Endogenous Formation of Optimal Teams*

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Abstract

We study the role of incentives in determining how individuals with high and low ability endogenously form teams with homogeneous or heterogeneous abilities. Standard incentives that reward the best-performing team (*team incentives*) or the best member of each team (*individual incentives*) consistently lead to the formation of homogeneous teams, even when socially inefficient. Conversely, *equal sharing* rules, which offer all members an identical share of total production, elicit optimal matching but are vulnerable to moral hazard. We show that *hybrid incentives*, which combine team and individual incentives, elicit optimal matching and are robust to moral hazard. We conduct two experimental studies showing that hybrid incentives produce significantly more optimal teams than standard incentives, though fewer than under equal sharing.

Keywords: assortative matching, team formation, comparisons, incentives
JEL-Codes: C91, D82, M52

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1 Introduction

Organizations today widely adopt a team-based approach, and teams are increasingly self-organised. By 1996, 78% of large US firms had shifted from rigid hierarchical structures to include self-organizing teams (Lazear and Shaw, 2007). Two decades later, over 90% of companies reported using teamwork, with 31% operating mostly or entirely in teams (Deloitte, 2016, 2019). Organizations allow teams to structure themselves on a project basis to improve adaptability, flexibility, and motivation (Kauffeld, 2006; Magpili and Pazos, 2018). Empirical evidence (Hamilton, Nickerson and Owan, 2003) and experiments in the field (Bandiera, Barankay and Rasul, 2013) and laboratory (Almaatouq et al., 2021; Büyükboyaci and Robbett, 2019; Chen and Gong, 2018) show that allowing individuals to self-select into teams can enhance performance.

In this paper, we study how incentives influence individuals of varying abilities to endogenously form teams. A well-established result (Babcock et al., 2015; Bandiera, Barankay and Rasul, 2005; Van Dijk, Sonnemans and Van Winden, 2001) is that standard incentives, rewarding either the best-performing team (*team incentives*) or the best-performing member of each team (*individual incentives*), motivate individuals to form teams of homogeneous ability (*positive assortative matching*, PAM). However, PAM is not always optimal. When the marginal impact of adding a high-ability member to a team is lower if the other member is also of high ability, a property known as *decreasing differences* (Becker, 1973), teams of heterogeneous abilities (*negative assortative matching*, NAM) maximize performance.

Recent empirical evidence suggests that NAM may often be optimal in practice. For instance, Herkenhoff et al. (2024) find that in the US labor market, less knowledgeable coworkers benefit the most from working with more knowledgeable ones, with learning from coworkers accounting for two-thirds of the human capital accumulated on the job. This effect has also been observed in the garment industries of California (Hamilton, Nickerson and Owan, 2003) and India (Adhvaryu et al., 2024). Furthermore, Chade and Eeckhout (2018) show that NAM is optimal for experts working in teams to jointly solve problems based on informative individual signals. Conversely, German university students tend to assortatively self-select into coursework teams, leading to lower aggregate performance than when teams are randomly formed (Fischer, Rilke and Yurtoglu, 2023).

In theory, *equal sharing* rules, which offer all members an identical share of total production, can elicit NAM. While the prospect of joint profitability incentivizes NAM, such rules are prone to moral hazard and incompatible with rewarding effort.

Our main theoretical contribution is the introduction of *hybrid incentives*, which combine competition across and within teams. This approach achieves optimal matching, whether PAM or NAM, while avoiding the issue of moral hazard. We show that when a share of the incentive payment goes to the best-performing team and the rest to the best-performing member of each team, it is always possible to incentivize individuals to match in a way that maximizes expected total surplus.

When NAM maximizes the surplus, there is always an overlap between the share of individual incentives that motivates high-ability individuals to match with low-ability ones and the share of team incentives that motivates low-ability individuals to match with high-ability ones. Conversely, when PAM maximizes the surplus, no such overlap exists. We also show theoretically that moral hazard is not a concern under hybrid incentives. To evaluate this approach, we conduct two experimental studies.

Our experimental game involves groups of four participants, two with high ability and two with low ability. The team production function models decreasing differences, making NAM optimal. Participants endogenously form two teams by proposing to each other. We analyze behavior across four incentive schemes. The first two are standard incentives: *Individual Incentives* and *Team Incentives*. As expected, we observe mostly PAM. The third is an *Equal Sharing* rule that divides the team surplus equally among members, testing whether participants understand the profitability of NAM. It also serves as a performance yardstick for eliciting NAM due to its simplicity and transparency. We confirm that NAM is chosen when profitable. The fourth is *Hybrid Incentives*. As expected, we predominantly observe NAM.

Our main results are robust across both studies. In Study 1, we use a Multiple Price List (Holt and Laury, 2002, "MPL") to elicit matching preferences across the full range of weights assigned to the two standard incentive schemes within Hybrid Incentives. This allows us to identify the switching points for both participant types, determining the range of weights wherein NAM is achieved. Since the MPL includes weights of 1 for pure Individual and Team Incentives, we can directly compare these standard schemes with Hybrid Incentives. Additionally, we test an information intervention where individuals are provided with the expected value of each match under Equal Sharing and Hybrid Incentives. We apply this *Information* treatment to half the sessions and find that it significantly increases social efficiency.

To test the robustness of our results, we pre-registered and ran Study 2, which involved repeated observations of Hybrid Incentives using a fixed weight assigned to the two standard incentive schemes rather than a MPL. This data can be directly compared to the data from repeated observations in the two standard incentives and Equal Sharing, allowing for experience. We only ran the "No Information" treatment, reflecting real-world settings where such information is rarely available. The results of Study 2 corroborate those of Study 1, showing that participants understand NAM generates higher surpluses, and in turn form more NAM teams under Hybrid Incentives, though less than under Equal Sharing. This aligns with recent research highlighting the benefits of equal pay, such as reducing gaming of performance metrics (Corgnet et al., 2019) or mitigating the negative impact of monitoring on intrinsic motivation (de Rochambeau, 2017).

The problem we address arises from asymmetric information between an organization or manager and their workers, who better understand their own abilities and those of their co-workers. Natural settings with such challenges include new or inexperienced managers unfamiliar with their workers' abilities, or non-experts appointing teams of specialists. For example, academic economists can quickly evaluate each other's abilities, but a non-specialist administrator may struggle to do so. Workers repeatedly solving joint problems likely understand their abilities better than any supervisor with imperfect monitoring capacity.

We anticipate two potential reasons for deviations from our theoretical results. First, standard incentive schemes might not lead to socially inefficient PAM if individuals perceive ability differences as unfair and opt for NAM to maximize aggregate team payments. Our experimental results do not support this possibility. Second, participants might struggle to calculate expected payoffs under Hybrid Incentives. We find that providing information about expected payoffs promotes optimal team formation. Study 1 shows that more participants make optimal decisions when given this information, while Study 2 confirms that participants still make more optimal decisions under Hybrid Incentives than under standard incentives, even without it.

We relate our results to the literature in Section 2 and present our theoretical results in Section 3. The two experiments and their results are described in Section 4. We conclude in Section 5.

2 Related literature

Our hybrid incentives combine features from two classic incentives schemes, who both lead to Negative Assortative Matching for different reasons.

Team incentives compare performance between teams and reward the best-performing one (Griffith and Neely, 2009). With such incentives, the competition occurs across teams, and all individuals prefer to team up with others of higher ability. In a field experiment with fruit pickers, Bandiera, Barankay and Rasul (2013) found that the most productive workers left their teams to match with other top performers after the introduction of team incentives. Filippin and van Ours (2015) found a similar pattern in the formation of teams for athletic relay races. Therefore, in endogenously formed teams, high ability individuals match with each other, and low ability individuals have no choice but to stay together.

Individual incentives compare performance between individuals and reward the best-performing individual of each team (Bailey, Hecht and Towry, 2011; Kräkel and Schöttner, 2010; Lazear and Rosen, 1981; Rajan and Reichelstein, 2006), fostering competition within teams. This encourages individuals to form teams with others of lower ability, as it maximizes their probability of outperforming their teammates. Indeed, Van Dijk, Sonnemans and Van Winden (2001) found that in exogenously formed teams, less productive workers are unhappy when matched with more productive co-workers. Similarly, Cullen, Long and Reback (2013) and Estevan et al. (2018) found that a policy guaranteeing university access to the top 10% of performers within each high school led high socio-economic status students to apply to lower-ranked schools to face less competition. Therefore, in endogenously formed teams, low ability individuals prefer to match with each other, and high ability individuals have no choice but to stay together.

Our paper revisits a classic problem (Becker, 1973; Legros and Newman, 2007): when there are rigidities in how surplus can be shared within teams,[1] self-interest often leads to PAM, even when NAM would have maximized the surplus produced. In line with these standard models, we look at players forming teams based on rational expectation of their respective production, including how they will behave once matched. However, it is possible to extend this problem to include the post-matching provision of effort within endogenously formed teams (see Appendix B.1).

While more realistic, introducing effort to our setting implies that individual decisions are

[1] This assumption corresponds to the idea that monetary transfers between team members are impossible. One reason is that such transfers would be non-contractible, as they would force low-ability workers to publicly reveal their type.

based not only on objective expected payoffs but also on respective expectations of effort, making it difficult to assess if a participant's choice is consistent with self-interest, and making individual choices more prone to errors. Thus, as our primary aim is to cleanly analyze the matching problem, we need to treat post-matching effort choices as exogenous in the experiment. Experimental evidence suggests that hybrid incentives also improve performance in the moral hazard dimension (Danilov, Harbring and Irlenbusch, 2019; Majerczyk, Sheremeta and Tian, 2019).

We also contribute more generally to the growing literature on team formation and mechanism design. There are two broad issues related to team formation: how team composition affects effort incentives, and how teams are formed. Most of the literature focuses on the former, while our work relates to the latter. Perhaps the closest to our theoretical contribution is Kambhampati and Segura-Rodriguez (2022), who show that when the production function is supermodular, and thus makes PAM the optimal matching structure, delegating the formation of teams to invidual workers rewarded by a form of teams incentives always lead to the optimal matching. However, they do not look at the case where the function is submodular, and the socially optimal matching structure is NAM. The main tradeoff identified in the literature on effort incentives is between the complementarity of ability and the propensity for free-riding in effort contributed to team projects (Franco, Mitchell and Vereshchagina, 2011; Kaya and Vereshchagina, 2014). It shows that contracts that make workers reveal their types to the principal may fail to elicit PAM when it is optimal because the distortion necessary to make low types reveal themselves is too high. When an organization monitors teams with limited capacity, NAM can be optimal (Halac, Kremer and Winter, 2024).

Finally, our work relates to the experimental literature on endogenous group formation in public good games by focusing on matching choices based on ability rather than other behavioral or social dimensions such as in the following studies. In the experiment by Ehrhart and Keser (1999), participants could freely move from one group to another based on information about average contributions in each group. They find that participants prefer to match with the most cooperative individuals. Page, Putterman and Unel (2005) find a similar pattern when participants are allowed to vote for whom to include in their group. Coricelli, Fehr and Fellner (2004) find that endogenous team formation leads to higher total contributions, as do Chen and Gong (2018), who show that this happens when participants self-select into teams based on their social networks.

3 Theory

3.1 Preliminaries

A game has four risk-neutral players, two of low ability (*type L*), and two of high ability (*type H*) (appendix A.5 shows that our main result holds for a continuum of types).[2] Two players form a *blocking pair* if they both prefer being matched to each other than to their current match. The teams are formed by letting players form blocking pairs, starting from a random initial allocation, until the matching is stable (Roth and Vate, 1990). As we are primarily concerned about the feasibility of inducing specific team structures, we assume the outside option of workers to be equal to zero. We show in Appendix B.2 that if we introduce outside options, there are cases where a social planner may prefer not to induce NAM, even when it generates a higher total surplus, because it involves giving higher rents to workers. The cases where this happens involve either the outside options of the two types being too similar, or too different.

Each game has two problems of equal difficulty, one for each team, to solve. Let the expected production of team $i \in 1, 2$ be denoted by $f_i(j, k)$, representing the quality of their solution, where $j, k \in \{L, H\}$. We assume that both teams have identical production functions and that f is symmetric and strictly increasing in both arguments. Additionally, we assume $H > L$, implying that $f_i(H, H) > f_i(H, L) > f_i(L, L)$. Finally, the value of the total production is $g(f_1, f_2)$, which is strictly increasing and symmetric in both arguments. This means that a "social planner," e.g. a policymaker or firm manager, values better solutions to each problem equally.[3]

Given the structure of the game, there are two possible matching outcomes. The first is *Positive Assortative Matching* (PAM), where the two players of type H form a team together, and the two players of type L do the same. The other possibility is *Negative Assortative Matching* (NAM), where each team is formed of a player of type H and a player of type L.

Which of those matching outcomes is socially preferred depends on the shape of f and g.

[2] What matters is that it is always possible to induce NAM when it generates higher aggregate surplus by using the share of the payment coming from Team Rewards as a way to transfer utility between types. We keep two types here for expositional clarity and because it is the model we test in the experiment.

[3] Relaxing this assumption, we could have a case where the solution to one problem is much more important than another, so that even if f displays decreasing differences g is maximized with PAM. This however does not affect our main result that when NAM is optimal Individual and Team incentives lead to a suboptimal matching, but hybrid incentives can always be designed to reach the optimal one.

Table 1: Example of values of f such that PAM is socially preferred, for $g = f_1 + f_2$

	L2	H2
L1	2	3
H1	3	5

Table 2: Example of values of f such that NAM is socially preferred, for $g = f_1 + f_2$

	L2	H2
L1	2	4
H1	4	5

Whenever

$$g\left(f_1(H,H), f_2(L,L)\right) \geq g\left(f_1(H,L), f_2(H,L)\right), \tag{1}$$

PAM is the socially preferred outcome. When condition (1) is not satisfied, NAM is the socially preferred outcome. The condition for NAM to be optimal is also known as *decreasing differences*, meaning that the positive impact of adding a player of type H to a team is higher when the other player is of type L than when it is of type H. To simplify the notation, we denote $g\left(f_1(H,H), f_2(L,L)\right) = g^{PAM}$ and $g\left(f_1(H,L), f_2(H,L)\right) = g^{NAM}$ for the rest of the paper.

We illustrate the difference with two examples in Tables 1 and 2, assuming $g = f_1 + f_2$. In Table 1, when matching is positive assortative, we have $f(L,L) = 2$ and $f(H,H) = 5$ so that $g^{PAM} = 7$. When matching is negative assortative, $f(H,L) = 3$ such that $g^{NAM} = 6 < g^{PAM}$. In Table 2, however, $f(H,L) = 4$, so that $g^{NAM} = 8 > g^{PAM} = 7$, and NAM produces the highest surplus. We return to these two tables as a running example of our theoretical results throughout this section.

3.2 Suboptimal matching under Team Incentives

Team Incentives involve ranking the performance of the two different teams, and providing the best-performing team with a share of the total surplus generated. Under Team Incentives, a share s of the total production g is awarded to the best-performing team, who then split it equally between the team's members. As we are not concerned about participation constraints, we simply take $s \in (0,1)$ as a measure of the exogenously determined relative bargaining power of players and the social planner.

We assume that the social planner uses a benchmarking technology with precision $p \in [\frac{1}{2}, 1]$ to (possibly imperfectly) evaluate the relative performance of both teams. Imperfect benchmarking could reflect the cost of auditing or monitoring performance, the asymmetric information between players and the social planner, or simply a level of randomness in the actual outcomes (as is the case in our experiment). Whenever the two teams have the same composition (NAM), the technology reports that each team performed the best with equal probability, so that all players receive an expected payment

$$\hat{\pi}^{NAM}_{L,team} = \hat{\pi}^{NAM}_{H,team} = \frac{1}{4} s \times g^{NAM}.$$

When the teams are of different abilities (PAM), each member of the team composed of two players of type H receives an expected payment

$$\hat{\pi}^{PAM}_{H,team} = \frac{1}{2} p \times s \times g^{PAM}.$$

Each member of the team of two type L players therefore receives

$$\hat{\pi}^{PAM}_{L,team} = \frac{1}{2}(1-p) \times s \times g^{PAM}.$$

We assume that all players are risk neutral so that the expected payment can equivalently be interpreted as shares of the total or as probabilities.

Proposition 1 *With Team Incentives, there are values of the parameters such that NAM is optimal but PAM is the equilibrium. The opposite is not true. The unique equilibrium is PAM whenever* $p > \frac{1}{2}\frac{g^{NAM}}{g^{PAM}}$, *NAM whenever* $p < \frac{1}{2}\frac{g^{NAM}}{g^{PAM}}$, *and both equilibria coexist when* $p = \frac{1}{2}\frac{g^{NAM}}{g^{PAM}}$.

The formal proof is in Appendix A.1. Proposition 1 shows the existence of a tradeoff between the quality of the benchmarking technology and the quality of matching: unless $p = 1/2$, there are values of the parameters such that the total surplus is higher with NAM ($\frac{g^{NAM}}{g^{PAM}} > 1$) but the unique equilibrium is such that players match assortatively (PAM). The reason is that players of type H often want to form a blocking pair and guarantee themselves a large share of the smaller surplus g^{PAM} instead of matching with a type L and receiving a lower share of the higher surplus

g^{NAM}. Unless the total surplus under NAM is at least twice as large as the surplus under PAM, a perfectly precise benchmarking technology $p = 1$ fails to lead to a NAM equilibrium.

As an illustration, assume the benchmarking technology is perfect, $p = 1$. In the example where PAM generates the highest surplus (Table 1), we see immediately that the two players of type H form a blocking pair. If they match together, they receive half of the share s of the high surplus with certainty $\frac{s}{2} \times g^{PAM} = \frac{7s}{2}$. If a type H matches with a type L, they only win half of the share of the surplus with probability $\frac{1}{2}$, and this surplus is lower, $\frac{s}{4} \times g^{NAM} = \frac{3}{2}s$. When PAM generates the highest surplus, Team Incentives thus lead to the optimal outcome. In the example of Table 2, where NAM generates the highest surplus, the same blocking pair continues to exist. Winning with certainty yields an expected payment of $\frac{s}{2} \times g^{PAM} = \frac{7s}{2}$. If a type H matches with a type L, their expected surplus is $\frac{s}{4} \times g^{NAM} = 2s < \frac{7s}{2}$. Team Incentives therefore lead to the optimal matching when it is PAM, but not when it is NAM.

3.3 Suboptimal matching under Individual Incentives

Individual Incentives involve rewarding the best-performing member of each team. Under Individual Incentives, a share s of the total production g is split equally between the best-performing members of each team. We assume the same benchmarking technology as for Team Incentives, such that in any team with two identical players (PAM), both are reported as the highest performer with equal probability; while in teams with different abilities (NAM), the player of type H is reported as the better performer with probability $p \in [1/2, 1]$. For simplicity, we assume the same technology for assessing teams and individual incentives, but we show in Appendix A.4 that our main result still holds with two distinct p, as long as at least one of them is informative.

Whenever matching is negatively assortative, each player of type H receives expected surplus

$$\hat{\pi}^{NAM}_{H,individual} = \frac{1}{2} p \times s \times g^{NAM},$$

while players of type L receive

$$\hat{\pi}^{NAM}_{L,individual} = \frac{1}{2}(1 - p) \times s \times g^{NAM}.$$

When abilities are identical within teams (PAM), all players receive the same expected surplus

$$\hat{\pi}^{PAM}_{L,individual} = \hat{\pi}^{PAM}_{H,individual} = \frac{1}{4} s \times g^{PAM}.$$

Proposition 2 *With Individual Incentives, there are values of the parameters such that NAM is optimal but PAM is the equilibrium. The opposite is not true. The unique equilibrium is PAM whenever* $p > 1 - \frac{1}{2}\frac{g^{PAM}}{g^{NAM}}$*, NAM whenever* $p < 1 - \frac{1}{2}\frac{g^{PAM}}{g^{NAM}}$*, and both equilibria coexist when* $p = 1 - \frac{1}{2}\frac{g^{PAM}}{g^{NAM}}$*.*

The formal proof is in Appendix A.2. Proposition 2 shows a tradeoff similar to Team Incentives, but for different reasons. When benchmarking happens within a team, everybody wants to be compared to players of type L. As in the case of Team Incentives, matching becomes less efficient when the benchmarking technology improves, and a perfectly precise benchmarking technology $p = 1$ fails to lead to a NAM equilibrium when surplus under NAM is larger than under PAM.

When PAM generates the highest surplus, Individual Incentives lead to the optimal outcome. In the example in Table 1, both players of type L form a blocking pair when the benchmarking technology is perfect $p = 1$. If two type L match together, they receive half of the share s of the high surplus with probability $1/2$, $\frac{s}{4} \times g^{PAM} = \frac{7s}{4}$. If a type H matches with a type L, the type L player is certain to receive zero surplus. In the example in Table 2, where NAM generates the highest surplus, the same blocking pair continues to exist, as a player of type L is certain to lose against a type H. Individual Incentives, just like Team Incentives, therefore lead to the optimal matching when it is PAM, but not when it is NAM.

3.4 Optimal matching with moral hazard under Equal Sharing

A corollary of Propositions 1 and 2 is that it is possible to reach the efficient matching allocation if the benchmarking technology is sufficiently bad, equivalent to an Equal Sharing rule where all participants receive $s \times g$ with probability $1/4$. While this result is useful as an illustration of the tradeoff between the quality of benchmarking and matching efficiency, it is a much weaker solution when matching precedes a last stage of effort provision where we expect moral hazard. Without additional incentives, effort provisions under Equal Sharing are similar to a game of voluntary contributions to the public good g, and equilibrium levels of effort are always lower than with the other schemes (see Appendix B.1).

Besides incentivizing effort, there are two main reasons why a social planner would not want to rely on such a scheme. First, introducing a participation constraint would mean it is more costly to attract type H if they receive the same expected payment as type L (assuming their outside options are different, see Appendix B.2). Second, players may care about being able to signal their type in the longer run through their evaluations, whether to be promoted within an organization, or to improve their outside option.

In the next section, we show that a combination of Team and Individual Incentives can, however, also achieve the efficient allocation, even when the benchmarking technology is perfectly precise.

3.5 Optimal matching without moral hazard under Hybrid Incentives

The key behind the fact that standard incentives schemes always lead to PAM is our assumption that utility is non-transferable within teams. The condition for a payment that rewards team success to lead to NAM in our case is for "frog to be a prince" (Legros and Newman, 2007): the lowest ability workers must be able to transfer some utility to the highest ability ones. In our context, we can satisfy this condition by introducing a dose of Individual Incentives to Teams Incentives.

Consider a combination of the two standard reward schemes presented above, such that a share $q \times s$ of the total production g goes to the best-performing team (Team Incentives), while a share $(1-q) \times s$ is shared equally between the best-performing members of each team (Individual Incentives). As we assume all players to be risk neutral, this specification is equivalent to using Team Incentives with probability q and Individual Incentives with probability $1 - q$. For instance, the expected profit of a player of type L with NAM is equal to

$$\hat{\pi}^{NAM}_{L,hybrid} = q \times \hat{\pi}^{NAM}_{L,team} + (1 - q) \times \hat{\pi}^{NAM}_{L,individual},$$

and the same logic holds for other players and configurations.

Proposition 3 *For all possible values of the precision of the benchmarking technology p, there exists a weight put on Team Incentives q^* such that the unique equilibrium is always optimal: NAM whenever $g^{NAM} > g^{PAM}$, PAM whenever $g^{NAM} < g^{PAM}$ and both equilibria coexist when $g^{NAM} = g^{PAM}$.*

The formal proof for the general case is in Appendix A.3. Looking first at the example where PAM is optimal in Table 1 and assuming a perfect benchmarking technology $p = 1$, there is a blocking pair from the two players of type H whenever the probability of Team Incentives is sufficiently high,

$$q > \frac{5}{11} = \bar{q}. \tag{2}$$

There is a blocking pair from the two type L whenever this probability is sufficiently low,

$$q < \frac{7}{13} = \underline{q}. \tag{3}$$

As, in this case, $\bar{q} < \underline{q}$, for every possible value of q there is a blocking pair ensuring the unique equilibrium matching is the optimal one, PAM.

Looking now at the example in Table 2, there is a blocking pair from players of type H whenever the probability of Team Rewards is sufficiently high,

$$q > \frac{3}{5} = \bar{q}'. \tag{4}$$

There is a blocking pair from the two type L whenever this probability is sufficiently low,

$$q < \frac{7}{15} = \underline{q}'. \tag{5}$$

In this case, $\bar{q}' > \underline{q}'$, so that for any $q^* \in (\underline{q}', \bar{q}')$ the unique equilibrium is NAM: both types of players propose to the other type. Intuitively, when NAM generates the highest surplus, there is always a way to weight two standard schemes to make players pick that option. Moreover, opting for Hybrid Incentives with $q^* \in (\underline{q}', \bar{q}')$ ensures the optimal matching in all configurations, as for any q the unique equilibrium is PAM whenever it is optimal. In contrast with an Equal Sharing rule, Hybrid Incentives are compatible with a perfect benchmarking technology, and offer a feasible solution when matching precedes a last stage of effort provision where we do not expect moral hazard (see Appendix B.1).

We present Hybrid Incentives in terms of weight q^* to make salient that our proposed scheme is a combination of Team and Individual Incentives, with the objective to make their interest clear to team members in an experimental setting. We could however design an identical payment scheme in an even simpler way, by offering three different fixed bonuses. Assuming

$g^{NAM} > g^{PAM}$, a principal could offer a bonus $B_{Ww} = (1-q^*)\times s\times g^{NAM}$ to the best-performing member of the best-performing team (as measured by the imperfect benchmarking technology), and identical bonuses $B_{Wd} = B_{Dw} = \frac{q^*\times s\times g^{NAM}}{2}$ to the best-performing member of the worst performing team, and to the worst performing member of the best-performing team. A principal not aware of g^{NAM} could reach a similar outcome by committing to equivalent shares of the total surplus. We provide a formal proof of this result in Appendix A.6.

4 Two experiments

We run two experimental studies to test our theoretical predictions from complementary angles and the robustness of our main results.

4.1 Study 1

4.1.1 Design

Matching procedure The game is played in groups of four participants each. A participant is either a high or low ability type, labeled as "Type I" and "Type II" respectively. Two participants within a group are randomly assigned high ability, while the other two are assigned low ability. Participants make a binary choice about which type of other participant they propose to pair with. Every participant knows her own type and it is common knowledge that there are two participants of each type. Two participants form a team if their proposals are matched. For example, if high ability participant X proposes to a low ability participant, and a low ability participant Y proposes to high ability participant, then X and Y's proposals are matched – they form a team. In the situation where one's proposal matches two participants' proposals, one is randomly paired with either of the two. If there is only one team formed by matching proposals, the remaining two participants form another team. As players propose to match with a type and not a specific individual, there is always at least one pair of proposals matching each other.

Production function and benchmarking After the two teams are formed, each participant draws a number between 0 and 10 from the uniform distribution, which is multiplied by a factor 4 (low type) or 10 (high type) to generate a personal score. The production function of a team is such that the highest personal score in each team is counted as the team score. Intuitively, this is close to the experts in Chade and Eeckhout (2018) observing signals of various quality or the written group coursework of students in Fischer, Rilke and Yurtoglu (2023). It should be somehow familiar to our participants, and therefore a good candidate where the optimality of NAM is intuitive.

The total production of the group is equal to the sum of the two team scores. We tell participants that winning in a given incentive scheme means receiving a number of experimental points corresponding to this total production. This corresponds to our theoretical assumption that income is a share of the total surplus.

The benchmarking technology for Individual Incentives corresponds to comparing the two personal scores within a team. For Team Incentives, it corresponds to comparing the two team scores. A higher ability (or average ability in the team) increases the probability of being ranked first, but the benchmarking technology only imperfectly identifies the different types. In our experimental setting, the imperfection of the benchmarking technology arises from the draw of a random number.

We expected participants to understand the payoff structures and profit-maximizing choices under the standard schemes. Our first main unknown is to what extent participants understand the optimality of NAM. While the intuition is familiar to economists, computing the exact expected payoffs in different configurations is not as straightforward. The second main unknown corresponds to the decisions made under Hybrid Incentives. We did not expect participants to be able to compute the exact cutoff point at which they should switch from matching with one type to the other, but the principle of switching at some probability level should follow directly from making optimal decisions in Teams and Individual Incentives. We provide the computations and expected values in Appendix B.3.

Incentive schemes We are interested in matching decisions under four incentive schemes. The first two are the standard Team Incentives and Individual Incentives. The third is Equal Sharing, a scheme equivalent to the non-informative benchmarking technology $p = 0.5$ discussed in the theory section. Decisions under this scheme reflect whether participants understand the optimality of NAM. The fourth is Hybrid Incentives where participants are compensated based on Team Incentives with probability $q \in [0, 1]$ and Individual Incentives with probability $1 - q$.

Rationality and preferences To test the extent to which computational complexity rather than social preferences account for behavior that deviates from payoff-maximization, we varied the amount of information on expected payoffs provided to participants across sessions. In all sessions, participants had unlimited use of a simulator that randomly drew numbers to generate hypothetical payoffs, which was activated by clicking a "sim" button on the screens. In half of the sessions, we applied an *Information* treatment that additionally provided the expected values of pairing with each type in Equal Sharing and Hybrid Incentives, which were not provided in the *No-Information* treatment.

Logistics The experiment was conducted in August 2022 in the experimental economics laboratory of Nanyang Technological University (NTU), Singapore, and received IRB approval from the university. It was fully computerized and programmed in z-Tree (Fischbacher, 2007). A total of 96 students from various fields and years of study participated in a total of eight sessions, with twelve participants in each session. Participation was voluntary and advertised through email invitations. Each participant took part in only one session.

At the start of each session, four participants were assigned to a group, which remained unchanged throughout the session. Types were fixed throughout the session. Each session had four stages, each of which applied one incentive scheme to determine participants' earnings. This within-subject design therefore gives us 24 independent observations per incentive scheme at the group level. For Team Incentives, Individual Incentives, and Equal Sharing, the game was repeated for six rounds in each stage to allow for learning. At the end of each round, participants received feedback on the team composition and earnings of each person. Testing Team and Individual Incentives before combining them in Hybrid Incentives served as training, familiarizing participants with the two standard incentives schemes that form the basis of the more complex Hybrid Incentives. We can also test if participants understand the profitability of NAM under Equal Sharing.

In Hybrid Incentives, we used an MPL – inspired by Holt and Laury (2002) – to elicit participants' decisions across eleven scenarios with q varying from 0 to 1 with increments of 0.1, as shown in the screenshot from the experiment in Figure 1. The objective of Study 1 was to elicit preferences for a large range of values of q for each individual, in order to identify their switching point (if any), something we could not achieve by picking a value of q at random. The MPL also allows us to elicit behavior for Team and Individual Incentives, which are the polar cases where $q = 1$ and $q = 0$, respectively, again and in a way that is directly comparable to choices across the range of non-degenerate parameter values. To indirectly control for potential spillover effects across stages, we counterbalanced the orders between Team and Individual

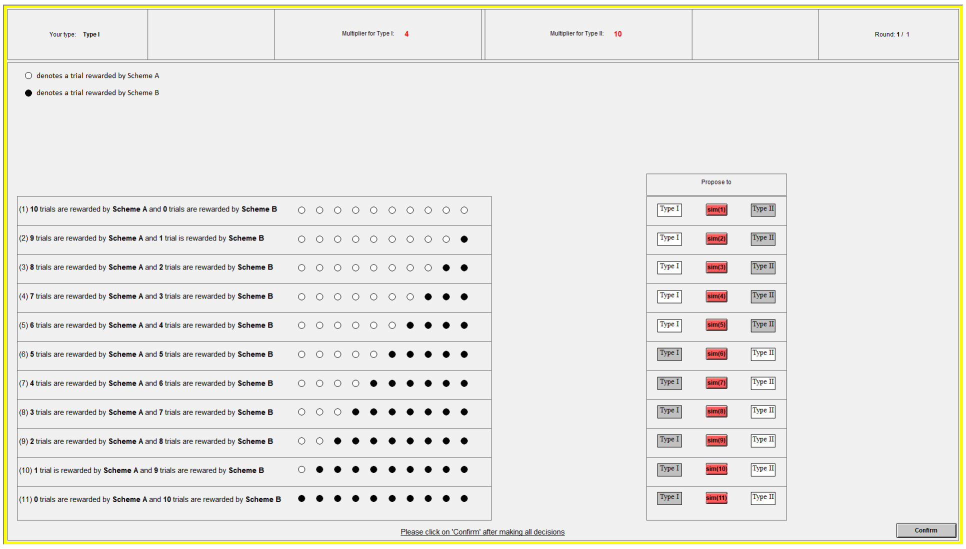

Figure 1: Screenshot of participants' decisions in Hybrid Incentives (Study 1)

Incentives, and between Equal Sharing and Hybrid Incentives. This gives us four sequences, and interacting them with the *Information* treatment gives us eight experimental conditions, as shown in Table 3.

Table 3: Experimental conditions (Study 1 and 2)

	No-Information	Information for H and E
T – I – H – E	Session 1	Session 5
I – T – H – E	Session 2	Session 6
T – I – E – H	Session 3	Session 7
I – T – E – H	Session 4	Session 8

Note: T = Team Incentives, I = Individual Incentives, E = Equal Sharing, H = Hybrid Incentives.

Upon arrival, participants were randomly assigned to partitioned terminals in the laboratory. The partitions prevented visual communication between participants. Verbal communication was also prohibited. Once seated, participants received a copy of the instructions. The instructions are found in the Online Appendix (currently placed in Appendix E.1 and to be made available on osf.io for the published version). The experimenter read the instructions aloud to establish common knowledge of the tasks. Participants were then required to answer a control questionnaire regarding the experiment to check their understanding of the procedure, and were allowed to proceed once their understanding was confirmed. Participants were advised to raise their hand for assistance at any point in the experiment. All questions were answered privately by the experimenter. The experiment started once all participants passed the quiz.

At the end of the experiment, participants completed a questionnaire on demographics and comments about their tasks. Descriptive statistics of our sample are provided in Appendix D. Participants then received their earnings from seven randomly selected rounds and a S$6 (Singapore dollar) participation fee. We randomly selected two rounds from each stage of Team Incentives, Individual Incentives, and Equal Sharing, as well as one scenario from the Hybrid Incentives stage. Participants were paid through PayNow, an electronic bank transfer method where senders require only the mobile phone numbers of recipients to make transactions. Each experimental point was worth S$0.02. On average, each participant received S$14.98.[4] Each session lasted around 60 minutes.

Hypotheses Summarizing our theoretical predictions, the experiment looks at the following four hypotheses.

H1: With Team Incentives, teams are formed according to PAM. Both types propose to match with high ability types.

H2: With Individual Incentives, teams are formed according to PAM. Both types propose to match with low ability types.

H3: With Equal Sharing, teams are formed according to NAM. High ability types propose to match with low ability types and vice versa.

H3 corresponds to the idea that the higher surplus in NAM is intuitive, even when only a simulator is provided. The difference between treatments with and without expected values should give us an idea of whether decisions inconsistent with NAM are the reflect of a failure to understand the surplus maximizing choice or a matter of preferences.

H4: With Hybrid Incentives, all participants have a unique cutoff value of q at which they switch their proposal. Teams are formed according to NAM for $q = 0.4$ and $q = 0.5$ and PAM for all other values.

H4 implies that participants understand that switching their proposals is in their interest as the probability (q) of being rewarded by Team Incentives increases. Low ability types should switch their proposals (from low to high type) at $q > 0.3$, while high ability types switch (from low to high type) at $q > 0.5$ (see Table 6 in Appendix B.3). We test whether participants are able to identify the exact point at which switching occurs when provided with expected values, which renders $q = 0.4$ and $q = 0.5$ the area where both types propose to each other and where NAM teams will be formed.

[4]This is more than the average student assistant wage of S$10 per hour at the university.

Departing from self-interest, we review in Appendix B.4 the potential role of social preferences and their impact on the above theoretical hypothesis. A significant share of high ability types sacrificing their higher expected surplus in order to equalize payoffs and increase total efficiency in Team Incentives would reflect a perception that random differences in ability are inherently unfair. This should not happen with Individual Incentives, unless efficiency concerns are paramount as all expected payoffs in Individual Incentives are identical when teams are of homogeneous abilities.

4.1.2 Results

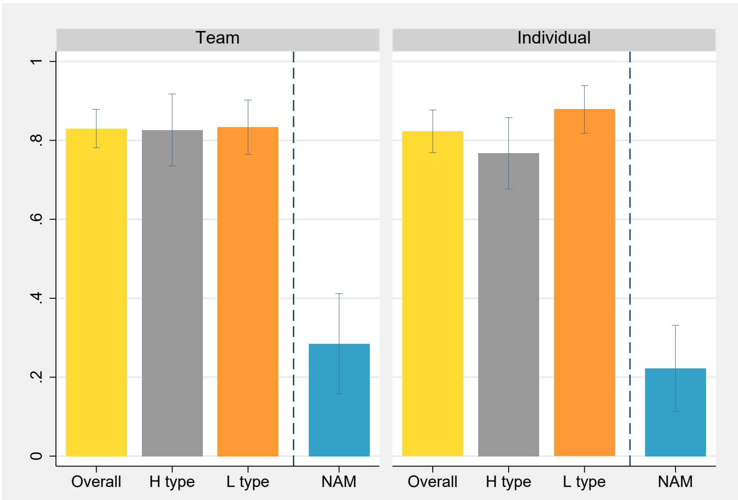

Figure 2: Share of decisions conforming to model predictions and proportion of NAM teams in Team and Individual Incentives (Study 1)
Note: Capped spikes show 95% CIs with data clustered at group-level.

H1 and H2: Team and Individual Incentives Figure 2 reports the aggregate results of the two standard incentive schemes. Overall, 83% of decisions propose to a high type in Team Incentives and to a low type in Individual Incentives. There is no significant difference between the decisions made by the two types of participants in Team and Individual Incentives. Consequently, 71.5% and 77.8% of the teams are PAM in Team and Individual Incentives respectively, consistent with H1 and H2. Figure 13 in Appendix C.1 shows that participants' decisions have no time trend across rounds in the two standard schemes.

Figure 3 presents the distributions of decisions by each participant that were consistent with predictions for Team and Individual Incentives. 74% and 70.8% of participants chose as predicted at least five times out of six in Team and Individual Incentives respectively, while only 2.1% of the participants chose the predicted decisions less than two times. The remaining minority of participants seem to diversify between two choices. The analysis of preference for naïve diversification is further explored in the section on Hybrid Incentives below and in Appendix C.1.2. This means that a large majority understands the two standard schemes and systematically chose the theoretically predicted decision.

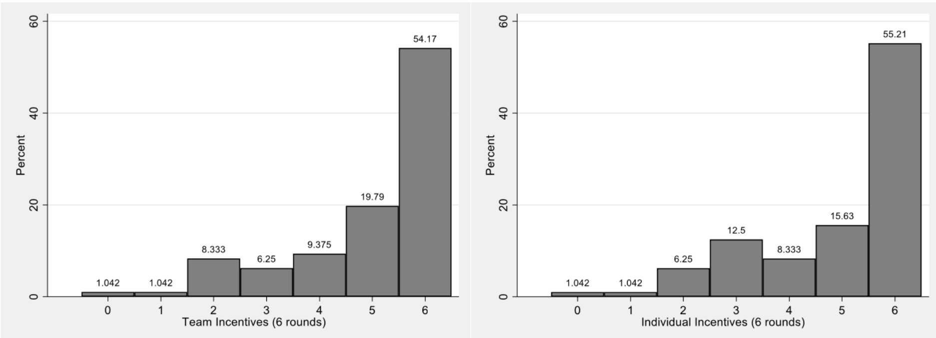

Figure 3: Distribution of the number of decisions per participant consistent with the predictions in Team and Individual Incentives (Study 1)
Note: Each bar shows the proportion (vertical axis) of the number of decisions consistent with predictions (horizontal axis) for two schemes.

We find no significant evidence of inequity aversion (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000), which as shown in Appendix B.4 predicts more H types proposing to team up with L types in Team Incentives than L types proposing to team up with H types in Individual Incentives (Wilcoxon p = .52).[5] Indeed, both cases deviate from profit-maximization, but if the exogenous ability of our participants is perceived as unfair, NAM increases equity in Team Incentives, but decreases it in Individual Incentives.

H3: Equal Sharing The aggregate results for Equal Sharing are reported in Figure 4.[6] Consistent with H3, 76.7% of proposals are made to the other type, which maximizes expected monetary payoffs. In the No-Information treatment, 70.5% of the decisions are consistent with self-interest, as compared to 83% in the Information treatment (Mann-Whitney U test, MWU p = .09). Without information, a share of decisions did not reflect an appreciation of the nature of decreasing differences, and the share of H types making correct offers is not significantly higher than a random choice. In the post-experiment questionnaire, several participants also stated that their choice "does not matter, as everyone wins in Equal Sharing."

As a result, the share of NAM teams is 85.4% in Equal Sharing, with a sharp difference between No-Information and Information treatment (75% vs. 95.8%, MWU p = .04). To see

[5] All p-values reported in our analysis are two-tailed.
[6] Details of the number of individual decisions conforming to prediction can be found on Figure 15 in Appendix C.1.3.

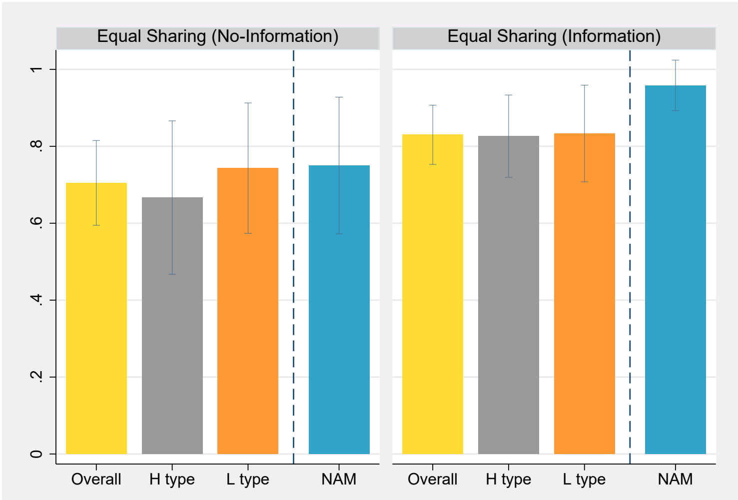

Figure 4: Share of decisions conforming to model predictions and proportion of NAM teams in Equal Sharing (Study 1)
Note: Capped spikes show 95% CIs with data clustered at group-level.

why the latter figure is close to 100% despite 17% of incorrect individual decisions, note that it is enough for a single participant of each type to propose to the other type to guarantee NAM. This is a feature of the experiment, but also of real-world matching: if two people agree to match each other, their choice reduces the possibilities offered to the others. Figure 14 in Appendix C.1.3 shows that there is no apparent dynamic trend in decisions made by participants across rounds.

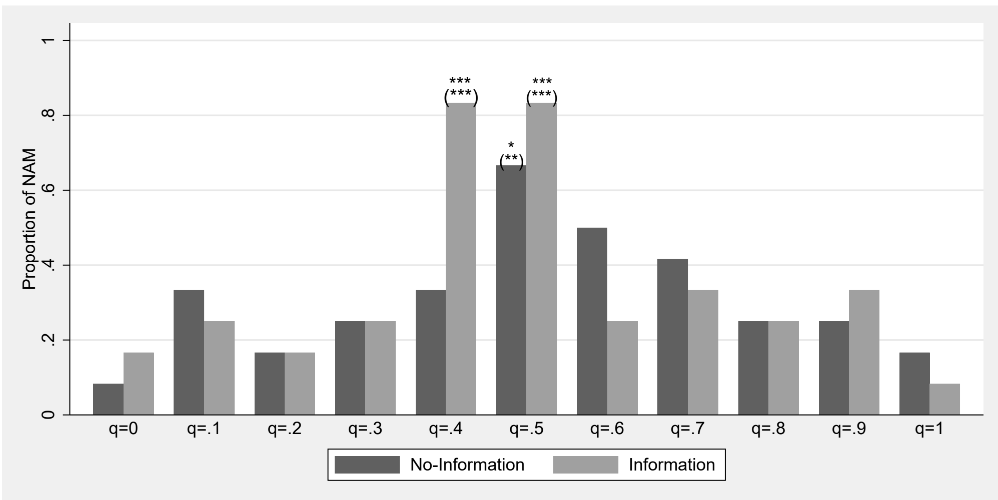

Figure 5: Proportions of NAM teams in Hybrid Incentives for different values of q (Study 1)
Note: * (**) [***] denotes p < 0.1 (0.05) [0.01] in Table 10 of Appendix C.1. Upper (lower) asterisks show the comparison with Team (Individual) Incentives where $q = 1$ ($q = 0$) in the same stage.

H4: Hybrid Incentives Figure 5 shows the share of NAM teams formed in Hybrid Incentives. The shares of NAM teams at the tail ends where $q = 0$ (Individual Incentives) and $q = 1$ (Team

Incentives) are consistent with predicted and actual proportions in the two standard schemes. Table 10 in Appendix C.1 compares team formation of each q in Hybrid Incentives with $q = 0$ (Individual Incentives) and $q = 1$ (Team Incentives) based on the data from this stage (i.e. not the data from the preceding stages of repeated observations); the results are presented in Figure 5. It shows Hybrid Incentives can successfully generate more NAM teams than the polar schemes for $q = 0.4$ only with information on expected values and for $q = 0.5$ with or without expected values. Hence, Hybrid Incentives have the potential to improve the optimality of matching in self-organizing teams, but this may not come immediately or naturally.

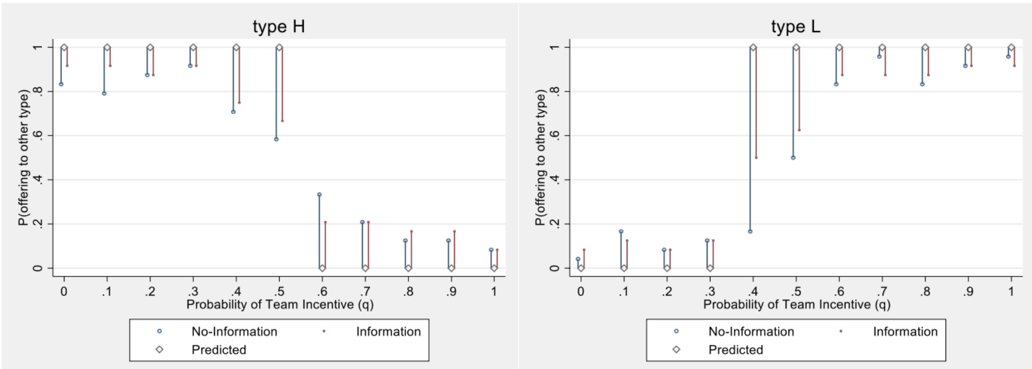

Figure 6: Predicted and actual share of proposals to other type in Hybrid Incentives for different values of q per player type (Study 1)

Looking at choices for the MPL, we find that 68.75% of our participants switch systematically (only once) between proposing to L and H and in the right order. The difference is not significant between the No-Information and Information treatments (64.6% vs. 72.9%, MWU p = .44). Among those who do not make systematic proposals in Hybrid Incentives, six participants (20%) keep proposing to one type. For the rest who are alternating proposals, 54.2% of them also switch choices (more than twice) across rounds in the stages of Team or Individual Incentives, which suggests they might have an innate preference for naïve diversification (see Appendix C.1.2).

Figure 6 depicts the shares of proposals to the other type in Hybrid Incentives for different values of q. The hollow diamonds mark the predicted value which takes either 0 or 1. Theoretically, H types should switch their proposals (from L to H) at $q > 0.5$, while L types should switch (from L to H) earlier at $q > 0.3$, which makes $q \in [.4, .5]$ the overlapping area where both types of participants are willing to match with each other. The dots show the actual share while the lines indicate the share of decisions that deviate from theoretical predictions.

Information on expected values helps L types switch systematically and optimally. At

q = 0.4 and q = 0.5, the deviation rates are 50% and 37.5% respectively when expected values are provided; however, they increase to 83.3% and 50% with no expected values provided (MWU p = .01 for q = 0.4). Overall 33.3% of the L types switch at the predicted point q = 0.3 in the Information treatment, while no L types does so in the No-Information treatment (MWU p = .00). We find no such significant difference for the H types, perhaps because the switching point at q = 0.5 corresponds to a more intuitive cutoff.

Table 4: Logit regressions on team formation in Equal Sharing (Study 1)

Dependent Variable: *NAM* = 0 or 1			
	No-Information	Information	All
	(1)	(2)	(3)
Individual	-0.418	-0.238	-0.334
	(0.734)	(0.663)	(0.487)
Equal	1.857***	4.265***	1.901***
	(0.432)	(0.815)	(0.386)
Information			-0.260
			(0.370)
Equal×Information			2.300***
			(0.809)
Round	-0.041	-0.122	-0.073
	(0.060)	(0.079)	(0.047)
Constant	-0.615	-0.682	-0.542
	(0.407)	(0.474)	(0.344)
Observations	216	216	432

Note: Robust standard errors clustered by groups are in parentheses. Two-tailed p-values < 0.1*, 0.05**, 0.01***.

Regressions on team formation To corroborate our result that Equal Sharing can induce more NAM teams than the two standard schemes, we run logit regressions with robust standard errors clustered at the group-level on team formation using as dependent variable *NAM*, taking value 1 when NAM teams are formed, and 0 for PAM. We include *Individual* (= 1 for Individual Incentives, 0 otherwise) and *Equal* (= 1 for Equal Sharing, 0 otherwise) to compare between Equal Sharing and two standard schemes. *Information* (= 1 if with information on expected values was provided, 0 otherwise) controls for the information treatments. Time is controlled by *Round* (= 1 to 6). Table 4 reports the results. Models 1 and 2 test data in No-Information and Information treatments respectively, while model 3 pools the data. The dummy *Equal* is positive in models 1-3, showing more NAM teams are formed under Equal Sharing than Team Incentives (coefficients of *Equal* are also larger than *Individual*, all p < .01). The impact of providing expected values on Equal Sharing can be seen from the positive interaction term *Equal* × *Information* in model 3. The main regression results are robust to controlling for the orders in which incentive schemes were presented during the respective sessions (see Appendix C.1.3).

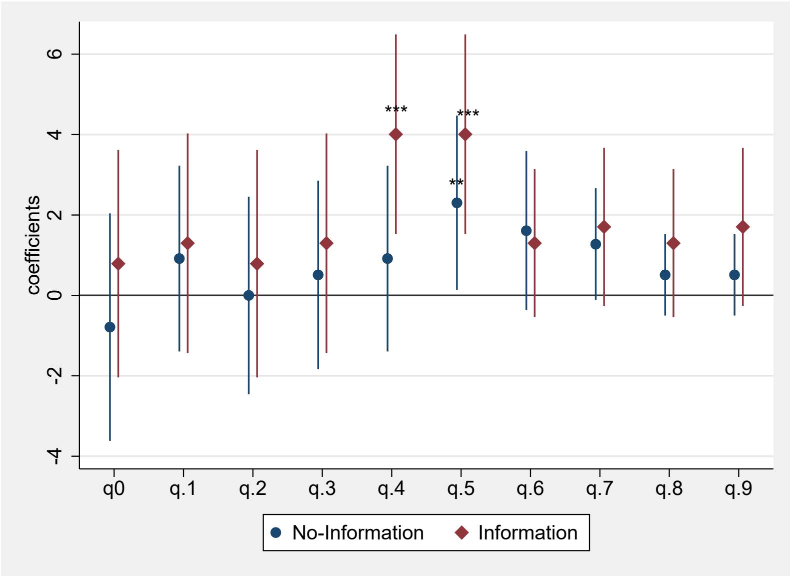

Figure 7: Coefficients of q in Hybrid Incentives with Team Incentives as baseline (Study 1)
Note: 95% confidence intervals based on robust standard errors clustered by groups are illustrated by the vertical lines stemming from each node. Two-tailed p-values < 0.1*, 0.05**, 0.01*** for comparisons with the baseline $q = 1$.

We further verify that Hybrid Incentives can induce more NAM teams when $q \in [.4, .5]$ than under the two standard schemes. We run regressions to test the dependence of *NAM* on q. To compare each scenario to Team Incentives where $q = 1$ (or Individual Incentives where $q = 0$), we define a dummy variable for each value of q except $q = 1$ ($q = 0$) which serves as the baseline. Figure 7 shows the coefficients for each q value for the comparison with Team Incentives. The differences relative to Team Incentives are significant for $q = 0.5$ with No-Information (p = .04), and for $q = 0.4$ and $q = 0.5$ with Information (both p = .00). The results are robust if we use $q = 0$ as baseline, or if we control for the order of treatments (see Appendix C.1.3). We thus confirm our findings in Figure 5 that Hybrid Incentives can lead to more NAM teams for $q = 0.4$ with information and for $q = 0.5$ with or without information.

Comparison between Equal Sharing and Hybrid Incentives Here we compare the superiority of the two schemes, i.e. Equal Sharing and Hybrid Incentives, which can successfully induce more optimal teams. While Hybrid Incentives generate slightly fewer NAM teams than

Equal Sharing, this difference is not significant for $q = 0.4$ and $q = 0.5$. In the No-Information treatment, the difference between the proportion of NAM teams in Equal Sharing (75%) and Hybrid Incentives with $q = 0.5$ (66.7%) is not significant (Wilcoxon p = .67). In the Information treatment, Equal Sharing (95.8%) leads to more NAM teams than Hybrid Incentives with $q = 0.4$ (83.3%) and $q = 0.5$ (83.3%), although insignificant (Wilcoxon p = .75 and .5, respectively).

4.2 Study 2

4.2.1 Design

In Study 2, we modified the experiment to directly compare incentive schemes using repeated observations. Specifically, we replaced the Multiple Price List (MPL) in the hybrid scheme with a fixed stage where $q = 0.5$, repeated over six rounds. We focused on the treatment without information, meaning participants were not informed of the expected value corresponding to their choices in the Hybrid Incentives and Equal Sharing schemes. The rest of the protocol mirrored Study 1. This alternative implementation relates better to real world settings, and replicating our main results will demonstrate the robustness of our proposed Hybrid Incentives. Study 2 was preregistered at osf.io/g2aym and conducted in November 2024 and January 2025 in the experimental economics laboratory of Nanyang Technological University (NTU), Singapore. We conducted eight sessions with twelve participants each, totaling 96 students, mirroring Study 1. The demographic distributions are similar to Study 1 (see Appendix D). We counterbalanced the orders of incentive schemes across sessions, as in Study 1. Each sequence in Table 3 was tested for two sessions. The experimental instructions for Study 2 are included in Appendix E.2.

4.2.2 Teams formed across schemes

Our main pre-registered hypothesis in Study 2 is to determine whether Hybrid Incentives can lead to more NAM teams than Team Incentives and Individual Incentives when NAM is optimal (for $q = 0.5$). We also tested whether an Equal Sharing rule, which divides the team surplus equally among members, could lead to the formation of NAM teams.

Figure 8 shows the proportion of NAM teams across different schemes. As predicted by the theory, NAM teams rarely form under both Team and Individual Incentives (0.18 vs 0.29,

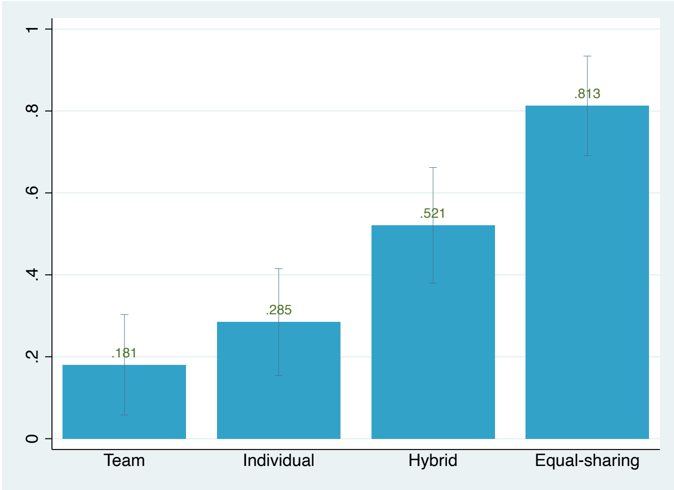

Figure 8: Proportion of NAM teams across schemes (Study 2)
Note: 95% confidence intervals based on robust standard errors clustered at group-level.

Wilcoxon p = .14). However, Hybrid Incentives and Equal Sharing significantly induce more NAM teams than the standard schemes (Wilcoxon, all $p < .01$). These results align with the No-Information treatments of Study 1, where the respective proportions were 0.32 for Team Incentives, 0.24 for Individual Incentives, 0.67 for Hybrid Incentives (with q=0.5), and 0.75 for Equal Sharing. The results are similar at the individual level (see Appendix C.2).

To corroborate these results, we run logit regressions on team formation with the dependent variable indicating whether NAM teams were formed ($NAM = 1$) or not ($NAM = 0$). Table 5 reports the results, with Team Incentives and Individual Incentives as baseline in model 1 and 2, respectively. The positive coefficients for *Hybrid* and *Equal* in both models are consistent with the findings reported in Figure 8.

Table 5: Logit regressions on team formation (Study 2)

Dependent Variable: *NAM* = 0 or 1			
	(1)		(2)
Team	-0.591	*Individual*	0.591
	(0.536)		(0.536)
Hybrid	1.005***	*Hybrid*	1.596***
	(0.303)		(0.420)
Equal	2.388***	*Equal*	2.979***
	(0.588)		(0.571)
Period	-0.008	*Period*	-0.008
	(0.046)		(0.046)
Constant	-0.894***	*Constant*	-1.485***
	(0.281)		(0.401)
Observations	576	Observations	576

Note: Robust standard errors clustered by groups are in parentheses. Two-tailed p-values < 0.1*, 0.05**, 0.01***.

We also find that the performance yardstick Equal Sharing elicits significantly more NAM teams than Hybrid Incentives (Wilcoxon $p < 0.01$).[7] In the context of our experiment, where the only problem faced by the organization is adverse selection on the ability of the workers, offering all workers a fixed share of the total production may thus be the optimal way to endogenously form teams. The main tradeoffs with Hybrid Incentives is that these have been shown empirically to also induce higher effort than standard schemes, so they will be preferable to an Equal Sharing rule in a context where moral hazard is a major concern.

5 Conclusion

In this paper, we show that a simple combination of two standard incentive schemes has the potential to lead to the surplus-maximizing match of abilities in self-organizing teams. Our theoretical results therefore suggest that hybrid incentives are an effective way to compensate workers in a world where teams are increasingly allowed to operate autonomously. Indeed, we experimentally showed that hybrid incentives elicit signficantly more negative assortative matching than team and individual incentives. We also found that equal sharing provides a simpler yet effective solution for matching in settings where moral hazard is not a concern, which may very well help explain why they remain so prevalent in practice. However, when moral hazard or participation constraints are of concern, hybrid incentives offer a solution.

[7] Also in Table 5, the coefficients of *Equal* are significantly higher than *Hybrid* (p = .00).

From the perspective of firms and organizations, hybrid incentives could be enhanced by information interventions that make it clearer to workers that they can expect to be better off by forming heterogeneous teams. Two types of social preferences could also make heterogeneous teams more difficult to build outside the lab. The first is assortative bias or homophily: workers may have a preference to team up with someone similar to them, and this may include similar abilities – something we cannot test in our experimental setting with randomly allocated types. We also cannot rule out social preferences such as inequity aversion at the individual level, although we find no evidence of it at the aggregate level.

In order to isolate the role of incentives on ability matching, we opted to test a setting that completely rules out any differences based on effort. This allows us to clearly identify matching preferences, something that is much easier when expected payoffs in the different configurations are taken as given. In practice, it is often difficult to distinguish the respective outcomes of ability and effort. While our experiment focused on ability, future research can include effort to help understand to what extent hybrid incentives solve the two asymmetric information problems at the same time. Testing this mechanism in the field would help bridge the gap between theory and application in organizations. Further research could consider alternative implementations of hybrid incentives that pay wages that are complementarily proportioned by team and individual incentives, information interventions to help individuals understand their incentives and optimal choices, or alternative matching protocols to enhance efficient matching by using the power of the default (Thaler and Sunstein, 2009) of optimal team configurations from which players are allowed to deviate. We could also consider how hybrid incentives influence matching outcomes in larger groups, which would involve looking at different voting procedures within groups to offer members to join.

To conclude, we proposed and showed the efficacy of hybrid incentives as a way to elicit socially efficient matching between players of different abilities. Our positive results encourage further work that builds on this idea.

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Appendix

A Proofs

A.1 Proof of Proposition 1

A player of type H proposes to match with another type H whenever $\hat{\pi}^{PAM}_{H,team} > \hat{\pi}^{NAM}_{H,team}$. Replacing the expected payoff by their value this condition is equivalent to

$$\frac{1}{2} \times p \times s \times g^{PAM} > \frac{1}{4} \times s \times g^{NAM} \Leftrightarrow p > \frac{1}{2}\frac{g^{NAM}}{g^{PAM}}. \tag{6}$$

A player of type L proposes to match with a type H whenever $\hat{\pi}^{NAM}_{L,team} > \hat{\pi}^{PAM}_{L,team}$. Replacing the expected payoff by their value this condition is equivalent to

$$\frac{1}{4} \times s \times g^{NAM} > \frac{1}{2} \times (1-p) \times s \times g^{PAM} \Leftrightarrow p > 1 - \frac{1}{2}\frac{g^{NAM}}{g^{PAM}}. \tag{7}$$

There are therefore two cases, depending on whether g^{PAM} or g^{NAM} is higher.

1. If $g^{PAM} = g^{NAM}$, both conditions become $p > \frac{1}{2}$. As, by definition, the benchmarking technology is informative, all players propose to type H, and the two type H form a blocking pair. The matching is always positive assortative.

2. If $g^{PAM} > g^{NAM}$, condition (6) is always satisfied. The two type H form a blocking pair and the matching is always positive assortative.

3. If $g^{NAM} > g^{PAM}$, condition (7) is always satisfied. Thus, the equilibrium matching is determined by condition (6). If it is satisfied, the two type H form a blocking pair and the matching is always positive assortative. Else, the two type H propose to type L and the two type L propose to type H: the matching is negative assortative.

A.2 Proof of Proposition 2

A player of type H proposes to match with a type L whenever $\hat{\pi}^{NAM}_{H,individual} > \hat{\pi}^{PAM}_{H,individual}$. Replacing the expected payoff by their value this condition is equivalent to

$$\frac{1}{2} \times p \times s \times g^{NAM} > \frac{1}{4} \times s \times g^{PAM} \Leftrightarrow p > \frac{1}{2}\frac{g^{PAM}}{g^{NAM}}. \tag{8}$$

A player of type L proposes to match with a type L whenever $\hat{\pi}^{PAM}_{L,individual} > \hat{\pi}^{NAM}_{L,individual}$. Replacing the expected payoff by their value this condition is equivalent to

$$\frac{1}{4} \times s \times g^{PAM} > \frac{1}{2} \times (1-p) \times s \times g^{NAM} \Leftrightarrow p > 1 - \frac{1}{2}\frac{g^{PAM}}{g^{NAM}}. \tag{9}$$

There are therefore two cases, depending on whether g^{PAM} or g^{NAM} is higher.

1. If $g^{PAM} = g^{NAM}$, both conditions become $p > \frac{1}{2}$. As, by definition, the benchmarking technology is informative, all players propose to type L, and the two type L form a blocking pair. The matching is always positive assortative.

2. If $g^{PAM} > g^{NAM}$, condition (9) is always satisfied. The two type L form a blocking pair and the matching is always positive assortative.

3. If $g^{NAM} > g^{PAM}$, condition (8) is always satisfied. Thus, the equilibrium matching is determined by condition (9). If it is satisfied, the two type L form a blocking pair and the matching is always positive assortative. Else, the two type H propose to type L and the two type L propose to type H: the matching is negative assortative.

A.3 Proof of Proposition 3

We are looking for values of q such that both types of players propose to match with the other type (NAM). A player of type H prefers to match with a player of type L whenever

$$\begin{aligned} qs\frac{1}{4}g^{NAM} + (1-q)sp\frac{1}{2}g^{NAM} &> qsp\frac{1}{2}g^{PAM} + (1-q)s\frac{1}{4}g^{PAM} \\ \Leftrightarrow q &< \frac{2pg^{NAM} - g^{PAM}}{(2p-1)(g^{PAM}+g^{NAM})} = \bar{q} \end{aligned} \tag{10}$$

A player of type L prefers to match with a player of type H whenever

$$\begin{aligned} qs\frac{1}{4}g^{NAM} + (1-q)s(1-p)\frac{1}{2}g^{NAM} &> qs(1-p)\frac{1}{2}g^{PAM} + (1-q)s\frac{1}{4}g^{PAM} \\ \Leftrightarrow q &> \frac{g^{PAM} - 2(1-p)g^{NAM}}{(2p-1)(g^{PAM}+g^{NAM})} = \underline{q} \end{aligned} \tag{11}$$

Thus, there exists a value of $q^* \in (\underline{q}, \bar{q})$ such that the unique equilibrium matching if and only if $\bar{q} > \underline{q}$. Using (10) and (11), this condition simplifies to $g^{NAM} > g^{PAM}$ for all $p > \frac{1}{2}$.

A.4 Proof that Proposition 3 holds for different p

Assume now two different values of p, with p^{indiv} corresponding to the individual incentive scheme, and p^{team} to teams rewards. Using the same procedure as in Proposition A.3, we find

$$qs\frac{1}{4}g^{NAM} + (1-q)sp^{indiv}\frac{1}{2}g^{NAM} > qsp^{team}\frac{1}{2}g^{PAM} + (1-q)s\frac{1}{4}g^{PAM}$$
$$\Leftrightarrow q < \frac{2p^{indiv}g^{NAM} - g^{PAM}}{(2p^{team}-1)g^{PAM} + (2p^{indiv}-1)g^{NAM}} = \bar{q} \qquad (12)$$

and

$$qs\frac{1}{4}g^{NAM} + (1-q)s(1-p^{indiv})\frac{1}{2}g^{NAM} > qs(1-p^{team})\frac{1}{2}g^{PAM} + (1-q)s\frac{1}{4}g^{PAM}$$
$$\Leftrightarrow q > \frac{g^{PAM} - 2(1-p^{indiv})g^{NAM}}{(2p^{indiv}-1)g^{NAM} + (2p^{team}-1)g^{PAM}} = \underline{q} \qquad (13)$$

Simplifying $\bar{q} > \underline{q}$ yields

$$\frac{2(g^{NAM} - g^{PAM})}{(2p^{indiv}-1)g^{NAM} + (2p^{teams}-1)g^{PAM}} > 0, \qquad (14)$$

which is true whenever $g^{NAM} > g^{PAM}$, $p^{indiv} \geq \frac{1}{2}$ and $p^{team} \geq \frac{1}{2}$ and at least one of the two latter inequalities is strict.

A.5 Proof that Proposition 3 holds for a continuum of types

Assume now that instead of two types, four workers $i \in \{1, 2, 3, 4\}$ have types θ_i drawn from a continuous distribution over the interval $[0, \bar{\theta}]$, with $\bar{\theta} > 0$. Without loss of generality, we rank them by ability $\theta_1 < \theta_2 < \theta_3 < \theta_4$.

We are looking for a threshold $\bar{q}$ such that, for $q < \bar{q}$, worker 4 offers to team up with worker 1, and a threshold $\underline{q}$ such that for $q > \underline{q}$, worker 1 offers to team up with worker 4.

Denote by p_{ij}^k the probability of being reported as top performing individual or team under procedure $k \in \{indiv, teams\}$ for worker i when teamed up with worker j. By rewriting the different payments, we find that

$$\bar{q} = \frac{g^{NAM} p_{4,1}^{indiv} - g^{PAM} p_{4,3}^{indiv}}{g^{NAM} p_{4,1}^{indiv} - g^{PAM} p_{4,3}^{indiv} - g^{NAM} p_{4,1}^{teams} + g^{PAM} p_{4,3}^{teams}} \tag{15}$$

and

$$\underline{q} = \frac{g^{PAM} p_{1,2}^{indiv} - g^{NAM}(1 - p_{4,1}^{indiv})}{g^{PAM} p_{1,2}^{indiv} - g^{NAM}(1 - p_{4,1}^{indiv}) + g^{NAM} p_{4,1}^{teams} - g^{PAM}(1 - p_{4,3}^{teams})} \tag{16}$$

Similarly, we can identify $\bar{q}'$ and $\underline{q}'$ such that for $q < \bar{q}'$, worker 3 offers to team up with worker 2 and for $q > \underline{q}$ worker 2 offers to team up with worker 3. Given the matching structure, a single blocking pair is sufficient to guarantee NAM, so that we only need to show that either $\bar{q} > \underline{q}$ or $\bar{q}' > \underline{q}'$ (or both conditions hold) whenever $g^{NAM} > g^{PAM}$. To do this, we show that $\bar{q} + \bar{q}' > \underline{q} + \underline{q}'$, which simplifies to

$$\frac{2(g^{NAM} - g^{PAM})}{(p_{3,2}^{indiv} + p_{4,1}^{indiv} - 1)g^{NAM} + (2p_{43}^{teams} - 1)g^{PAM}} > 0, \tag{17}$$

which is a similar condition to (14), satisfied whenever $g^{NAM} > g^{PAM}$, $\frac{p_{3,2}^{indiv} + p_{4,1}^{indiv}}{2} \geq \frac{1}{2}$ (always trues as $p_{3,2}^{indiv} \geq \frac{1}{2}$ and $p_{4,1}^{indiv} \geq \frac{1}{2}$) and $p_{43}^{team} \geq \frac{1}{2}$ and at least one of the two latter inequalities is strict.

A.6 Corollary: commitment to fixed bonus schemes

Define by $B^{Ij} = \sigma^{Ij} g^{NAM}$ the fixed bonus given to the best-performing (j=w) or worst performing (j=d) player in the best-performing (I=W) or worst performing (I=D) team, and express this bonus in share σ^{Ij} of the total surplus under NAM g^{NAM}. For our proposed scheme to be equivalent to the hybrid one, the two following conditions must hold for the chosen $q^* \in (\underline{q}, \bar{q})$, and setting a zero payment for the worst performing player in the worst performing team $\sigma^{Dd} = 0$:

$$\frac{q^* s}{4} + \frac{(1 - q^*)sp}{2} = \frac{p}{2}\sigma^{Ww} + \frac{p}{2}\sigma^{Dw} + \frac{1 - p}{2}\sigma^{Wd}, \tag{18}$$

$$\frac{q^* s}{4} + \frac{(1 - q^*)s(1 - p)}{2} = \frac{1 - p}{2}\sigma^{Ww} + \frac{1 - p}{2}\sigma^{Dw} + \frac{p}{2}\sigma^{Wd}. \tag{19}$$

Setting $\sigma^{Wd} = \sigma^{Dw}$ and solving for (18) - (19) yields

$$\sigma^{Ww} = (1 - q^*)s. \tag{20}$$

Replacing σ^{Ww} in (18) or (19) yields

$$\sigma^{Dw} = \sigma^{Wd} = \frac{q^* s}{2}. \tag{21}$$

B Further theoretical considerations

B.1 Moral hazard

B.1.1 Setup

Assume that the production function f is extended to introduce post matching individual effort, $f(j, k, e_j, e_k)$ where $j, k \in \{L, H\}$ are, as before, the individual types, and e_j and e_k the chosen levels of effort. The game has two stages, the matching stage as in the main paper, followed by a stage in which individuals provide effort within the existing team structure. The game is solved by backward induction. In the last stage, each individual i has a cost function $c_{ij}(e_i)$ increasing and convex, where j is the other member of i's team. We also need to assume f and g to be concave. This ensures that, for each of the three incentivized schemes Individual Incentives ($q = 0$), Team Incentives ($q = 1$), and Hybrid Incentives $q \in (0, 1)$, there is a unique vector of equilibrium individual effort levels $e^*(q, s, m)$, which depends on q the share of Team Incentives, s the share of the surplus shared among participants, and m the matching structure where $m \in \{NAM, PAM\}$.

As before, we assume the existence of an informative benchmarking technology on the relative performance of players and teams, that could either depend solely on the types or on the level of effort. An example of the latter technology is a Tullock contest function. In the case of Individual Incentives the probability that a member i of team k receives the prize would then be $p_{i,individual}(e) = \frac{e_{ik}}{\sum_{i \in k} e_i}$. In the case of Team Incentives, $p_{i,team}(e) = \frac{\sum_{i \in k} e_i}{\sum_i e_i}$. What matters to our results is that effort levels in all teams have a unique equilibrium and that, *ceteris paribus*, one's probability of winning is continuous, concave, and increasing in e_{ik} so that high types provide more effort in equilibrium if they have a lower marginal cost of effort than low types.

B.1.2 Proof that Proposition 3 holds with moral hazard

As effort happens in the last stage, matching decisions are based on rational expectations of effort and of team composition. We can then rewrite the expected individual surplus as a function of q and the matching structure: for instance a player i of type H when Individual Incentives are selected, under Hybrid Incentives where Individual Incentives are selected with probability $1 - q$, and with negative assortative matching,

$$\pi^{NAM}_{H,individual}(q, s) = \frac{1}{2} p_{i,individual}(e) \times s g^{NAM}(q, s) - c_{HL}(q),$$

where $g^{NAM}(q, e^*(q, s, NAM), s) = g^{NAM}(q, s)$ and $c_{HL}(e_H(q, e_L(q, e_H))) = c_{HL}(q)$. Under Hybrid Incentives q in NAM, the expected surplus for a player of type H is thus

$$\hat{\pi}^{NAM}_{H}(q) = q\hat{\pi}^{NAM}_{H,team}(q, s) + (1 - q)\hat{\pi}^{NAM}_{H,individual}(q, s). \tag{22}$$

Define $\Delta_L(q) = \hat{\pi}^{NAM}_{L}(q) - \hat{\pi}^{PAM}_{L}(q)$ and $\Delta_H(q) = \hat{\pi}^{NAM}_{H}(q) - \hat{\pi}^{PAM}_{H}(q)$, the difference between a player surplus in NAM and PAM with a probability q of team incentives. Our main results in the main part of the paper is that, (i) when PAM is optimal, PAM is the matching equilibrium and, (ii) when NAM is optimal, there exists a value of q such that NAM is the matching equilibrium.

Part (i) is always true in the presence of a last stage of moral hazard as if PAM yields higher total surplus than NAM, it must hold that at least for one type i, $\Delta_i < 0$. And, whenever two players of the same type are better off matching with each other, they form a blocking pair and the unique matching equilibrium is PAM. On part (ii), the case where NAM creates so much surplus that $\Delta_i > 0$ for both types is also trivial: the unique matching equilibrium is NAM.

More interesting is the case for which NAM generates higher total surplus than PAM for all q, but not enough for both Δ to be positive for all q. Whenever the marginal cost of effort is lower for the higher type, our above hypothesis implies that (a) the share of the surplus within a NAM team going to player L increases with the probability of team incentives q, and (b) the share of the surplus going to the PAM team composed of two players of type L decreases with q. This implies that $\frac{d\Delta_L(q)}{dq} > 0$ and $\frac{d\Delta_H(q)}{dq} < 0$: the higher the probability of being rewarded by Team Incentives, the higher the (relative) preference of both types for matching with a high ability player.

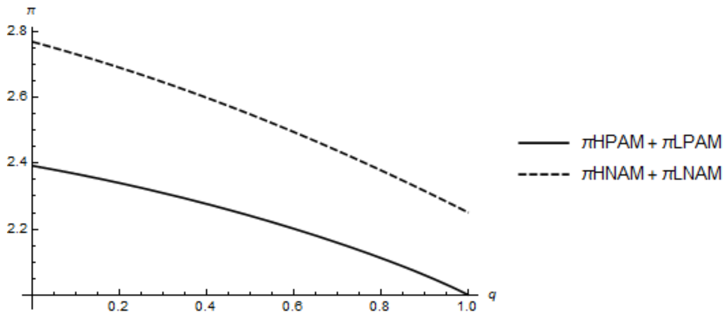
As a consequence, if $\hat{\pi}_L^{NAM}(q) + \hat{\pi}_H^{NAM}(q) > \hat{\pi}_L^{PAM}(q) + \hat{\pi}_H^{PAM}(q), \forall q \in (0,1)$, then, there always exists a q such that NAM is the equilibrium matching outcome. In the non-trivial case where $\Delta_H(0) < 0$ and $\Delta_L(1) < 0$, there exists only one value $\underline{q}$ such that $\Delta_L(\underline{q}) = 0$ and one value $\bar{q}$ such that $\Delta_H(\bar{q}) = 0$. By our assumption that NAM yields strictly higher surplus for all q, it must thus hold that $\Delta_H(\underline{q}) > 0$ and $\Delta_L(\bar{q}) > 0$. As Δ_H decreases with q and Δ_L increases with q, it implies that $\underline{q} < \bar{q}$ and for all $q \in (\underline{q}, \bar{q})$ both types of players are better off matching with the other type, so that NAM is the unique equilibrium of the matching stage.

What the above result guarantees is that whenever NAM always generates higher total surplus than PAM, then there exists q such that NAM is an equilibrium. This does not however guarantee that the total surplus for this value of q is higher than the total PAM surplus for either $q = 0$ or $q = 1$. In order to do so, the hypothesis must be that for at least one value of $q \in (\underline{q}, \bar{q})$, this surplus is higher than the surplus with PAM for any other value of q.

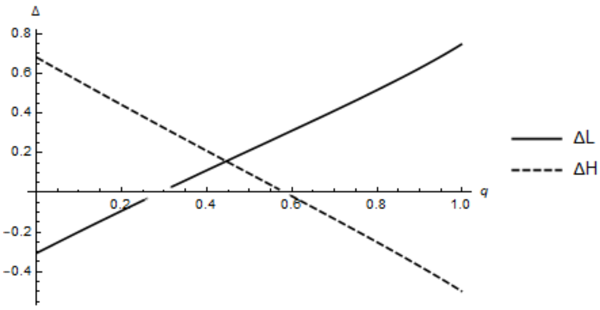
We illustrate the result for NAM in Figure 9 with $f = e_1 + e_2$, $g = f_1 + f_2$, $c = c_{ij}\frac{e_i^2}{2}$ and $c_{hh} = c_{hl} = 1$, $c_{lh} = 2$ and $c_{ll} = 3$, where c_{ij} is such that i is the type of the player and j the type of the match. This is an obvious example of decreasing differences: the cost function of the high type is unaffected by who their match is, but the low type benefits from a lower cost function when working with the high type. As we see on Figure 9a, the total surplus is thus always higher in NAM than in PAM. This is however not sufficient for NAM to always benefit everyone. Figure 9b represents the respective values of $\Delta_L(q)$ and $\Delta_H(q)$ for $q \in (0,1)$. Whenever team incentives dominate (high q), $\Delta_H < 0$, the high type would prefer to be with the low type. Whenever individual incentives dominate, $\Delta_L < 0$, the low type prefer to match with another low type. For $q \in (0.31, 0.57)$ however, both $\Delta_i > 0$ and the unique matching equilibrium is NAM. In this case, the surplus is indeed higher than the highest total surplus with PAM, when $q = 0$.

B.1.3 Proof that effort is lower with an Equal Sharing rule

Finally, we show that for a given total level of effort E, total effort in one team $E_1 = e_i + e_j$ and in the other $E_2 = e_k + e_l$ the marginal benefit for individual i of increasing e_i is always lower under Equal Sharing than with Individual Incentives, Team Incentives, or any combination thereof, so that the equilibrium level of effort will always be lower.



(a) Total Profit



(b) Difference in expected profit between NAM and PAM

Figure 9: Moral hazard: an example with NAM optimal

To see this, we can compare the three marginal benefits,

$$MB_i^{equal} = \frac{g'(E)}{4} \tag{23}$$

$$MB_i^{individual} = \frac{e_i}{e_i + e_j}\frac{g'(E)}{2} + \frac{e_i}{(e_i + e_j)^2}\frac{g(E)}{2} \tag{24}$$

$$MB_i^{teams} = \frac{E_1}{E_1 + E_2}\frac{g'(E)}{2} + \frac{E_2}{(E_1 + E_2)^2}\frac{g(E)}{2} \tag{25}$$

Solving for $MB_i^{individual} > MB_i^{equal}$, we get $\frac{e_j}{2(e_i+e_j)}[\frac{g(E)}{e_i+e_j} - g'(E)] > 0$. The first term is strictly positive. As g is concave, $\frac{g(E)}{E} \geq g'(E)$, and, by definition $E > e_1 + e_2$, hence $[\frac{g(E)}{e_i+e_j} - g'(E)] > 0$.

Doing the same exercise for $MB_i^{teams} > MB_i^{equal}$, we find $\frac{E_2}{2E}[\frac{g(E)}{E} - \frac{g'(E)}{2}] > 0$, always true by concavity.

B.2 Participation constraints

Until now, we have assumed all players have an identical outside option of zero, meaning that no participation constraint is binding. In that extreme case, a social planner's expected profit under hybrid incentives with any value of $q^* \in (\underline{q}, \bar{q})$ is equal to $(1 - s)g^{NAM}$. It follows that the value of s maximizing the social planner's surplus is $s = \epsilon$ with $\epsilon > 0$ arbitrarily small.

Consider now a variant in which the two types have possibly different outside options in the labour market, $\bar{v} > 0$ for H-types and $\underline{v} \in (0, \bar{v}]$ for L-types. Under hybrid incentives designed in a way to lead to NAM ($q^* \in (\underline{q}, \bar{q})$), the two participation constraints become:

$$q^* \pi^{NAM}_{L,teams} + (1 - q^*)\pi^{NAM}_{L,indiv} \geq \underline{v} \tag{26}$$

$$q^* \pi^{NAM}_{H,teams} + (1 - q^*)\pi^{NAM}_{H,indiv} \geq \bar{v}. \tag{27}$$

As $\pi^{NAM}_{L,teams} = \pi^{NAM}_{H,teams} = \frac{sg^{NAM}}{4}$ and $\pi^{NAM}_{L,indiv} < \pi^{NAM}_{H,indiv}$ we immediately see that, for any $q \in (\underline{q}, \bar{q})$, the expected surplus of a H-type with Hybrid Incentives is strictly higher than a L-type.

B.2.1 Identical outside options

We start by the simplest case, where both types have the same outside option $\underline{v} = \bar{v} = v$. Conditional on reaching a NAM matching structure, the social planner minimizes the rents given to workers by reducing as much as possible the rewards to the high-ability type and thus setting the share of team payments as high as possible $q^* = \bar{q}$. Then, the binding constraint remains the L-type (as they always receive a lower expected payment), so that the optimal s^* solves, by replacing $q^* = \bar{q}$,

$$\begin{aligned} & q^* \pi^{NAM}_{L,teams} + (1 - q^*)\pi^{NAM}_{L,indiv} = v \\ \Leftrightarrow s^*_{NAM} = & \frac{4v(g^{NAM} + g^{PAM})}{g^{NAM}(2g^{NAM} - (2p - 1)g^{PAM})}. \end{aligned} \tag{28}$$

Unsurprisingly, the optimal share increases in the outside option. Perhaps more surprisingly, it increases in the precision of the monitoring technology p. This happens because, in the case of hybrid incentives leading to NAM, p is only relevant to individual rewards. Hence, a higher p means lower payment for the low-ability types, so that they need a higher share of the production to accept the contract, guaranteeing a higher rent to the H-types.

The social planner can then compare this optimal s^* to what it would need to offer in a PAM setting. Conditional on PAM, individual incentives maximize the surplus of the social planner as, in equilibrium, all players receive an identical expected payment. The social planner can then offer zero rent to all types by using exclusively individual incentives $q = 0$.

The payment to both L and H types is then equal to $\frac{sg^{PAM}}{4}$, so that the planner's optimal choice is to set $s^*_{PAM} = \frac{4v}{g^{PAM}}$.

Whenever $g^{NAM} > g^{PAM}$, the social planner thus faces a tradeoff between a higher surplus with NAM, and the need to provide a rent to the high type. Formally, the social planner is better off using Hybrid Incentives to reach NAM whenever $(1 - s^*_{NAM})g^{NAM} \geq (1 - s^*_{PAM})g^{PAM}$. We have already established that $(1 - s^*_{PAM})g^{PAM} = g^{PAM} - 4v$ as there is no rent with PAM and $q = 0$, while by replacing s^*_{NAM} by its optimal value we find $(1 - s^*_{NAM})g^{NAM} = g^{NAM} - 4v\frac{(g^{NAM}+g^{PAM})}{2g^{NAM}-(2p-1)g^{PAM}}$. Putting both together, the social planner prefers NAM whenever

$$p \leq \frac{-2g_{NAM}^2 + g_{NAM}g_{PAM} - 4g_{NAM}v + g_{PAM}^2}{-2g_{NAM}g_{PAM} + 2g_{PAM}^2 - 8g^{PAM}v} = \bar{p}. \quad (29)$$

In our example of table 2 with $g^{NAM} = 8$ and $g^{PAM} = 7$ relatively close to each other, we plot on Figure 10 for different values of v and p the difference between the surplus of the social planner with NAM and PAM, so that the zero on the vertical axis corresponds to $\bar{p}$ in equation (29). We see that when both the outside option v and the quality of the benchmarking technology p are high, the planner is better off choosing PAM even if it lowers total surplus. Note that $v = 1.75$ is the highest possible value we can consider, as the sum of the four outside option is equal to the entire production under PAM, and thus $s^*_{PAM} = 1$.

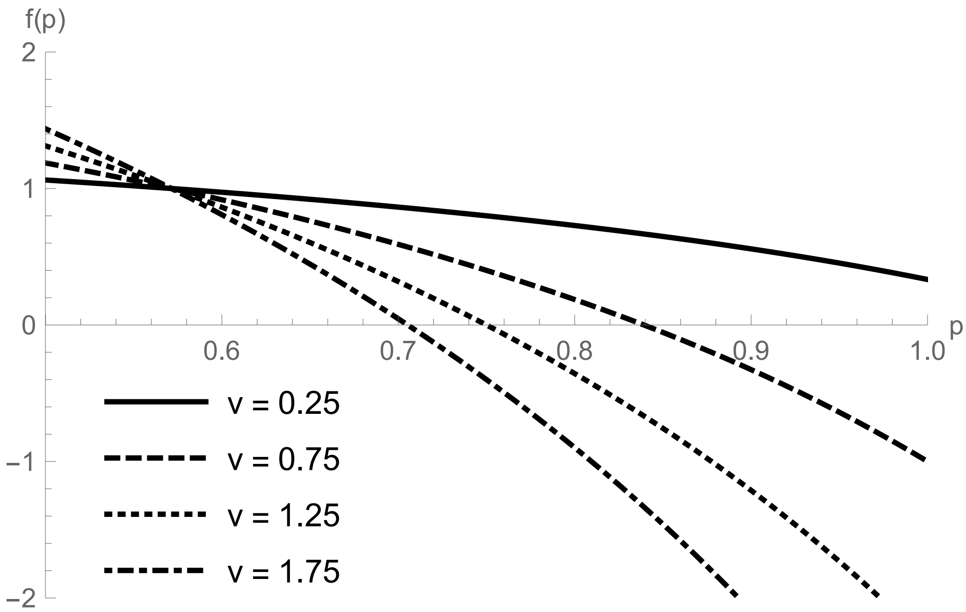


Figure 10: Difference between the social planner surplus with NAM and PAM, for $g^{NAM} = 8$ and $g^{PAM} = 7$.

B.2.2 Higher outside option for high-ability types

When outside options are different, $\bar{v} > \underline{v}$, there is a point at which $\bar{v}$ is sufficiently high for the binding participation constraint becomes the one of the high type, so that $q^* = \underline{q}$, the social planner wants to minimize transfers to the L-type. For any

$$\bar{v} \geq \underline{v}\frac{(2g^{NAM} + g^{PAM}(2p-1))}{g^{PAM}(3-2p)} = v_2, \tag{30}$$

the binding constraint with $q^* = \underline{q}$ is the one of the higher-ability types.

For any

$$\bar{v} \leq \underline{v}\frac{g^{PAM}(2p+1)}{2g^{NAM} - g^{PAM}(2p-1)} = v_1, \tag{31}$$

the binding constraint with $q^* = \bar{q}$ is the one of the lower-ability types. It is easy to show that, whenever $g^{NAM} > g^{PAM}$, $v_2 > v_1$ as $v_2 - v_1 = \frac{4\underline{v}(g^{NAM}-g^{PAM})(g^{NAM}+g^{PAM})}{g^{PAM}(3-2p)(2g^{NAM}-2g^{PAM}p+g^{PAM})} > 0$.

Thus, for $\bar{v} < v_1$, the solution is similar to the case with identical v, simply replacing v by $\underline{v}$. For $v \in (v_1, v_2)$, there always exists a $q^* \in (\underline{q}, \bar{q})$ such that both types receive the exact same surplus, which can then be lowered to zero. In that case, the social planner surplus is always higher with NAM.

Finally, for $v > v_2$, the binding constraint is the one of the H-type even for $q = \underline{q}$, so that the social planner must give a rent to the L-type under NAM.

In that case, a possibly superior alternative for the social planner is PAM. Increasing the share of Team Incentives above $\bar{q}$ ensures PAM and, by varying the share of q, allows to offer zero surplus to both types and a surplus for the social planner equal to $g^{PAM} - 2\underline{v} - 2\bar{v}$. This holds up to the point where $\bar{v}$ is so high that, even for $q = 1$, the binding constraint is the one of the high-type. This is the case if $\frac{(1-p)}{2}g^{PAM} - \underline{v} \geq \frac{p}{2}g^{PAM} - \bar{v} \Leftrightarrow \bar{v} \geq \underline{v} + (p - \frac{1}{2})g^{PAM} = v_3$. Then, the social planner sets $s^*_{PAM} = \frac{2\bar{v}}{pg^{PAM}}$ and must offer some surplus to the low type.

To see whether it benefits the social planner to use Hybrid Incentives, we first need to compute the value of s^*_{NAM}, corresponding to the smallest value of s satisfying the participation constraint of the high ability type for $q = \underline{q}$,

$$s^*_{NAM} = \frac{4\bar{v}(g^{NAM} + g^{PAM})}{g^{NAM}(2g^{NAM} + (2p-1)g^{PAM})}. \tag{32}$$

The main difference with the case where the lowest PC is binding is thus that a higher precision of the signal benefits the social planner here, as it allows giving a higher share of the surplus to the high type. But, in this case, a higher p also benefits the social planner in the PAM configuration, so that the impact on the difference between the two is not obvious.

The condition for the social planner to prefer PAM for $\bar{v} > v_3$ is

$$\bar{v} > \frac{p(g^{NAM} - g^{PAM})(2g^{NAM} + g^{PAM}(2p-1))}{2(g^{PAM} - 2g^{NAM}(1-p))} = v_5 \tag{33}$$

For $\bar{v} \in (v_2, v_3)$, the condition is $\bar{v} > \frac{(2g^{NAM}+g^{PAM}(2p-1))(g^{NAM}-g^{PAM}+2\underline{v})}{2g^{PAM}(3-2p)} = v_4$.

The condition to prefer PAM is then to either have $\bar{v} \in (v_2, v_3)$ and $\bar{v} > v_4$, or $\bar{v} > v_3$ and $\bar{v} > v_5$.

It is possible to derive a simpler analytical version of these results for the special case $\underline{v} = 0$. In that case, $v_1 = v_2 = 0$, the binding participation constraint is by definition always the high type. In that case, it is possible to show that $v_5 > v_4$. Figure 11 shows these threshold values for our leading example with $g^{NAM} = 8$ and $g^{PAM} = 7$. We denote by $vmax$ the maximum theoretical value for $\bar{v} = \frac{g^{PAM}}{2}$ such that the social planner can still have a positive surplus. The areas where the social planner prefers PAM are those below v_3 and above v_4 as well as those above both v_3 and v_5.

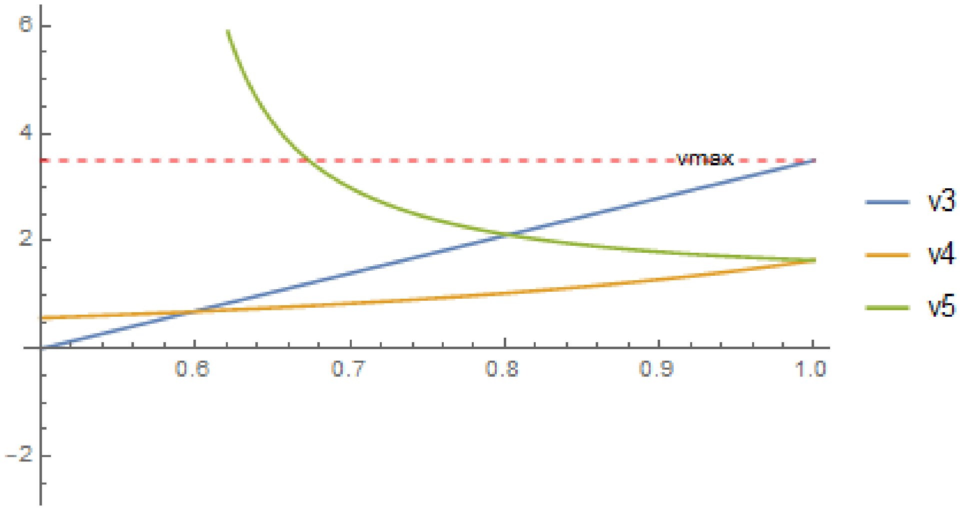


Figure 11: Threshold values of v_3, v_4, v_5 for $g^{NAM} = 8$ and $g^{PAM} = 7$.

B.3 Expected payoffs in the experiment

With PAM, the two low ability participants form a team, and so do the high type ones. The expected team score of two high ability participants $f(H, H)$ corresponds to the expected value of the maximum of two independent random draws uniformly distributed over the interval $[0, 100]$ (the second-order statistic), with $f(x) = 1/100$ and $F(x)$ the cumulative density

Table 6: Expected values in the experiment

	H types		L types	
	pair with H	pair with L	pair with H	pair with L
Team	89.1	52.7	52.7	4.3
Individual	46.7	89.5	15.9	46.7
Equal Sharing	93.3	105.3	105.3	93.3
Hybrid:				
q=0	46.7	89.5	15.9	46.7
q=.1	50.9	85.8	19.5	42.4
q=.2	55.1	82.1	23.2	38.2
q=.3	59.4	78.4	26.9	33.9
q=.4	63.6	74.7	30.6	29.7
q=.5	67.9	71.1	34.3	25.5
q=.6	72.1	67.4	37.9	21.2
q=.7	76.3	63.7	41.6	17.0
q=.8	80.6	60.0	45.3	12.7
q=.9	84.8	56.3	49.0	8.5
q=1	89.1	52.7	52.7	4.3

function,

$$f(H,H) = \int_0^{100} 2F(x)f(x)xdx = \frac{2}{3}100 \approx 66.7.$$

Similarly, the expected team score of a team of two low-ability players is $f(L,L) = \frac{2}{3}40 \approx 26.7$, so that $g^{PAM} \approx 93.3$. In the Negative Assortative Matching (NAM) case, each team is composed of a high and a low ability participant. The expected quality of the solution kept by a team is thus the expected value of the highest of two independent draws, one over the interval $[0,40]$, the other over the interval $[0,100]$,

$$f(L,H) = 0.4 \times \int_0^{40} 2\frac{x}{40}\frac{1}{40}xdx + \int_{40}^{100} f(x)xdx \approx 52.7,$$

so that $g^{NAM} \approx 105.3 > g^{PAM}$.

We report in table 6 the expected payoffs under the different incentive schemes. When matching is NAM with Individual Incentive, and PAM with Team Incentives, the computations are straightforward from the values of g: each of the four player wins a number of experimental points equal to g with equal probability $1/2$. In the two other configurations however, finding the result is more challenging and takes some arithmetic work we would not necessarily expect our participants in the lab to carry. In Team Incentives, and if matching is NAM, each participant receives g^{NAM} with equal probability. If matching is PAM however, the expected reward of a member of a team composed of two high ability participants under Team Incentives is given by

$\hat{\pi}^{PAM}_{H,team} = 0.6^2(80 + \frac{2}{3}40) + (1 - 0.6^2)(\frac{2}{3}40) + 0.48(70 + \frac{2}{3}40) \approx 89.1$. Similarly, in Individual Incentives each participant receive g^{PAM} with equal probability if matching is PAM. The expected reward of a high-ability member of a team composed of one high-ability and one low ability participant under Individual Incentives is given by $\hat{\pi}^{NAM}_{H,team} = 0.6 \times 70 + 0.2(\frac{2}{3}40) + 0.8 \times 52.7 \approx 89.5$.

B.4 Social preferences and equilibrium mismatch

The above theoretical results assume individuals maximizing their expected monetary payoffs. It is well-known, however, that when there is an exogenous difference in the endowment of different players – their ability in our case – social preferences may lead to different choices. We briefly review some of these preferences and how we would expect them to influence the results of Propositions 1, 2 and 3.

B.4.1 Inequity aversion

According to Fehr and Schmidt (1999) and Bolton and Ockenfels (2000)'s models of fairness, some participants may have an aversion for inequitable outcomes. Assuming the inequality of opportunities stemming from the different types is perceived as unfair, people who are inequity averse could make a choice that goes against their self-interest if it decreases the difference in payoffs. With Team Incentives, PAM leads to more unequal payoffs, while in Individual Incentives NAM is more unequal. Hence, we would expect inequity averse participants to form more NAM teams under Team Incentives (more type H proposing to team up with L) than under Individual ones (type L proposing to team up with H). This general prediction should not be affected by whether NAM or PAM generates the higher surplus.

It is however key that the initial heterogeneity in types is perceived as unfair, as the precise reason behind inequality determines preferences for redistribution (Cappelen et al., 2022). Seminal models studying the relative roles of merit and luck start from opposite hypothesis on that dimension: while Alesina and Angeletos (2005) treat exogenous ability as a fair source of inequality, Benabou and Tirole (2006) define exogenous differences between individuals as unfair, coming from differences in inherited monetary or social capital or being the consequence of discrimination. If participants perceive inequality in exogenous types as fair, inequity aversion should not give them any incentive to deviate from maximizing their monetary payoffs. A variant of this point corresponds to the idea of outcome bias (Baron and Hershey, 1988): high ability participants choosing the believe their type is somehow not the result of luck.

B.4.2 Efficiency concerns

As shown by Engelmann and Strobel (2004), experimental evidence on distribution experiments is consistent with a combination of selfishness, maximin preferences and efficiency concerns. If a share of the players have efficiency concerns, understood as maximizing the sum of the payoffs, those should be more likely to form NAM teams both under Team and Individual Incentives if it generates the largest surplus.

B.4.3 Guilt aversion

A third reason why participants may choose to make proposals different from their monetary self-interest is guilt aversion (Attanasi, Battigalli and Manzoni, 2016; Battigalli and Dufwenberg, 2007, 2022). For instance, if players of type H believe that players of type L expect them to propose a match under Team Incentives, guilt averse players of type H may do so to avoid bearing the psychological cost of betraying (second order) expectations. This type of social preferences is entirely based on beliefs and expectations, and could be linked to inequity aversion and efficiency concerns. By definition, all beliefs are possible so that while guilt aversion points to the possibility of outcomes deviating from pure self-interest, it does not provide an exact prediction in our context.

C Further data analysis

C.1 Additional results for Study 1

C.1.1 Decisions inconsistent with the theoretical predictions

In this section, we provide a measure of the link between decisions inconsistent with theoretical decisions and the level of understanding of the incentives. If (self-reported) understanding is correlated with inconsistent decisions, this is evidence that those decisions reflect a form of bounded rationality, and not an intrinsic preference for one type of match.

We split our sample into below-average and above-average participants based on their performance (rate of predicted decisions) in the two standard schemes. Table 7 shows that those below-average participants have lower self-reported understanding level than above-average participants. Regardless of whether or not we provide them with expected values, more than 80% of the participants who made profit-maximizing decisions in the standard schemes continue to do so in Equal Sharing and Hybrid Incentives.

Table 7: Below and above average participants' performance in later schemes and understanding level

	Below-average participants	Above-average participants
	No-Information	
P(predicted decisions) – Equal	.56 (.36)	.85 (28)
P(systematically) – Hybrid	.38 (.49)	.92 (.28)
Understanding level – post survey	2.2 (.7)	2.6 (.49)
	Information	
P(predicted decisions) – Equal	.72 (.28)	.90 (.21)
P(systematically) – Hybrid	.53 (.51)	.86 (.35)
Understanding level – post survey	2.2 (.76)	2.5 (.51)

Note: Standard errors are in parentheses.

Table 8: Logit regressions on matching decisions

Dependent Variable: *Predictdecision* = 0 or 1				
	Team	Individual	Equal	Hybrid
	(1)	(2)	(3)	(4)
Htype	-0.142	-0.924**	-0.340	0.0878
	(0.460)	(0.365)	(0.452)	(0.192)
Information	0.393	0.289	0.677*	0.132
	(0.356)	(0.323)	(0.406)	(0.297)
Round	-0.0782	0.0409	-0.0279	
	(0.0709)	(0.0740)	(0.0385)	
Understand	0.514*	0.663**	0.705**	0.270
	(0.284)	(0.284)	(0.338)	(0.192)
Performance polar			2.272***	2.022***
			(0.776)	(0.638)
Constant	-1.153	3.115	-4.422	-0.525
	(1.940)	(2.853)	(3.531)	(1.448)
Individual controls	yes	yes	yes	yes
Observations	576	576	576	1,056

Note: Robust standard errors clustered by groups are in parentheses. Two-tailed p-values < 0.1*, 0.05**, 0.01***.

To confirm the results, we run logit regressions with dependent variable *Predictdecision* (=1 if decisions conform to theory prediction, 0 if otherwise) and error clustering at group-level. *Htype* (1 for type H, 0 for type L) controls for the type of participants. *Information* (1 if with information on expected values, 0 if otherwise) controls for the information provided in the experiment. We include time (*Round* = 1 to 6 except for Hybrid Incentives which uses the multiple price list method) and individual (*age, gender, economics major, and local*) controls.[8] *Understand* examines whether the understanding level affects their decisions. *Performance polar* (rate of predicted decisions in the two polar schemes Team and Individual Incentives) in models 3-4 further investigates whether the decisions in later stages depends on participants' performance in these first two standard schemes. Models 1-4 test decisions in Team, Individual, Equal Sharing, and Hybrid Incentives respectively. Table 8 reports the results. *Htype* is negative in model 2, indicating type H tend to match with type H in Individual Incentives. *Information* is marginally positive in model 3, showing the effect of providing information in Equal Sharing. It is not significant in model 4 maybe because providing information is only effective in some scenarios of Hybrid Incentives (see Table 11 in Appendix C.1.3). *Understand* is positive in models 1-3, indicating whether participants make the predicted decision depends on their understanding level.[9] The positive *Performance polar* in models 3-4 confirms that the decisions in Equal Sharing and Hybrid Incentives strongly rely on participants' performance in two standard schemes.

C.1.2 Naïve diversification

Naïve diversification (Benartzi and Thaler, 2001) is the idea that some participants might follow a simple heuristic of allocating their choices (such as capital investments) equally (or near equally) among the available options. We show below that our data is consistent with some of our participants adopting this heuristic.

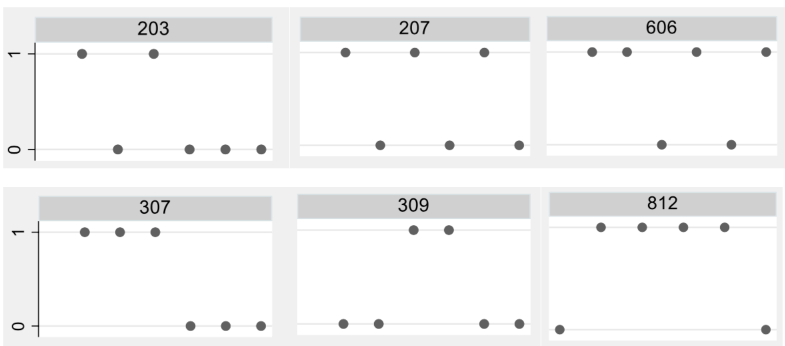


Figure 12: Examples of different forms of diversification

[8]The regressions are robust to controlling for the orders of incentive schemes.

[9]The lack of significance in model 4 might be due to the multicollinearity between *Understand* and *Performance polar*. Dropping *Performance polar* makes *Understand* significant (p < .01).

Table 9: Switching behaviors in Team and Individual Incentives by participants with systematic proposals and with switching proposals in Hybrid Incentives

		Switch systematically	Switch more than once in Hybrid
Team	#switch=0	0.62	0.33
	#switch=1	0.13	0.17
	#switch=2	0.18	0.21
	#switch>2	0.07	0.29
	average #switch	0.73	1.63
Individual	#switch=0	0.65	0.25
	#switch=1	0.15	0.17
	#switch=2	0.14	0.21
	#switch>2	0.06	0.37
	average #switch	0.65	1.92

Figure 12 depicts some examples of participants' decisions (=1 if consistent with theory prediction, 0 if otherwise). The first row corresponds to participants switching their decision more than twice. The second corresponds to participants selecting the "wrong" decision more than once, making it unlikely to simply be a mistake. Including both forms of diversification, among those who are alternating proposals in Hybrid Incentive, we find 75% of them also exhibit a pattern of diversification in Team or Individual Incentives.

Table 9 compares the switching behaviors in Team and Individual Incentives between participants who make systematic proposals and who switch more than once in Hybrid Incentives. Among the former, more than 60% make consistent choices across rounds while only 7% switch more than twice in Team and Individual incentives. By contrast, around 30% of the latter switch more than twice in two standard schemes. They indeed switch more frequently than those with systematic proposals (1.63 vs .73 in Team, 1.92 vs .65 in Individual).

C.1.3 Time trends and distributions

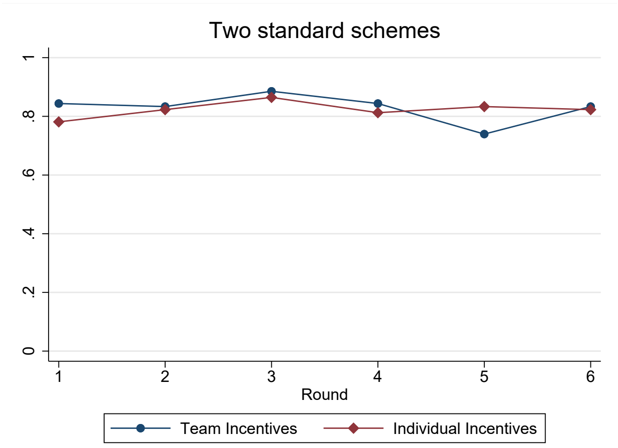


Figure 13: Time trends for rate of predicted decision in the two standard schemes

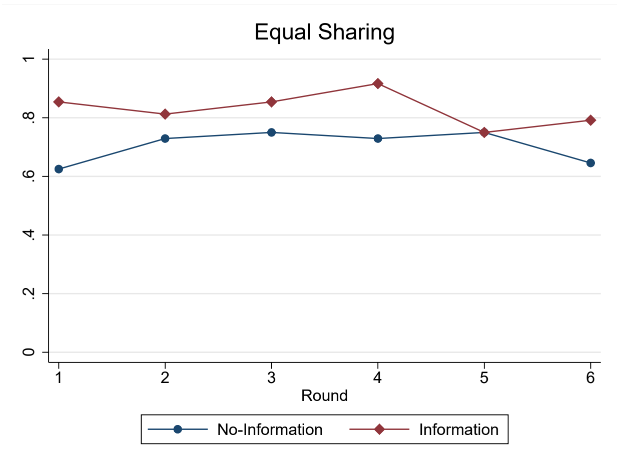


Figure 14: Time trends for rate of predicted decision in Equal Sharing scheme

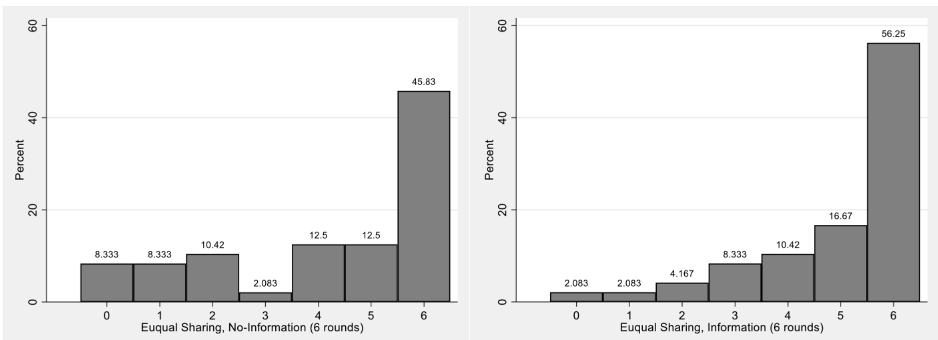


Figure 15: Frequency of the number of predicted decisions made by a participant in Equal Sharing without (left) and with expected values (right)

Table 10: Share of NAM teams in Hybrid Incentives per treatment, and p-values of non-parametric tests

	No-Information			Information		
	Share	>Team(q=1)	>Individual(q=0)	Share	>Team(q=1)	>Individual(q=0)
q=0	0.083	p=1	NA	0.167	p=1	NA
q=.1	0.333	p=.69	p=.25	0.250	p=.63	p=1
q=.2	0.167	p=1	p=1	0.167	p=1	p=1
q=.3	0.250	p=1	p=.5	0.250	p=.63	p=1
q=.4	0.333	p=.69	p=.25	0.8333++	p=.00	p=.01
q=.5	0.667	p=.07	p=.02	0.833	p=.00	p=.01
q=.6	0.500	p=.22	p=.13	0.250	p=.5	p=1
q=.7	0.417	p=.25	p=.22	0.333	p=.25	p=.69
q=.8	0.250	p=1	p=.63	0.250	p=.5	p=1
q=.9	0.250	p=1	p=.63	0.330	p=.25	p=.69
q=1	0.167	NA	p=1	0.083	NA	p=1

Note: p-values of Wilcoxon tests between each q and two standard incentives are presented in the table. + (++) [+++] denotes p-values < 0.1, 0.05, 0.01 for MWU tests between No-Information and Information treatments.

Table 11: Share of predicted decisions, per player type and treatment, Hybrid Incentives

	Share of decisions conforming to prediction			
	H type		L type	
	No-Information	Information	No-Information	Information
q=0	0.833	0.917	0.958	0.917
q=.1	0.792	0.917	0.833	0.875
q=.2	0.875	0.875	0.917	0.917
q=.3	0.917	0.917	0.875	0.875
q=.4	0.708	0.750	0.167	0.5***
q=.5	0.583	0.667	0.500	0.625
q=.6	0.667	0.792	0.833	0.875
q=.7	0.792	0.792	0.958	0.875
q=.8	0.875	0.833	0.833	0.875
q=.9	0.875	0.833	0.917	0.917
q=1	0.917	0.917	0.958	0.917

Note: * (**) [***] denotes p-values < 0.1, 0.05, 0.01 for the comparison between No-Information and Information treatments.

Table 12: Logit regressions on team formation in Equal Sharing

Dependent Variable: *NAM* = 0 or 1			
	No-Information	Information	All
	(1)	(2)	(3)
Individual	-0.438	-0.241	-0.337
	(0.770)	(0.667)	(0.493)
Equal	1.972***	4.309***	1.927***
	(0.483)	(0.904)	(0.390)
Information			-0.263
			(0.381)
Equal×Information			2.315***
			(0.803)
Round	-0.0428	-0.123	-0.0740
	(0.0628)	(0.0780)	(0.0473)
ITHE	0.374	0.314	0.332
	(0.678)	(0.855)	(0.521)
TIEH	-0.388	0.594	0
	(0.690)	(0.815)	(0.502)
ITEH	-1.025	0.594	-0.360
	(0.819)	(1.050)	(0.642)
Constant	-0.398	-1.068	-0.544
	(0.714)	(1.028)	(0.584)
Observations	216	216	432

Note: *ITHE*, *TIEH*, and *ITEH* (= 1 for the respective order, and 0 if otherwise) control for orders between incentive schemes with *TIHE* as the benchmark, where T = Team Incentives, I = Individual Incentives, E = Equal Sharing, H = Hybrid Incentives. Robust standard errors clustered by groups are in parentheses. Two-tailed p-values < 0.1*, 0.05**, 0.01***.

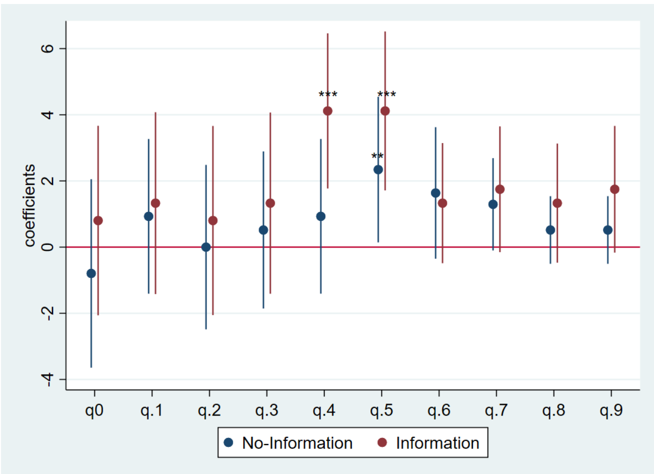


Figure 16: Coefficients of q in Hybrid Incentives with Team Incentives as baseline controlling for order of stages.

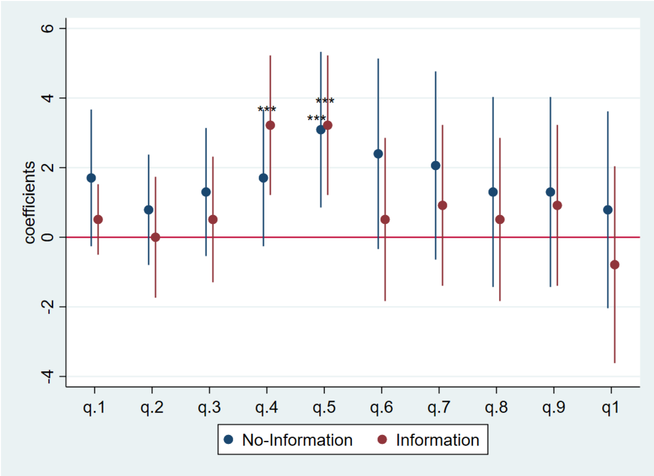


Figure 17: Coefficients of q in Hybrid Incentives with Individual Incentives as baseline.

C.2 Additional results for Study 2

C.2.1 Individual decisions analysis

Table 13: Proportions of proposals to the other type

	Team	Individual	Hybrid	Equal Sharing
Overall	.476	.446	.491	.703
Type H	.10	.69	.38	.55
Type L	.85	.20	.61	.86

Table 13 shows the proportions of proposals to the other type across Incentives schemes. It shows that it is the H (L) types who were refusing to pair with the other type in Team incentives (Individual Incentives), which leads to the failure of formation of NAM teams. With Hybrid Incentives and Equal Sharing, the blocking types, i.e. H types in in Team Incentives and L types Individual incentives, become willing to proposal to the other type, successfully forming more NAM teams than two standard incentive schemes. To verify, we run logit regressions on individual decisions with dependent variable *NAMdecision* (=1 if proposal to the other type, and 0 if otherwise). Table 14 (15) reports the results with Team (Individual) Incentives as baseline. Model 1 tests overall decisions, while model 2 (3) tests H (L) types' decisions. In Team (Individual) Incentives, the blocking type is H (L); the positive *Hybrid* and *Equal* estimates in model 2 (3) in Table 14 (15) shows that Hybrid Incentives and Equal Sharing induce more H (L) types propose to form NAM teams than Team (Individual) Incentives.

Table 14: Logit regressions on individual proposals (Team Incentives as baseline)

Dependent Variable: *NAMdecision* = 0 or 1			
	Overall	Type H	Type L
	(1)	(2)	(3)
Individual	-0.119	3.021***	-3.140***
	(0.162)	(0.392)	(0.403)
Hybrid	0.063	1.699***	-1.318***
	(0.179)	(0.388)	(0.308)
Equal	0.962***	2.418***	0.056
	(0.183)	(0.451)	(0.381)
Round	-0.003	0.042	-0.061
	(0.016)	(0.027)	(0.038)
Constant	0.019	-2.835*	1.856***
	(0.938)	(1.714)	(0.667)
Individual controls	yes	yes	yes
Observations	2304	1152	1152

Note: Robust standard errors clustered by groups are in parentheses. Two-tailed p-values < 0.1*, 0.05**, 0.01***.

Table 15: Logit regressions on individual proposals (Individual Incentives as baseline)

Dependent Variable: *NAMdecision* = 0 or 1			
	Overall	Type H	Type L
	(1)	(2)	(3)
Team	-0.119	3.021***	-3.140***
	(0.162)	(0.392)	(0.403)
Hybrid	0.063	1.699***	-1.318***
	(0.179)	(0.388)	(0.308)
Equal	0.962***	2.418***	0.056
	(0.183)	(0.451)	(0.381)
Round	-0.003	0.042	-0.061
	(0.016)	(0.027)	(0.038)
Constant	0.019	-2.835*	1.856***
	(0.938)	(1.714)	(0.667)
Individual controls	yes	yes	yes
Observations	2304	1152	1152

Note: Robust standard errors clustered by groups are in parentheses. Two-tailed p-values < 0.1*, 0.05**, 0.01***.

C.2.2 Time trends

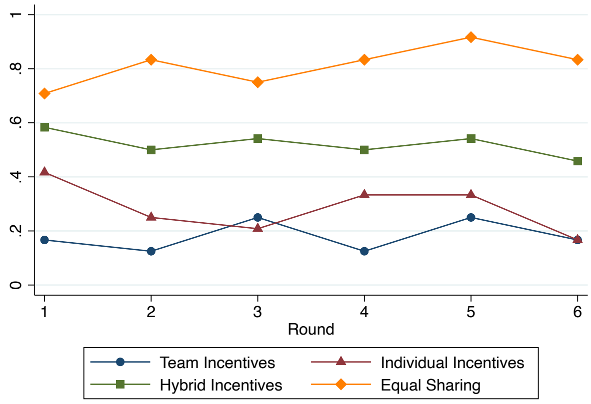


Figure 18: Time trends for rate of NAM teams across schemes

D Demographic information

Each study consists of a total of 96 students from various disciplines and years of study. Table 16 reports the demographic information of our participants. Most participants were undergraduate students with approximately 25% studying in Economics or Business related major. Mean age was 21 and gender ratio was with 37.5% being female. More than half of participants were local students and most were Chinese ethnicity. The rest are from Malaysia, India, China, an so on. The average economic status is middle class. Participants understand the experiment well.[10] The demographic of participants in two studies is comparable.

Table 16: Demographic information

	Study 1		Study 2	
	mean	sd	mean	sd
Age	20.5	.201	21.6	.231
Undergraduate	1	0	.979	.015
Economics major	.250	.044	.240	.044
Female	.375	.049	.375	.050
Singaporean	.521	.051	.521	.051
Chinese	.760	.043	.896	.031
Understanding level (0-3)	2.385	.065	2.438	.064
Economic status (1-5)	2.896	.144	.319	.155

[10] Understanding level = 0-3 for weak to strong understanding. Family's social economic status = 1-5 for lower, working, middle, upper middle, and upper class, respectively.

E Online Appendix: Experimental Instructions

Note: The instructions will be made available on osf.io for the published version of the paper.

E.1 Study 1

General Instructions

Welcome and thank you for participating in this experiment on decision making funded by the Ministry of Education, Singapore. It is organized by Nanyang Technological University (NTU) and has been approved by the Ethics Committee of NTU. All the data from this experiment will be used only for research purposes. Your choices will not be linked to your personal identity, which will be kept private and confidential.

In this experiment, you will perform some tasks on the computer. The experiment has four stages. You will be able to earn experimental points based on your choices and performance in these tasks. Each point is worth $0.02. You will also receive a participation fee of $6. At the end of this session, your experimental payment will be sent to you privately through 'PayNow'.

Please read the instructions carefully and complete the quiz before proceeding to the tasks. The purpose of the quiz is to make sure that you have understood the instructions. If you have any questions at any point of time, please raise your hand and we will attend to you in private. Please do not communicate with other participants during the experiment. Do not use your mobile device or any other software apart from the experimental program that is provided. To maintain the scientific integrity of the experiment, it is important that you follow these rules.

Note: 【】 for information treatments.

Stage 1 Instructions

Stage 1 has 6 **rounds**. In each round, you will have 10 **trials** where you can score points to earn money. You shall perform the task with three other coparticipants, who will remain unchanged throughout the experiment. To complete the 10 trials, the four of you are asked to form two groups of two members each.

Types: Amongst the four of you, there will be two **types** of persons, **Type I** and **Type II**. Two persons will be Type I, and two persons will be Type II. The computer will randomly assign your type, which remains unchanged throughout the experiment. Two types differ in terms of their **multiplier**, which determines how many points a person can score for each trial.

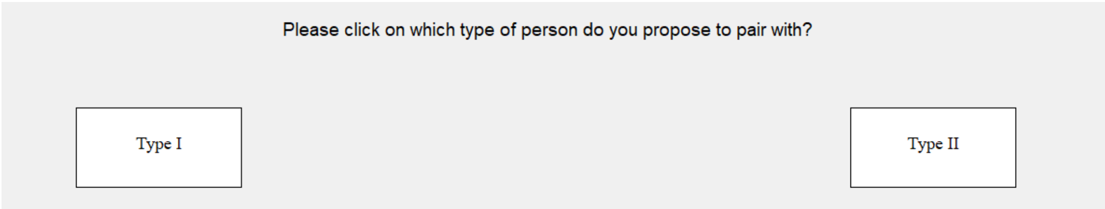
Trials: After forming into two groups, for every trial, each of you will draw a random number between 0 and 10, which will be multiplied by your multiplier to obtain your **personal score**. The highest personal score in each group will be used as the **group score**.

Reward scheme: For each trial, your earnings will be determined by your *personal score* and *group score* based on **Scheme A**.

- **Scheme A:** Each member of the group with the higher group score wins a prize, which is the sum of the two group scores. Members of the other group earn nothing.

Completing the 10 trials requires the four of you to form into two groups.

How to form groups: you will be asked to choose a type of person to propose to pair with (see screenshot).

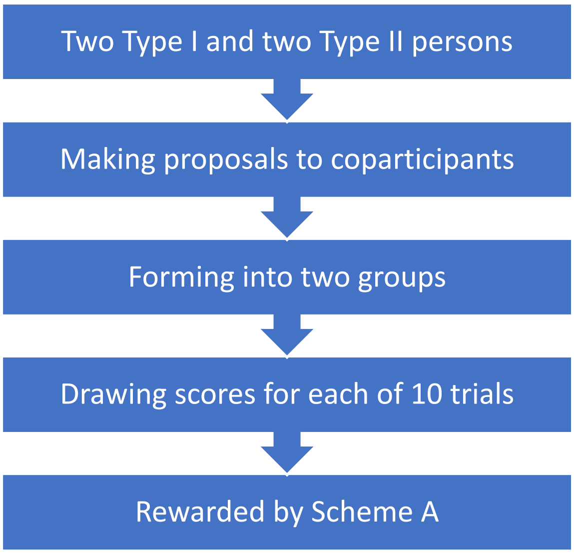


Two persons will form a group if both their **proposals** match. For instance, if person A (Type I) proposes to pair with Type I and person B (Type I) proposes to pair with Type I, then A's and B's proposals are matched -- they will form a group.

In the situation where one's proposal matches two coparticipants' proposals, one is randomly paired with either of the two. For example, if A (Type I) proposes to pair with Type II, and C and D (both Type II) propose to pair with Type I, then A's proposal is matched with both C's and D's, then A is randomly paired with either C or D with equal likelihood.

If there is only one group formed by matching proposals, then the other two persons whose proposals do not match will automatically form another group.

This is a summary of the procedure for **each round** in Stage 1:



At the end of each round, the computer will randomly select 1 trial from the 10 trials. Your earnings in that trial will be your earnings in the round.

To check if you have understood, please answer a Quiz. You can proceed after correctly answering all questions.

(see the quiz on your computer)

At the end of Stage 1, two rounds will be randomly selected.

Your experimental payment in Stage 1 will be the earnings from the selected rounds.

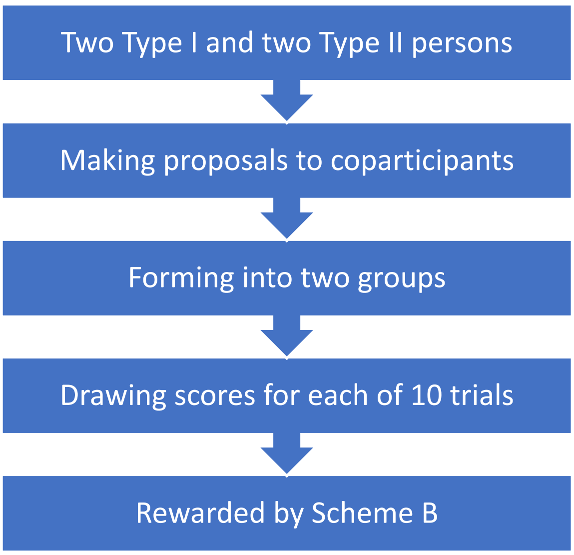
Stage 2 Instructions

Stage 2 has 6 **rounds**. The same as the previous stage, in each round, you will have 10 **trials** where you can score points to earn money. You shall perform the task with the same three coparticipants in the previous stage. To complete the 10 trials, the four of you are asked to form two groups by making **proposals**. After forming into two groups, for every trial, each of you will draw a random number to obtain the **personal score** and **group score**. The reward scheme in Stage 2 will be different.

Reward scheme: For each trial, your earnings will be determined based on **Scheme B**.

- **Scheme B:** The person with the higher personal score in each group wins a prize, which is the sum of the two group scores. The other member of each group earns nothing.

This is a summary of the procedure for **each round** in Stage 2:



At the end of each round, the computer will randomly select 1 trial from the 10 trials. Your earnings in that trial will be your earnings in the round.

To check if you have understood, please answer a Quiz. You can proceed after correctly answering all questions.

(see the quiz on your computer)

At the end of Stage 2, two rounds will be randomly selected.

Your experimental payment in Stage 2 will be the earnings from the selected rounds.

Stage 3 Instructions

Stage 3 has 1 **round.** The same as the previous stages, in the round, you will have 10 **trials** where you can score points to earn money. You shall perform the task with the same three coparticipants in the previous stages. To complete the 10 trials, the four of you are asked to form two groups by making **proposals**. After forming into two groups, for every trial, each of you will draw a random number to obtain the **personal score** and **group score**. <u>The reward scheme in Stage 3 will be different.</u>

Reward scheme: Your earnings will be determined based on **Scheme C**, where some trials (out of 10) will be rewarded by **Scheme A** while the rest will be rewarded by **Scheme B**.

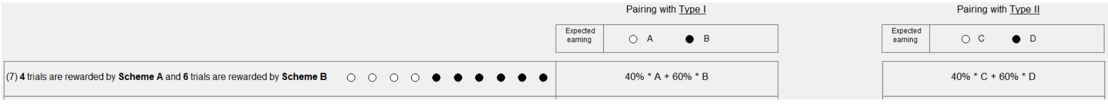
- **Scheme A:** Each member of the group with the higher group score wins a prize, which is the sum of the two group scores. Members of the other group earn nothing.
- **Scheme B:** The person with the higher personal score in each group wins a prize, which is the sum of the two group scores. The other member of each group earns nothing.

You will not know how many trials will be rewarded by Scheme A and B in advance. You need to make proposals under all possible scenarios (see screenshot below).

		Propose to	
(1) **10** trials are rewarded by **Scheme A** and **0** trials are rewarded by **Scheme B**	○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Type I	Type II
(2) **9** trials are rewarded by **Scheme A** and **1** trial is rewarded by **Scheme B**	○ ○ ○ ○ ○ ○ ○ ○ ○ ●	Type I	Type II
(3) **8** trials are rewarded by **Scheme A** and **2** trials are rewarded by **Scheme B**	○ ○ ○ ○ ○ ○ ○ ○ ● ●	Type I	Type II
(4) **7** trials are rewarded by **Scheme A** and **3** trials are rewarded by **Scheme B**	○ ○ ○ ○ ○ ○ ○ ● ● ●	Type I	Type II
(5) **6** trials are rewarded by **Scheme A** and **4** trials are rewarded by **Scheme B**	○ ○ ○ ○ ○ ○ ● ● ● ●	Type I	Type II
(6) **5** trials are rewarded by **Scheme A** and **5** trials are rewarded by **Scheme B**	○ ○ ○ ○ ○ ● ● ● ● ●	Type I	Type II
(7) **4** trials are rewarded by **Scheme A** and **6** trials are rewarded by **Scheme B**	○ ○ ○ ○ ● ● ● ● ● ●	Type I	Type II
(8) **3** trials are rewarded by **Scheme A** and **7** trials are rewarded by **Scheme B**	○ ○ ○ ● ● ● ● ● ● ●	Type I	Type II
(9) **2** trials are rewarded by **Scheme A** and **8** trials are rewarded by **Scheme B**	○ ○ ● ● ● ● ● ● ● ●	Type I	Type II
(10) **1** trial is rewarded by **Scheme A** and **9** trials are rewarded by **Scheme B**	○ ● ● ● ● ● ● ● ● ●	Type I	Type II
(11) **0** trials are rewarded by **Scheme A** and **10** trials are rewarded by **Scheme B**	● ● ● ● ● ● ● ● ● ●	Type I	Type II

Only one scenario will occur. Since you do not know which scenario will occur, please treat each with the same importance.

At the end of Stage 3, you will be informed which scenario has occurred. The computer will randomly select 1 trial from the 10 trials. Your experimental payment in Stage 3 will be the earnings from the selected trial.



【In addition, we will tell you how much you are expected to earn from a ○ trial (rewarded by Scheme A) and a ● trial (rewarded by Scheme B) given the type of person you are paired with. See the above screen as an example. The left numbers show that if you pair with a Type I person, you are expected to earn *A* points from a ○ trial and *B* points from a ● trial. The right numbers show that if you pair with a Type II person, you are expected to earn *C* points from a ○ trial and *D* points from a ● trial. (Note: 'expected' means how much you could earn on average if the trial were repeated for an infinite amount of times.)

Based on this information, we also provide you **overall** how much you are expected to earn from pairing with two types of persons under each scenario.

For example, under scenario (7) where there are 4 ○ trials and 6 ● trials, your earnings will come from a ○ trial with $40\% = \frac{4}{4+6}$ probability and from a ● trial with $60\% = \frac{6}{4+6}$ probability. Thus, by pairing with a Type I person, you expect to earn *A* points from a ○ trial with 40% probability and expect to earn *B* points from a ● trial with 60% probability. Overall, you can expect to earn *A*40% + B*60%* from pairing with a Type I person. Likewise, you can expect to earn *C*40% + D*60%* from pairing with a Type II person.

There is no right or wrong decision, you can use the information or choose to ignore it. 】

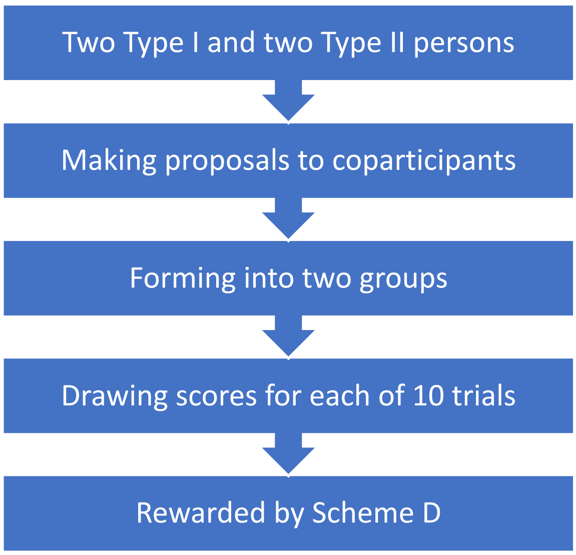
Stage 4 Instructions

Stage 4 has 6 **rounds**. The same as the previous stages, in each round, you will have 10 **trials** where you can score points to earn money. You shall perform the task with the same three coparticipants in the previous stages. To complete the 10 trials, the four of you are asked to form two groups by making **proposals**. After forming into two groups, for every trial, each of you will draw a random number to obtain the **personal score** and **group score**. The reward scheme in Stage 4 will be different.

Reward scheme: For each trial, your earnings will be determined based on **Scheme D**.

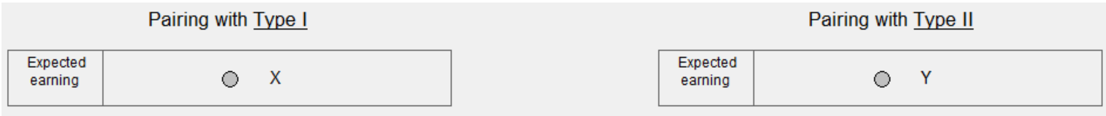
- **Scheme D:** Each person of each group wins a prize, which is the sum of the two group scores.

This is a summary of the procedure for **each round** in Stage 4:



At the end of each round, the computer will randomly select 1 trial from the 10 trials. Your earnings in that trial will be your earnings in the round.

【In addition, we will provide you how much you are expected to earn from a ○ trial (rewarded by Scheme D) given the type of person you are paired with.



See the above screen as an example. The left number shows that if you pair with a <u>Type I</u> person, you are expected to earn *X* points from a ○ trial. The right number shows that if you pair with a <u>Type II</u> person, you are expected to earn *Y* points from a ○ trial. (Note: 'expected' means how much you can earn on average if the trial were repeated for an infinite amount of times.)

There is no right or wrong decision, you can use the information or choose to ignore it. 】

To check if you have understood, please answer a Quiz. You can proceed after correctly answering all questions.

(see the quiz on your computer)

At the end of Stage 4, two rounds will be randomly selected.

Your experimental payment in Stage 4 will be the earnings from the selected rounds.

Your total experimental payment will be the sum of the following parts:

1. Earnings in Stage 1
2. Earnings in Stage 2
3. Earnings in Stage 3
4. Earnings in Stage 4
5. Participation fee

E.2 Study 2

Note: Only the instructions in Hybrid Incentives are different from Study 1.

Stage 3 Instructions (Study 2)

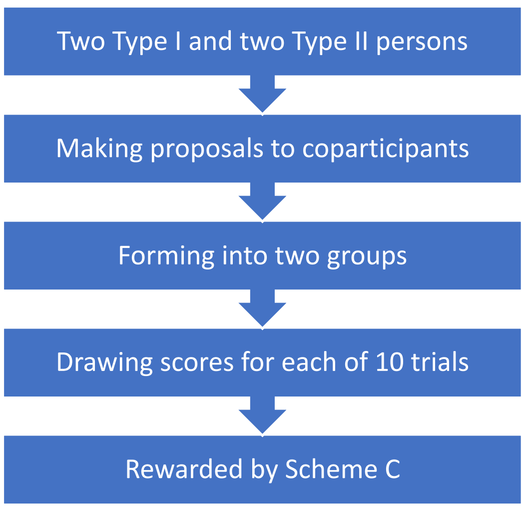
Stage 3 has 6 **rounds.** The same as the previous stages, in each round, you will have 10 **trials** where you can score points to earn money. You shall perform the task with the same three coparticipants in the previous stages. To complete the 10 trials, the four of you are asked to form two groups by making **proposals**. After forming into two groups, for every trial, each of you will draw a random number to obtain the **personal score** and **group score**. The reward scheme in Stage 3 will be different.

Reward scheme: Your earnings will be determined based on **Scheme C**, where some trials (out of 10) will be rewarded by **Scheme A** while the rest will be rewarded by **Scheme B**.

- **Scheme A:** Each member of the group with the higher group score wins a prize, which is the sum of the two group scores. Members of the other group earn nothing.
- **Scheme B:** The person with the higher personal score in each group wins a prize, which is the sum of the two group scores. The other member of each group earns nothing.

You will be informed of how many trials will be rewarded by Scheme A and B on the screen later.

This is a summary of the procedure for **each round** in Stage 3:



At the end of each round, the computer will randomly select 1 trial from the 10 trials. Your earnings in that trial will be your earnings in the round.

To check if you have understood, please answer a Quiz. You can proceed after correctly answering all questions.

(see the quiz on your computer)

At the end of Stage 3, two rounds will be randomly selected.

Your experimental payment in Stage 3 will be the earnings from the selected rounds.