dominated option comparatively less risky for any given q^H – lowering the gap between a donor's expected payoff from choosing H and L, and so other things equal, the level of q^H at which a donor is indifferent between selecting H and L must fall.

Incumbency bias can be incorporated into the QRE framework by adding the term $\ln(1 + \mu\, m^j)$, $j \in \{H, L\}$ to the arguments of the exponential functions, where where m^H and m^L are indicators that are either zero or one, depending on whether H or L is the incumbent, and μ is a non-negative parameter. So, for example, if L is the incumbent, we obtain

$$q^H = \frac{\exp\left(\lambda E[Q \mid q^H_{-i} = q^H,\, q^H_i = 1]\right)}{\exp\left(\ln(1+\mu\, m^L) + \lambda E[Q \mid q^H_{-i} = q^H,\, q^H_i = 0]\right) + \exp\left(\lambda E[Q\, i \mid q^H_{-i} = q^H,\, q^H_i = 1]\right)}. \tag{21}$$

This specification implies that, for $\lambda = 0$, we have $q^H = 1/(2+\mu) < 1/2$ if L is the incumbent and $q^H = (1+\mu)/(2+\mu) > 1/2$ if H is the incumbent, whereas for $\lambda \to \infty$,

[11] The conditions for q^H to be strictly increasing in ϕ need to be separately derived for each N; in Section 3 we will focus on the case $N = 3$ and we will discuss conditions for that case.

μ has no impact on play. For finite values of λ, it can be immediately verified that q^H is increasing in μ if H is incumbent and is decreasing in μ if L is the incumbent.

In Section 3 we employ the QRE solution concept as a tool for interpreting experimental results. Specifically, we derive structural estimates of the behavioural parameters of a QRE model from experimental data, and then use those parameters to characterize the comparative statics properties of predicted equilibrium choices with respect to changes in cost parameters around the estimated equilibrium.

2 Implications for competition and entry

We now come to the heart of our discussion, i.e. the question of how fixed costs in charity provision affect charity selection. Our results so far imply that fixed costs work can impede donor coordination on the more efficient provider – by skewing the dominance comparison against high fixed cost providers and/or by lowering the mixed-strategy equilibrium probability of mixed-probability choice of high fixed cost providers being selected by donors. Implications for charities' entry and exit choices immediately follow from our previous analysis.

With reference to the two-charity scenario we have focussed on so far, suppose now that each of the two charities has the option to exit (or not to enter), given the entry choice of the other charity; and suppose that each charity's objective is

$$V_j = (1+\omega)Q_j + Q_{-j}, \qquad j \in \{H, L\}; \tag{22}$$

where $\omega > 0$ is a a "warm-glow" premium that charities attach on own provision simply by virtue of being involved in its provision – despite the fact that charities provide a homogenous good. Following entry choices, if both charities have entered, provision outcomes are determined by donors' choices, as we have characterized them earlier; if only one charity is present, all donors give to the extant charity; if no charity is present, provision is zero.

Then, a charity's calculation of whether or not it should participate involves a simple comparison, namely between the payoff it obtains if it does not participate and the payoff it obtains if it does. The former payoff is zero if the other provider also chooses not to participate, and is otherwise equal to the full-coordination payoff that relates to the alternative charity – which, by our normalization, equals unity for H if it is H that chooses not to participate and equals $1 + \delta$ for L if it is L that chooses not to participate – if the alternative charity participates. The latter payoff is $1 + \delta$ (for H) or 1 (for L) if the another provider chooses not to participate, and is otherwise equal to level that can be expected to arise in the binary choice problem as we have analyzed it so far; in a QR equilibrium with mixing probability q^H, this is equal to $E[V_H; q^H]$ for provider H and $E[V_L; q^H]$ for provider L.

If $\omega = 0$, i.e. if charities are entirely pro-socially motivated, $E[V_H; q^H]$ and $E[V_L; q^H]$ coincide with each other and also with the common payoff that donors obtain. For q^H strictly between 0 and 1, this common payoff is always less than the full-coordination payoff of $1+\delta$ that obtains when all donors select H or when H is the only provider. Not only is this payoff greater, but if one of the charities exits (or does not enter in the first place), this payoff obtains with certainty, thus unambiguously dominating all other outcomes. Thus, although the entry game may also admit equilibria where H exits (or does not enter),[12] the favoured equilibrium for all parties is one where L exits (or refrains from entering), and therefore there need not be any competition failure, coordination on an outcome where only H operates is a dominant outcome.

If, however, $\omega > 0$, then $E[V_H; q^H]$ and $E[V_L; q^H]$ are not the same. Since $E[V_H; q^H]$ and $E[V_L; q^H]$ are both increasing in ω, the payoff gaps that determine entry choices ($E[V_H; q^H] - 1$ for H and $E[V_L; q^H] - (1+\delta)$ for L) are increasing in ω, implying that, if ω is large enough, outcomes will no longer be Pareto rankable; several different scenarios can then arise, some of which involve inefficient selection:[13] (i) $\omega > \delta$ but both $E[V_H; q^H] < 1$ and $E[V_L; q^H] < 1+\delta$, the entry game has a "Hawk-Dove" structure, admitting two equilibria that cannot be Pareto ranked – with either H or L as the only provider; (ii) if $E[V_H; q^H] > 1$ and $E[V_L; q^H] < 1+\delta$, then the only outcome will be one where H is the only provider – the efficient outcome; (iii) if $E[V_H; q^H] < 1$ and $E[V_L; q^H] > 1+\delta$, then the only outcome will be one where L is the only provider – an inefficient outcome; (iv) if $E[V_H; q^H] > 1$ and $E[V_L; q^H] > 1+\delta$, then the only equilibrium outcome will be a duopoly – an inefficient outcome from the donors' point of view.

In cases where L is the only provider – cases (i) and (iii) – fixed costs translate into an inefficient entry barrier that protects the position of a less efficient provider. In case (iv) fixed costs translate into a failure to repel inefficient challengers, making it possible for a less efficient provider to enter and survive competition. None of the above would be relevant to entry choices by for-profit providers – the only equilibrium outcome in that case would be one with H as the only active provider.

Note that, by raising $E[V_H; q^H]$, a higher ω could in principle improve selection if it brings about (ii) rather than (i). In other words, if a higher ω makes the efficient provider comparatively more aggressive and willing to participate, inducing exit by the less efficient provider, it could play a positive selection role. However, it can be shown that, other things equal, a higher ω raises entry incentives for the less efficient charity more than it does for the more efficient charity:

[12]If q^H is such that $E[Q; q^H] < 1$, then an outcome where L enters and H does not enter is also an equilibrium.

[13]The possibility of inter-charity competition giving rise to inefficiencies was first raised by Rose-Ackermann (1982) with respect to fundraising. A recent analysis of selection failure in the presence of adverse-selection and warm-glow charities is Scharf (2014).

Proposition 5 *Provided that the dominance premium, δ, is sufficiently small, an increase in own provision bias, ω, raises the expected payoff of the less efficient provider, when it is chosen by donors with probability approaching unity, comparatively more than it increases the expected payoff of the more efficient provider, when it is when it is chosen by donors with the same probability.*

PROOF: The expressions for $E\left[V_H \mid q^H\right]$ and $E\left[V_L \mid q^H\right]$ are respectively

$$E\left[V_H \mid q\right] = \sum_{x=0}^{N} \binom{N}{x} (1-q^H)^{N-x} (q^H)^x \Big((1+\omega)\, Q_H(x) + Q_L(N-x)\Big); \tag{23}$$

$$E\left[V_L \mid q\right] = \sum_{x=0}^{N} \binom{N}{x} (1-q^H)^{N-x} (q^H)^x \Big(Q_H(x) + (1+\omega)\, Q_L(N-x)\Big). \tag{24}$$

Proceeding along similar lines as we did in the proof of Proposition 2, the derivative with respect to ω of the difference between the limit of $\partial E\left[V_H \mid q^H\right]$ for q^H approaching unity and the corresponding limit of $\partial\Big(E\left[V_H, \mid q^H\right]/(1+\delta)\Big)/\partial q^H$ for q^H approaching zero can be written, after simplification, as

$$-(1+\delta)N\left(\frac{1}{(N-F)(\delta+\omega+\delta\omega)^2(N-F)} - \frac{1}{\big(N-F/(1+\phi)\big)(\delta-\omega)^2}\right); \tag{25}$$

which, evaluated at $\delta = 0$, equals

$$-N\,\frac{\phi/(1+\phi)}{\omega^2(N-F)(\big(N-F/(1+\phi)\big)} < 0, \tag{26}$$

and so is negative for δ sufficiently small. □

This implies that, *ceteris paribus*, an increase in ω is more likely to encourage entry by the low fixed cost, inefficient provider than by the high fixed cost efficient provider – i.e. to give rise to scenario (iii) rather than scenario (ii), as the following example illustrates. Consider once more a scenario with $N = 3$, $F = 2$, $\delta = 1/10$, $\phi = 1/3$ – the same case we considered in Section 1.2, and suppose that $q^H = 1/2$. In this case, for $\omega < \delta = 1/10$ an outcome where H is the only provider is an undominated equilibrium; for ω between 1/3 and 2.85 there are two undominated equilibria, each with a single provider; for ω between 2.85 and approximately 4.45 the only equilibrium features L and the unique provider; for $\omega > 4.45$, both providers participate; i.e. case (ii) never occurs. Intuitively, when donors select the two charities with equal probabilities, own provision bias bolsters the entry stance of the inefficient, low fixed cost charity comparatively more because it attaches a premium to positive levels of output that it can provide even when it is only selected by a few donors, whereas the corresponding levels of output are smaller or zero for the more efficient charity.

Incumbency effects can affect the entry outcome simply because they affect the probability with which each donor selects a provider, raising it for the incumbent and lowering it for the challenger. They can therefore help offset selection failure – when the efficient provider is the incumbent – or they can exacerbate it.

If, additionally, own output-biased charities can select a technology amongst a set of available technologies, selection failure can take a different form: given that low fixed costs confer a competitive advantage, charities may choose to forgo high fixed cost technologies that allow them to exploit scale economies and opt for inferior technologies instead. If there are two competing providers having access to the same technologies, the immediate conclusion would be that, for ω sufficiently large, both providers would choose to enter and would select the inefficient, low fixed cost technology, i.e. they would engage in a technological race to the bottom. Thus, not only do fixed costs can impede efficient entry and exit, or allow inefficient exit and exit, but they could also impede efficient technology adoption and innovation.

3 Laboratory experiments

We conducted a series of laboratory experiments to explore whether fixed-cost based trade-offs lead to suboptimal choices of individual participants and to coordination failures. In Experiment 1 (the Baseline Experiment), participants were asked to play forty rounds of the following game: at the beginning of each round they are split in groups of three people each by a random draw;[14] participants are then asked to choose between two options, one of them (potentially) payoff dominant but involving a higher fixed cost, as discussed in the previous section. In Experiment 2, one of the options was pre-selected as the default option before subjects had an opportunity to make a selection.

Payoffs (derived from underlying cost parameters) were chosen so that deviation by a single player from the dominant option results in a payoff equal to zero. A representative payoff profile, as the number of players choosing the dominant option progressively increases from zero to three, has therefore the structure $\big(x,\ \alpha\, x,\ 0,\ (1+\delta)x\big)$, with $\delta \geq 0$ and $0 \leq \alpha \leq 1/2$ (the order is reversed in alternative treatments), with x, α and δ varying across treatments.[15] Denoting with b each player's notional contribution, the implied cost parameters, in relation to our earlier theoretical setup, are as follows: $F_D = 2b$, $c_D = (b/x)/\big(1+\delta\big)$, $F_0 = 3b - b/(1-\alpha) < F_D$, $c_0 = (b/x)/(1-\alpha) > c_D$. The implied fixed-cost premium is therefore $\phi = \alpha/(2-3\alpha)$ which is positively related to α. In Experiments 1 and 2, payoffs were directly displayed to the subject. In Experiment 3, subjects

[14] $N = 3$ is the smallest level of N for which there can be asymmetric, partial coordination outcomes (i.e. more donors coordinating on one charity than on the other, short of full coordination).

[15] A zero payoff may be perceived by subjects as being especially salient (Bordalo *et al.*, 2012); this would have an analogous effect as risk aversion (e.g. it would be tantamount to the zero payoff being "counted" by subjects as a negative payoff, rather than a zero); but it would not change our theoretical predictions nor our interpretation of the experimental results. In the maximum likelihood estimation exercise we discuss below, we allow for non-linearities.

were required to derive the payoffs themselves from the cost parameters. The number of distinct experimental subjects who participated in the lab sessions is 102.[16] An additional set 30 subjects used an online experimental portal for a treatment variant where payoffs were paid to a charity.

For simplicity and in order to insure that players could easily understand the game and, at the same time, that they would not be influenced by the framing, the two available options were labeled as “Green Option” and “Purple Option”. To control for the possible order effects, the colour attached to the high fixed-cost option was randomized, and we also varied the displays shown to the participants: in some sessions payoffs were displayed in terms of increasing number of players choosing Green over Purple, and in other sessions the order was reversed. The stranger design we adopted minimizes learning effects. Furthermore, participants did not receive feedback about their payoffs from previous rounds until the very end of the experiment. In most of the treatments, subjects were shown pre-calculated payoffs, but in a treatment variant, subjects were required to derive payoffs independently on the basis of cost a parameters and a set of detailed instructions.

Twenty distinct payoff structures were used as a basis for the treatments in each round of the experiment. These are shown in Table 1, ordered in terms of number of players selecting the high-fixed cost option. The number of payoff structures doubles to forty with randomization of the order of payoffs as they are presented to subjects. Note that in some of those treatments we allowed for the low-fixed cost option to dominate the high-fixed cost option, i.e. they involved a negative δ. Accordingly, in the analysis of results we shall examine choices with reference to the level of fixed costs rather than dominance, but we shall draw a distinction between treatments where $\delta > 0$ and those where $\delta < 0$. In most treatments, subjects were asked to choose one of the options without a default choice being made for them. In others, a default choice is made for them, and subjects had the option of overturning it. We included this treatment variant in order to investigate incumbency

[16]Laboratory experiments where conducted in the Behavioural Science Laboratory at Warwick Business School. The majority of participants were undergraduate students at the University of Warwick: more than 70% of them studied Economics, Psychology or Business Administration, the rest were other majors. The majority of participants had some experience with economic experiments, but none of them had taken part in similar coordination experiments before. The average age was 21 years of age. Almost exactly half of the participants were male and half female. The experiment was conducted using the experimental software z-Tree (Fischbacher, 2007). Upon arriving at the laboratory, each participant was seated at a workspace, equipped with a personal computer. scratch paper and a pen. The workspace of each participant was private; the session was monitored and any communication between participants was strictly forbidden. Participants received experimental instructions on a computer screen. At the beginning of a session, instructions were read aloud by the experimenter, and participants had an opportunity to re-read the instructions and ask individual questions. Participants were also asked to play a practice round; the payoff structure used in the practice round did not repeat any of the combinations used in the experiment. The experiment lasted approximately one hour.

effects.

3.1 Subjects' choices

Table 2 gives descriptive statistics for subjects' choices (frequencies) in the base sample of 102 subjects across the twenty basic treatments, both in aggregate and broken down by incumbency treatment variant.

To investigate the relationship between subjects' choices and payoff structures – which in turn reflect underlying technological differences – we can focus on normalized payoffs, which are computed as follows. Denoting with x_t^H, x_t^L and x_t^{PC}, in any given treatment t, respectively the full-coordination payoff for the high-fixed cost option (H), the full-coordination payoff for the low-fixed cost option, and the partial-coordination payoff associated with the low fixed-cost option (H), we compute *Dominance Gap*$_t = x_t^H / x_t^L = 1 + \delta_t$, and *Fixed Cost Gap*$_t = x_t^{PC} / X_t^L = \alpha_t$ (which, as discussed before, is positively related to the fixed cost premium).

Carrying out the comparison of expected payoffs for the high- and low-fixed cost options (as we did in Proposition 2 but for cases where $\delta < 0$), we come to the conclusion that in this cases a higher ϕ (α) unambiguously raises the ratio of expected payoffs for options H and L for $\gamma > 0$ (unlike in the case where $\delta > 0$). Thus, if player choices are driven by expected payoff comparisons, we should expect a higher α to produce effects of a different sign depending on whether $\delta > 0$ or $\delta < 0$. Analogously, if we focus on stable, mixed-strategy QRE equilibria for the case $N = 3$, as shown in the proof of Proposition 4, the sign of the comparative statics effects of a parameter β (either the dominance premium, δ, or the fixed cost gap, α) on the mixed-strategy equilibrium probability of selecting H agrees with the sign of $\Omega_\beta(q^H, \beta)$. For $N = 3$, we have $\Omega_\delta(q^H, \beta) = \lambda (q^H)^2\, \Xi$, where $\Xi \equiv \exp\left(\lambda(E^H - E^L)\right) / \left(1 + \exp\left(\lambda(E^H - E^L)\right)\right)^2 > 0$ – which implies $\mathrm{d}q^H/\mathrm{d}\delta > 0$; and $\Omega_\alpha(q^H, \beta) = \lambda\left(3(q^H)^2 - 4q^H + 1\right)\Xi$ – which implies that $\mathrm{d}q^H/\mathrm{d}\alpha > 0$ is negative if $q^H > 1/3$ and positive or zero otherwise. In light of this, we could expect changes in δ across treatments to produce an effect of the same sign across treatments, and changes in α to produce effects of different sign depending on whether or not H is payoff dominant.

Table 3 presents results of random-effects logit panel regressions, where the dependent variable is the log of the odds of selecting the high-fixed cost option and the independent variables are the dominance gap ($1 + \delta$), the fixed cost gap (α), and incumbency treatment indicators. For the reasons just discussed, we also include an indicator flagging those scenarios where option H is payoff dominated, and separate coefficients for α for treatments where H is dominant and treatments where H is dominated – as a rough way of allowing for the non-monotonicity implied by the theory. Column 1 of Table 3 shows results for the full sample, whereas column 2 focuses on the sub-sample of subjects who were asked to calculate payoffs.

Table 1: Payoff treatments

No. of players selecting H	1	2	3	4
Payoff treatment	Payoffs			
1	200	100	0	200
2	200	100	0	201
3	200	100	0	205
4	200	100	0	210
5	200	100	0	215
6	180	50	0	175
7	180	50	0	180
8	180	50	0	181
9	180	50	0	185
10	180	50	0	190
11	150	70	0	145
12	150	70	0	150
13	150	70	0	155
14	150	70	0	160
15	150	70	0	165
16	175	25	0	145
17	175	25	0	160
18	175	25	0	175
19	175	25	0	190
20	175	25	0	205

H: high-fixed cost option

Table 2: Experimental choices:
Choice frequency for high-fixed cost option
(all subjects)

Payoff treatment	No default	L default	H default	All variants
1	0.206	0.233	0.100	0.197
2	0.441	0.600	-	0.477
3	0.456	0.467	0.533	0.466
4	0.574	0.800	0.767	0.621
5	0.588	0.667	0.767	0.617
6	0.039	0.233	0.167	0.076
7	0.132	-	0.350	0.182
8	0.456	0.400	0.400	0.443
9	0.475	0.567	-	0.496
10	0.554	-	0.633	0.572
11	0.069	-	0.033	0.057
12	0.147	0.667	0.633	0.261
13	0.475	0.700	0.700	0.527
14	0.544	0.533	0.533	0.542
15	0.549	0.567	0.567	0.553
16	0.078	0.067	0.167	0.087
17	0.049	0.033	-	0.042
18	0.172	0.067	0.067	0.148
19	0.642	0.833	0.867	0.689
20	0.799	0.833	0.867	0.811

H: high-fixed cost option; L: low-fixed cost option

Table 3: Individual Choice: Panel Random-Effects Logit Regressions
Dependent variable = $\text{logit}\big(\text{Prob}\{\text{Choice} = \text{High-fixed cost option}\}\big)$

Regressors	Full sample (1)	Subjects compute payoffs (2)
Dominance gap (H/L): $1+\delta$	15.599***	17.898***
	(1.356)	(2.388)
H dominated	-3.267***	-2.884***
	(0.371)	(0.600)
Fixed cost gap if H dominant: $\alpha = 2\phi/(1+3\phi)$	-1.165**	-2.207**
	(0.475)	(0.775)
Fixed cost gap if H dominated	1.545*	0.458
	(0.675)	(1.133)
H default	2.316***	
	(0.583)	
L default	-0.152	
	(0.582)	
Subjects must compute payoffs	0.446	
	(0.557)	
Constant	-16.103***	-17.735***
	(1.542)	(2.623)
Observations	4,080	1,320
Subjects	102	33
Fraction of variance due to individual effects	0.614	0.526

Standard errors in parentheses
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Looking at the full base sample, the effect of the dominance gap on the probability of selecting H is positive and significant. The sign of the effect is as would be trivially expected, but the statistical significance of the effect indicates that individuals do trade off full-coordination payoff dominance against other considerations, rather than just choosing the payoff dominant option. The sign on the coefficient for α is negative and significant for treatments where H is dominant. This is in line with theoretical predictions. It is worthwhile stressing how this finding should be interpreted: our normalization implies that changes in α do not affect the comparison between the two options in terms of their overall performance under full coordination, i.e. a higher fixed-cost gap, as measured by α does *not* make H less efficient; nevertheless, it makes the choice of H less likely in those cases where H is the dominant option. In cases where H is dominated, the effect of a higher α, is positive and significant. As noted above, this sign reversal is aligned with theoretical predictions.

Incumbency effects are as would be expected: incumbency of H has a positive and significant effect on the probability of H being selected, while incumbency of L has a negative effect; however only the first effect is statistically significant. Asking subjects to derive payoffs or earmarking payouts to charity has no significant effect in the full sample (column 1). Restricting the analysis to the sub-sample where subjects are asked to derive payoffs delivers strikingly similar results (column 2), suggesting that computational complexity (or lack thereof) does not play a central role in shaping behaviour. Augmenting the base sample with the additional 30 subjects whose payoff went to charity gives very similar results (not shown), with the "charity treatment" indicator being statistically insignificant.

An alternative way of looking at experimental evidence is to focus on the probability of selecting the dominant option, which coincides with H in some treatments and with L in others. Under this specification, the combination of a negative effect of α on the probability of choosing H when H is dominant and a corresponding positive effect when H is dominated, would translate (by construction) into a negative effect of a higher α on the probability of choosing the dominant option *in all cases*. Results from this specification are shown in Table 4, and are indeed in agreement with those of Table 3 (the differences coming mainly from the exclusion of the separate treatment group indicator that is included in the specification of Table 1).[17] Incumbency effects have again the expected sign but only incumbency of the dominant option is statistically significant; and, again, asking subjects to derive payoffs or earmarking payouts to charity makes little difference.

We also carried out maximum likelihood estimation of the parameters of a QRE model as described in Section 1.3. We focus on three model variants: (i) one without incumbency

[17] Including the indicator from the first specification in the second specification lowers the significance of coefficients estimates on the fixed cost gap to analogous levels as those obtained under the first specification for cases where H is dominant.

Table 4: Individual Choice: Panel Random-Effects Logit Regressions
Dependent variable = $\text{logit}\left(\text{Prob}\{\text{Choice} = \text{Dominant option}\}\right)$

Regressors	Full sample (1)	Subjects compute payoffs (2)
Dominance gap (D/O): $1+\delta$	12.348***	13.790***
	(0.880)	(1.610)
Fixed cost gap: $\alpha = 2\phi/(1+3\phi)$	-1.562***	-2.146***
	(0.290)	(0.492)
Dominant option default	1.351***	
	(0.311)	
Dominated option default	-0.490	
	(0.301)	
Subjects must compute payoffs	0.084	
	(0.284)	
Charity	0.112	
	(0.289)	
Constant	-11.900***	-13.110***
	(0.970)	(1.729)
Observations	4,080	1,320
Subjects	102	33
Fraction of variance due to individual effects	0.284	0.222

Standard errors in parentheses
*** $p < 0.001$

effects, where the only structural parameter is λ; (ii) one with incumbency effects, with parameters λ and μ; (iii) one with both incumbency effects and with the payoff for the high-fixed restated as $\tilde{x}_t^H = x_t^H + \rho(x_t^H - x_t^L)$, where ρ is a positive scalar that measures the marginal valuation of payout levels in excess of x_t^H, and which can depart from unity;[18] this variant has three structural parameters: λ, μ, and ρ. The reason for including specification (iii) is the observation – clearly evidenced by the descriptive statistics in Table 2 – that subjects' choices are dramatically affected by a switch in the dominance relationship between x_t^L and x_t^L: for example, when moving from payoff treatment 1 to 2, which both feature $x^L = 200$, a change in x_t^H from 200 to 201 raises the measured frequency of H being chosen from 0.206 to 0.441 in the no-incumbency treatment variant, but the effect of subsequent increases in x_t^H – as we move to payoff treatments 3, 4 and 5 – is markedly less pronounced.

For every basic treatment, we have at most two observations per subject, and so no individual-specific parameter estimation is possible. Accordingly, in performing the estimation, the choices of individual subjects for any given treatment were pooled into a single sample.[19]

Maximum likelihood estimation results are shown in Table 5, which also shows likelihood ratios for moving from one specification to the next, progressively adding one parameter to the previous one. The implied value of λ is consistently around 0.012. Adding incumbency effects very significantly improves the model's fit to the experimental data. Allowing for non-linearities above x_t^L further improves the fit; more importantly, it brings predicted equilibrium values of q^H closer to the $1/3$ critical point – above which the effect of a higher fixed cost premium on q^H is non-positive, consistently with the results of the previous panel estimation results – for a larger subset of treatments where option H is the payoff dominant option.

Table 6 shows predicted choice frequencies corresponding to specification (iii), alongside actual frequencies. Out of the twenty basic payoff treatments we investigate, and with reference to observations for cases where there is no incumbency treatment, observed frequencies for all twenty scenarios are "right" in terms of the predicted comparative statics effects, i.e. they exceed $1/3$ in treatments where the high-fixed cost option is also the payoff dominant option or fall short of $1/3$ in treatments where the high-fixed cost option is the payoff dominated option – implying that in all scenarios a higher normalized fixed

[18] This non-linear specification can be interpreted as implying loss-aversion/loss-love, with x_t^L identifying subjects' reference point.

[19] Also note that, since multiple (stable) strictly mixed-strategy equilibria are possible for any given treatment and parameter configuration, the estimation procedure involves selecting the combination of equilibrium values across all treatments that delivers the maximal likelihood value for the given parameter configuration; and then, given those maximal values, selecting the parameter configuration that delivers the maximal overall likelihood value.

Table 5: Maximum likelihood QRE estimates

Parameter	Specification (i)	(ii)	(iii)
λ	0.0123	0.0125	0.0115
μ	-	0.1725	0.1425
ρ	-	-	2.98
Incremental likelihood ratio	-	212.2	115.8
Observations	4,080	4,080	4,080

(i) No incumbency effects

(ii) Incumbency effects

(iii) Incumbency effects + change in valuation above $\min\{x^L, x^H\}$

cost premium (holding dominance constant) is predicted by the theory (the QRE model) to lower the probability of choosing H, as is indeed implied by our earlier regression results. Of the predicted frequencies from the QRE estimation, thirteen out of twenty are on the right side of 1/3, and only two out of twenty are on the wrong side of 1/3 by more than 10% – i.e. less than 0.3 if H is dominant and greater than 0.367 if H is dominated; In other words, there are no obvious outliers that are obviously at odds with the augmented QRE specification.

On the whole, the experimental evidence provides quite strong support for our QRE based formalization/interpretation of the coordination problem and of the role that fixed costs play in it.

3.2 Group performance

Mean payouts by treatment are shown in Table 7 together with predicted mean payouts – based on the predicted mixed strategies obtained from the estimation of QRE specification (iii) (see Tables 5 and 6). In all cases, both actual and predicted expected payoffs fall short of the dominated, full-coordination payoff (the lower of x_t^L and x_t^H). On average groups achieve a payoff that is only 58% higher than what would be achieved under fully random choices – if all players selected options at random each with probability of one-half. This is significantly less that what could be theoretically achieved if all players always coordinated on the dominant option – which would average to 177% more than the average payoff under random play. In other words, if we removed the dominated option from the set of

Table 6: Predicted and actual choice frequencies – choice of option H (laboratory subjects only)

Payoff	No default		L default		H default		All variants	
treatment	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual
1	0.303	0.201	0.259	0.167	0.363	-	0.290	0.191
2	0.304	0.431	0.259	0.433	0.366	0.767	0.291	0.480
3	0.309	0.472	0.262	0.500	0.377	-	0.295	0.480
4	0.316	0.556	0.266	-	0.841	0.783	0.471	0.623
5	0.816	0.576	0.270	-	0.899	0.717	0.841	0.618
6	0.324	0.035	0.260	-	0.428	0.200	0.355	0.083
7	0.335	0.118	0.265	0.100	0.478	0.600	0.377	0.186
8	0.338	0.410	0.266	0.400	0.495	-	0.317	0.407
9	0.350	0.444	0.271	0.500	0.724	0.633	0.327	0.480
10	0.371	0.528	0.277	0.567	0.832	0.700	0.507	0.559
11	0.372	0.069	0.321	0.017	0.435	-	0.357	0.054
12	0.383	0.146	0.328	-	0.454	0.650	0.404	0.294
13	0.395	0.444	0.335	-	0.480	0.700	0.420	0.520
14	0.411	0.542	0.343	0.533	0.518	-	0.391	0.539
15	0.432	0.535	0.352	0.567	0.601	-	0.408	0.544
16	0.285	0.049	0.231	-	0.358	0.117	0.307	0.069
17	0.310	0.042	0.242	0.017	0.420	-	0.290	0.034
18	0.357	0.146	0.257	0.067	0.694	-	0.327	0.123
19	0.841	0.681	0.279	-	0.883	0.850	0.854	0.730
20	0.930	0.826	0.912	-	0.943	0.850	0.933	0.833

H: high-fixed cost option; L: low-fixed cost option
Predicted performance based on QRE specification (iii), with incumbency effects and non-linear valuation

Table 7: Predicted and actual payoff performance
(laboratory subjects only)

Payoff	No default		*L* default		*H* default		All variants	
treatment	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual
1	92.5	145.8	99.8	150.0	86.4	-	94.6	147.1
2	92.7	95.9	100.1	70.0	86.5	120.5	94.8	95.7
3	93.3	77.4	101.1	95.8	86.8	-	95.6	82.8
4	93.9	85.0	102.4	-	153.6	104.5	111.5	90.7
5	146.8	86.1	103.5	-	170.1	126.8	153.6	98.1
6	70.8	166.5	81.5	-	62.6	106.0	68.4	148.7
7	70.8	137.3	82.5	141.0	63.1	56.0	68.6	125.9
8	70.8	56.7	82.7	48.0	63.7	-	74.3	54.1
9	70.4	61.4	83.4	56.5	93.9	52.0	74.2	59.3
10	69.4	60.8	84.0	15.0	122.1	67.0	84.9	55.0
11	61.9	133.3	65.0	146.0	60.9	-	62.8	137.1
12	62.7	115.2	66.0	-	62.1	59.0	62.5	98.7
13	63.4	67.3	66.9	-	63.5	71.8	63.4	68.6
14	64.0	60.6	67.7	63.0	65.9	-	65.1	61.3
15	64.6	53.2	68.3	32.8	73.3	-	65.7	47.2
16	61.4	153.1	71.2	-	52.6	122.5	58.8	144.1
17	62.8	158.9	75.5	167.5	51.9	-	66.5	161.4
18	60.7	112.0	78.5	145.0	74.6	-	65.9	121.7
19	113.4	84.8	79.1	-	127.5	136.8	117.6	100.1
20	145.3	122.2	138.2	-	150.4	124.2	146.8	122.8

H: high-fixed cost option; *L*: low-fixed cost option
Predicted performance based on QRE specification (iii), with incumbency effects and non-linear valuation

Table 8: Group Performance: OLS Regressions
Dependent variable = *Payoff / Expected payoff under random play*

Regressors	
Dominance premium (D/O): $1+\delta$	1.512*
	(0.648)
Fixed cost gap: $\alpha = 2\phi/(1+3\phi)$	-2.907***
	(0.249)
Constant	0.994
	(0.725)
Observations	1,360
Adusted R^2	0.103

Standard errors in parentheses
*** $p < 0.001$, * $p < 0.05$

options available to subjects, their average payoff would increase by more than 75%. If we removed the *dominant* option instead, the players' average payoff would still increase by 66%.

One of they central conclusions from our earlier theoretical discussion is that fixed costs can give rise to coordination inefficiencies and can thus worsen overall performance even when they are technologically warranted, i.e. even when they are associated with lower average costs. To give a measure of how large this effect is in the experiments we conducted a simple OLS regression correlating group performance with the structure of treatments. Results are shown in Table 8. A higher dominance gap for the dominant option relative to the dominated option improves group performance; a higher fixed-cost gap, *holding dominance constant*, significantly worsens group performance. The ratio between the relevant coefficients is roughly -2, meaning that the increase in δ required to offset the negative effect on performance of an given increase in ϕ is more than double the increase in ϕ.

3.3 Implications for entry choices

There is abundant experimental evidence that, when faced with two risky alternatives one of which dominates the other both in terms of a higher expected payoff and a lower payoff variance, violations of dominance are very infrequent (Camerer, 1989). Since entry choices are based on such comparisons, as long as the potential competitors have experience of actual play performance or anticipate such performance, the results we can draw from the coordination experiments are fully sufficient to draw conclusions for hypothetical entry choices, as discussed in Section 2.

To illustrate, consider Treatment 14. The single-provider levels of output are respectively 160 for L and 150 for H. Thus, if the own-provision premium, ω, is less than $10/150 = 1/15$ for both providers, they will both favour an outcome where H is the only active provider. If ω_L is above that level, then L would favour an outcome where it is the only provider instead of H. If we use the predicted level of q in the no-incumbency variant of this treatment, which equals 0.411 (Table 6), to derive the minimal level of ω_L above which L will choose to enter even if H is active, we obtain a level of approximately 1.46; whereas if we use the actual frequency of 0.542 we obtain a value of 2.51. The corresponding values for ω_H are $7.05 > 1.46$ and $3.39 > 2.51$; i.e., the additional weight that L must attach on own provision in order to choose to compete with H is less than the corresponding level for H – and thus, for a common degree of own provision bias, H will be ore likely to concede to L than L will be to concede to H. In all cases, incumbency raises q^H and thus strengthens the comparative position of H.

4 Discussion and extensions

Competition between non-profit providers has been comparatively little studied – much less than the relative size of the non-profit sector should warrant. In particular, the question of how fixed costs affect contestability in the non-profit sector has, surprisingly, not been examined before.

Our analysis has shown that, absent a residual claimant, selection of the most efficient provider through the price mechanism cannot be guaranteed: unlike in the case of for-profit firms, the presence of fixed costs may interfere with competition amongst non-commercial charities and give rise to inefficient selection. Experimental evidence indeed suggests that donors' coordination and contribution performance can be adversely affected by the presence of fixed costs, that this effect can be significant, and that donors can be biased against higher-fixed costs providers even if these are more efficient, which in turn weakens the competitive position of more efficient providers.

Our discussion has intentionally abstracted from a number of real-world complications that would need to be incorporated in a minimally realistic model of competition and entry – which would in turn be be required for empirical identification of the effects we have investigated here theoretically and experimentally.[20] We touch on some of these extensions

[20] Data on charities' technology choices is scarce. The Canadian dataset previously mentioned is unique in providing a systematic account of the structure of charities' balance sheets; but, as noted earlier, information on balance sheets does not easily translate into information on provision technologies.

below, and then conclude with a brief discussion of implications for government policy.

4.1 Large donor pool

Clearly, fixed costs of any given size become negligible if variable costs become increasingly large due to an expansion of output, e.g. because the number of donors is large. Although this is formally true in our simple model specification, in practice inframarginal costs *do* scale up with the level of operation. For example, we would not expect a large manufacturer to incur the same inframarginal costs as a small workshop; and the same would apply to charities. Indeed, looking at the balance sheet of charities, we see that (unsurprisingly) categories of costs – such as manager's salaries or rental payments – that are correlated with fixed costs do increase with the size of a charity. Thus, operation on a large scale with the support of a large number of donors does not imply that inframarginal costs must be a negligible fraction of total donations.

Such positive relationship between size and inframarginal costs can be rationalized on the basis of technology sets that comprise different technologies with varying fixed and marginal costs, with providers selecting higher fixed cost, lower marginal cost technologies as they expand their scale of operation: if there are multiple technologies $t \in \{1, \ldots, T\}$ each involving a different fixed-cost level, F_t, and a different marginal cost, c_t, and such that F_t is increasing in t, c_t is decreasing in c_t, and $\arg\max_{t \in T}(N - F_t)/c_t$ is increasing in N, then a higher N calls for the adoption of a higher fixed-cost technology, i.e. the ratio of fixed to total costs does not become negligibly small if N becomes large.[21] Alternatively, it may reflect the need for lumpy, short-run capacity investment costs: in a scenario where there are a total of mN donors (m integer and positive), and where F_j is the short-run cost that provider j must incur to install enough capacity to provide a maximum level of output equal $N - F_j c_j$, with an additional cost F_j required to provide any level of output between $(N - F_j)/c_j$ and $2(N - F_j)/c_j$; and so on; then, fixed costs would scale up with m but would be taken as fixed when examining the choices of the marginal N donors – the choices we are focusing on in our discussion.[22]

[21] This specification provides a fully general framework to model increasing-returns-to-scale technologies that may exhibit decreasing marginal costs, whereby the technological frontier for producing the level of output Q (the production function) from a level of input X is obtained as the outer envelope $\max_{t \in T}(X - F_t)/c_t$.

[22] The same kind of lumpiness applied to for-profit providers: e.g. for example, a telecom operator with local telecom hubs each potentially serving a certain number of local households, with the cost of regularly maintaining and updating each hub being independent of the number of local households subscribing to the services.

4.2 Output differentiation

Donors may view the activities of competing charities as being imperfect substitutes, i.e. as differentiated goods. Then, as is the case for private sector competitors that produce differentiated varieties, incurring the fixed costs required to produce additional varieties may be warranted and socially optimal. For private goods the trade-off between the benefit of additional varieties and the additional costs involved can be resolved efficiently by market competition – as characterized by the mainstream models of monopolistic competition under product differentiation (e.g. Dixit and Stiglitz, 1977). But, as already noted, the mechanics of price competition do not readily carry over to the non-profit case.

While a single-provider outcome may not be necessarily the efficient outcome in this case, donors would still face a coordination problem, and charities that are own-output biased may still leverage on the resulting this to compete inefficiently, which would result in above-optimal differentiation and sub-optimal exploitation of economies of scale.

If charities are entirely pro-socially motivated, they could in principle resolve this trade-off optimally on their own and formulate optimal entry decisions accordingly – new charities would choose to enter only if the degree of differentiation and the volume of total donations warrant the additional fixed costs. However, even charities that are fully aligned with donors' objectives will typically be unable to directly observe donors' preferences for variety, and will have to infer those preferences from giving behaviour. They may then mistakenly interpret the outcome of coordination failure across donors – donors giving to multiple charities – as evidence of donors' valuing diversity, which may in turn bias their entry decisions.

4.3 Endogenous contribution levels

In our analysis we have deliberately abstracted from the choice of contribution levels, focusing on the coordination problem that fixed costs entail in isolation from other dimensions of donors' choices. Nevertheless, the coordination problem can be expected to affect the volume of donations.

Contribution performance is so poor in our laboratory experiments that, trivially, it could be improved simply by restricting the choice to either charity. Then, if donors have the option to contribute or withhold the contribution and direct it towards private consumption instead, they will be more likely to do that when multiple options are available. In other words, coordination failure across donors may also translate into a reluctance to make donations.

Too see this, consider a setting where contributions have the option of not giving at all – a discrete choice between giving and not giving – but where the private opportunity cost of giving, ν, for the marginal donor is less than the marginal private benefit, i.e. $\nu < 1/c_j$, $j \in \{1,2\}$. This means that provision does not entail free riding, and so an outcome where all donors make positive contributions to either charity is a Nash equilibrium; however, if fixed costs are large enough, an outcome with no contributions is also an equilibrium. In this setting, suppose that donors face a single option that involves fixed costs, and compare this scenario with one where donors face two fixed-cost options. In both scenarios, depending on parameter values, a no-contributions outcome could be a Nash equilibrium. But, in light of our earlier experimental evidence on contribution performance, we would expect that donors would anticipate that multiple options lower the expected value of marginal contributions and would accordingly be less willing to contribute, making a no-contribution outcome (or a low-contribution outcome) more likely where multiple providers are present.

4.4 Other negative connotations of fixed costs

Donors may dislike fixed costs for reasons that have nothing to do with the arguments we have presented. For example, in the presence of moral hazard, fixed costs may be taken by donors as a signal that funds are misused by charity managers – if, for example, managers obtain more "ego rents" or personal perks from fixed expenditures than from programme expenditures (although it must be said that opportunities for misuse and misappropriation of funds are just as great for variable expenditures). Or it may be that the extent of the "warm glow" that donors experience from their donations varies depending on the perceived destination of the donation.

While it is possible that other considerations play an important role in shaping how donors relate to fixed costs, our analysis and experimental result show that, even if these considerations are absent – as they are, by design, in both our theoretical and experimental settings – fixed costs can drive them away and can lead to inefficient selection. If donors have additional reasons for disliking fixed costs, those will add to the effects we have described.

4.5 Implications for government funding

The debate on the effect of government funding on the private provision of public goods and services has so far largely ignored the effects of government funding on inter-charity competition and market structure in the third sector. Our analysis shows that, once entry and technology adoption decisions are accounted for, there is no longer a theoretical prior that government grants that are directed towards charities' core funding needs should be neutral, i.e. that they should simply crowd out private donations. On the contrary, government grants might be are able to affect entry and/or charities' technology choices – and hence provision efficiency.

Specifically, selective government subsidization of fixed costs may then be required to promote efficient selection of service providers. Funding of charities' fixed costs can be expected to dominate direct regulation as a way of promoting efficient selection, as the latter would require the government to have full information on the technologies of individual providers; but it will still require an assessment of the comparative severity of the two kinds of failures related to competition and entry: if established charities are technologically entrenched and rely on unnecessarily high fixed costs technologies, and entry by start-ups can result in the adoption of more efficient technologies, then government funding of core costs should be directed towards start-ups; if instead start-ups are inefficient, opportunistic challengers that can take advantage of the higher fixed costs of more efficient, more established charities in order to divert private funds their way, making it difficult for established charities to fully exploit opportunities for economies of scale in provision, then funding the core costs of established charities should take priority, so as not to promote inefficient entry.

Government funding choices do appear to be sensitive to charities' core funding needs.[23] This is also directly reflected in institutional arrangements (e.g. an emphasis on "seed" grants in the dispersion of public funding support to charities). What is not clear is whether this sensitivity is motivated by the need to promote entry by new charities – overcoming the implicit entry barriers that fixed costs can create – or by the need to support efficient technology adoption by incumbents: indeed, the evidence suggests that it is the older, more established, charities that receive comparatively larger government grants (relative to their size).[24]

[23] Tax return information for a sample of more 48,346 distinct Canadian charities over the period 1997-2005 (T3010 forms made available by the Canada Revenue Agency) reveals a significant positive correlation between the proportion of fixed costs (as proxied by the category "Management and General Administration Expenses") in total costs and the proportion of revenue they receive from government, with a one percentage point increase in the proportion of fixed costs being associated, on average, with almost a two percentage point increase in the proportion of government funding.

[24] With reference to the same Canadian dataset, a charity's age appears to be positively and significantly correlated with the proportion of revenue it receives from government. Clearly, this pattern may have nothing to do with optimal policy choices on the part of government: it may simply be that established charities are better at soliciting government funding.

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