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Effectiveness and efficiency of decentralized and centralized mechanisms in teamwork: experimental evidence

Marc Lebourges

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Par

Marc LEBOURGES

Effectiveness and efficiency of decentralized and centralized mechanisms in teamwork: experimental evidence

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Rapporteurs avant soutenance :

Serge BLONDEL Professeur, Université d'Angers
Angela SUTAN Professeure, Burgundy School of Business

Composition du Jury :

Président : François COCHARD Professeur, Université de Franche-Comté
Examineurs : Serge BLONDEL Professeur, Université d'Angers
 Aurélié BONEIN Maître de Conférences, Université de Rennes
 Angela SUTAN Professeure, Burgundy School of Business
Dir. de thèse : David MASCLET Professeur, Université de Rennes

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Résumé

Cette thèse vise à contribuer à la littérature en économie des ressources humaines. L'économie des ressources humaines applique les principes de l'analyse économique à la gestion et à l'organisation du travail et des ressources humaines, au sein d'entreprises et plus généralement d'organisations. Différents aspects de la gestion des ressources humaines, notamment l'embauche, la rémunération, la formation, la promotion et la fidélisation du personnel, sont analysés d'un point de vue économique. L'économie des ressources humaines cherche à comprendre comment les individus prennent des décisions concernant leur travail, comment les entreprises établissent leurs dispositifs d'incitation et de rémunération pour attirer et fidéliser les talents, et comment ces décisions affectent en fin de compte la productivité, les performances et les résultats globaux de l'organisation (Rosen, 1982; Holmstrom, 1982; Holmstrom et Milgrom, 1991; Gibbs, 1995; Hamilton et al., 2003; Bloom et Van Reenen 2007; Lazear et Shaw, 2007). Dans cette thèse, nous concentrons notre attention sur l'efficacité et l'efficience des mécanismes qui peuvent être mis en œuvre, dans les entreprises, pour combattre les problèmes de passager clandestin et de coordination pouvant affecter les équipes de travail.

L'importance du travail d'équipe en entreprise

Beaucoup d'entreprises organisent le travail en équipe. Ainsi parmi les 1 000 plus grandes entreprises américaines, l'adoption du travail en équipe a fait un bond entre les années 1980 et 1996, lorsque le travail en équipe a atteint 94 % de ces grandes entreprises (Lazear et Shaw, 2007 ; Lawer et al., 2001). En Europe, selon les rapports du Cedefop et d'Eurofound (2019), 70 % des entreprises européennes ont recours à une forme de travail en équipe. Pour Delarue (2008), « le travail en équipe est apparu ces dernières années comme l'un des modes de réorganisation du travail les plus importants ».

L'étude du travail en équipe dans les entreprises revêt donc une importance particulière, dans la mesure où la plupart des entreprises ont adopté ce type d'organisation. Bien qu'il n'existe pas de définition universellement acceptée du travail d'équipe, pour les besoins de cette thèse, nous adoptons la formulation de Sundstrom (1999) : « Une équipe de travail est définie comme des individus interdépendants qui partagent la responsabilité de résultats spécifiques pour leur organisation. »

Le travail d'équipe offre plusieurs avantages aux entreprises. Il augmente la productivité, l'implication et la satisfaction des travailleurs (Alchian et Demsetz, 1972; Osterman, 1994, Delarue 2008; Owan, 2014). Par exemple, Osterman (1994) observe une augmentation de la

productivité des entreprises d'environ 30% grâce au travail en équipe. Selon Alchian et Demsetz (1972), les bénéfices du travail en équipe résultent de complémentarités entre membres de l'équipe. Delarue et al. (2008) avancent trois arguments théoriques pouvant expliquer une relation positive entre le travail en équipe et la productivité. Premièrement, les travailleurs peuvent travailler davantage, si le travail en équipe leur offre plus d'autonomie, donc plus de satisfaction au travail, ou si la dynamique d'équipe stimule leur motivation à atteindre ensemble un objectif commun. Deuxièmement, les travailleurs peuvent travailler plus efficacement, car les équipes autonomes peuvent résoudre les problèmes immédiatement, en utilisant les informations de terrain dont elles disposent, plutôt que d'attendre des interventions extérieures. De plus, les agents peuvent trouver satisfaisant de mobiliser leurs capacités intellectuelles. Troisièmement, le travail d'équipe diminue les coûts car il réduit le besoin d'encadrement. Delarue et al. (2008) présentent également une revue des études empiriques traitant du sujet et concluent que cette littérature confirme les effets positifs du travail d'équipe sur les performances des entreprises.

Le travail d'équipe favorise également l'entraide et les transferts de compétences entre travailleurs (Ichniowski et Shaw, 2003). Lorsque la performance collective plutôt qu'individuelle est récompensée, chaque travailleur a un intérêt personnel à contribuer au succès de l'équipe en aidant ses coéquipiers.

Un autre avantage du travail en équipe évoqué dans la littérature est qu'il offre davantage de flexibilité à l'entreprise pour faire face aux aléas de la production et aux variations de la demande (Schippers et al., 2015). En effet, le travail en équipe rend les travailleurs plus polyvalents, donc plus capables de remplacer des collègues absents. De plus, l'autorité est moins centralisée, ce qui augmente la réactivité de l'organisation et fait gagner du temps (Mascllet et Rebières, 2017). Schippers et al. (2015) observent des avantages similaires du travail d'équipe dans le contexte spécifique des équipes des centres de premiers soins médicaux au Royaume-Uni.

La littérature a également mis en exergue que les équipes prennent des décisions plus rationnelles que les individus isolés (Charness et Sutter, 2012). Ils apprennent plus vite, jouent et de manière plus stratégique (Cooper et Kagel, 2005 ; Kocher et Sutter, 2005 ; Kocher et al., 2006 ; Sheremeta et Zhang, 2010). Ils sont moins sujets aux biais cognitifs (Charness et Levin, 2005 ; Charness et al., 2010). Ils arbitrent mieux entre les risques et les bénéfices et ont tendance à prendre moins de risques (Rockenbach et al., 2007 ; Mascllet et al., 2009).

Bien que le travail d'équipe ait de nombreux avantages, il présente néanmoins aussi des limites, notamment des problèmes de coordination, des risques d'anti-sélection et des risques de comportement de passager clandestin.

Des études ont ainsi montré que la prise de décision en équipe peut se heurter à des problèmes de partage d'informations et de coordination (Driskell et Salas, 1991 ; Gruenfeld et al., 1996 ; Alper et al. 1998). Les décisions sont plus lentes et les équipes manquent de réactivité. Ce risque est d'autant plus élevé que les équipes sont souvent composées de personnes ayant des expériences et des compétences diverses.

Le travail d'équipe peut également engendrer des problèmes d'anti-sélection. Selon Cooper et al. (2019), lorsque les agents peuvent choisir entre une organisation du travail en équipe et une organisation du travail individuel, les plus productifs peuvent avoir intérêt à opter pour une organisation du travail individuel, afin de profiter pleinement de leur productivité, tandis que les moins productifs seraient tentés d'opter pour une organisation du travail en équipe, dans l'espoir de partager les bénéfices de la plus grande productivité de leurs collègues.

Enfin, le travail d'équipe peut inciter au comportement de passager clandestin, ce qui peut affecter négativement la production. En effet, lorsque le travail est organisé en équipes, la production de chaque équipe est valorisée globalement dans la mesure où la contribution individuelle des membres de l'équipe n'est pas observable par le principal (Holmstrom, 1982 ; Kandel et Lazear, 1992). En conséquence, la rétribution de chacun correspond à une part identique de l'output collectif de l'équipe. Ainsi, chacun doit partager avec ses coéquipiers le produit de ses efforts individuels, ce qui dilue les incitations individuelles à contribuer (Holmstrom, 1982 ; Kandel et Lazear, 1992).

Les travaux de Nalbantian et Schotter (1997) ont mis en évidence empiriquement l'existence de comportements de passager clandestin dans les équipes de travail dans le cadre d'une expérience en laboratoire. Dans cette expérience, les auteurs constatent qu'en l'absence de mécanismes d'incitation spécifiques, le partage des revenus conduit à un faible niveau d'effort au sein des équipes. La littérature expérimentale considérable sur les jeux de biens publics, démontre également que des comportements de passager clandestin se manifestent dans un tel contexte (voir par exemple Ledyard, 1995 ; Fehr et Gächter, 2000 ; Zelmer 2003 ; Toni et Volk, 2018).

Dans la présente thèse, nous concentrons notre attention sur deux des principaux problèmes associés au travail en équipe, à savoir le problème du passager clandestin et le problème de

coordination. Nous étudierons en particulier dans quelle mesure des mécanismes centralisés, des mécanismes décentralisés ou l'action d'un leader d'équipe permettent de résoudre ces problèmes. Ces différents mécanismes sont décrits plus en détail ci-dessous.

Littérature sur les incitations centralisées et décentralisées

Une façon de résoudre le problème du passager clandestin consiste à concevoir des mécanismes centralisés tels que des programmes basés sur des objectifs d'équipe ou des tournois collectifs.

Dans les mécanismes basés sur des objectifs d'équipe (Holmstrom, 1982), l'entreprise fixe un objectif de performance à atteindre par l'équipe. Si l'objectif est atteint, les travailleurs partagent les revenus engendrés. Dans le cas contraire, si l'objectif n'est pas atteint par l'équipe, chaque membre de l'équipe perçoit une rémunération fixe et plus faible. Holmstrom (1982) montre qu'en théorie, il est possible de fixer l'objectif de l'équipe et le montant de rémunération faible fixe de sorte que le niveau d'effort socialement optimal soit un équilibre de Nash.

Les entreprises peuvent également mettre en place des systèmes où l'objectif est rendu endogène en utilisant des tournois collectifs, c'est-à-dire des tournois entre équipes, comme le suggèrent Nalbantian et Schotter (1997). Dans les tournois collectifs, une équipe joue contre une autre et l'équipe gagnante reçoit un transfert de rémunération de l'équipe perdante. Avec une valeur appropriée pour le transfert de rémunération, le niveau d'effort socialement optimal devient un équilibre de Nash.

Nalbantian et Schotter (1997) utilisent une expérience en laboratoire pour tester ces mécanismes centralisés et comparer l'efficacité des dispositifs basés sur des objectifs d'équipe ou des tournois collectifs. Ils constatent que le dispositif fondé sur un objectif d'équipe, bien que l'objectif soit choisi de manière à favoriser les efforts optimaux, conduit à des niveaux d'effort plus faibles que ceux théoriquement attendus. En effet, les équipes atteignent rarement l'objectif, ce qui décourage leurs membres, et conduit au final à des niveaux d'effort très faibles, inférieurs même à ceux observés en l'absence de tout mécanisme d'incitation. En revanche, le mécanisme du tournoi collectif, lorsque le transfert de rémunération de l'équipe perdante vers l'équipe gagnante est choisi de manière appropriée, conduit à un niveau d'effort maximum.

Une seconde famille d'incitations pour résoudre le problème du passager clandestin consiste à mettre en œuvre des mécanismes décentralisés basés sur la pression des pairs. La pression des pairs peut être exercée par la simple observation mutuelle des comportements au sein d'une

équipe de travail (Falk et Ichino, 2006 ; Mas et Moretti 2009). Au-delà des effets positifs de l'observation mutuelle entre coéquipiers, une approche qui peut être appliquée pour résoudre le problème du passager clandestin consiste, pour le principal, à mettre en place des mécanismes décentralisés basés sur la pression des pairs entre coéquipiers (Coleman, 1990 ; Varian, 1990 ; Kandel et Lazear, 1992 ; Itoh, 1993 ; Barron et Gjerde, 1997 ; Carpenter et al., 2009). En effet, même si le principal ne peut pas observer lui-même l'effort des agents travaillant en équipe, les agents peuvent s'observer et se sanctionner mutuellement. Le principal peut créer un système d'incitation qui encourage les travailleurs à se mettre d'accord sur les actions souhaitées par le principal et à faire respecter ces accords en utilisant des sanctions informelles. De tels mécanismes décentralisés de pression des pairs correspondent à des pratiques observées dans le monde réel. Par exemple, le rôle de la pression des pairs et des normes sociales apparaît dans la littérature comme essentiel au succès des entreprises japonaises : Nahavandi et Aranda (1994) soulignent l'importance des normes sociales japonaises dans la réussite du travail d'équipe au Japon. Le succès du lean management (Shah et Ward, 2003) dans les entreprises nord-américaines et européennes repose, entre autres, sur l'introduction d'un contrôle mutuel entre les salariés au sein des équipes de travail (Delbridge et al., 1992).

L'analyse économique a modélisé les effets de la pression des pairs de façon générale et pour des contextes variés. Dans le cas spécifique du travail en équipe en entreprise, les modèles théoriques de référence sur la façon dont la pression décentralisée des pairs peut dissuader les comportements de passager clandestin sont ceux de Kandel et Lazear (1992) et de Barron et Gjerde (1997). Parce qu'il est difficile de mesurer l'efficacité de la pression des pairs à partir de données conventionnelles, des études empiriques ont mobilisé des données issues d'expériences en laboratoire, principalement en utilisant des jeux de bien public. Dans les expériences de jeux de biens publics, permettre aux membres de l'équipe de punir les individus les moins coopératifs de l'équipe est très efficace pour augmenter les niveaux de contribution. Les individus n'hésitent pas à amputer leurs propres gains pour réduire ceux des passagers clandestins (voir par exemple Fehr et Gaechter (2000), Masclet et al. (2003), Carpenter et al. (2004), Noussair et Tucker (2005), Bochet et al (2006), Denant-Boemont et al (2007), Sefton et al (2007), Carpenter et al (2009), Grosse et al. (2011)). Il est donc clair que, au moins dans certaines circonstances, les mécanismes de pression des pairs peuvent représenter un moyen efficace d'accroître la coopération au sein des équipes, et ainsi d'atténuer le problème du passager clandestin. Cependant, même si la capacité de punir améliore la coopération, punir coûte cher à la fois à celui qui punit et à celui qui est puni.

Dans la pratique, tenter de faire pression sur d'autres travailleurs peut avoir des effets relationnels négatifs, car les collègues punis peuvent accumuler du ressentiment, et celui qui sanctionne peut être blâmé, surtout s'il a des liens personnels avec celui qu'il sanctionne. Cela soulève également la question du problème du passager clandestin de second ordre, c'est-à-dire le problème de savoir qui, parmi les membres de l'équipe, supportera le coût de surveiller et de punir (Yamagishi, 1986). Il peut exister par ailleurs des représailles contre ceux qui sanctionnent, voire des représailles aveugles (Nikiforakis, 2004 ; Denant-Boemont et al., 2007), des punitions antisociales contre les contributeurs (Cinyabuguma et al., 2004, 2005) ou des punitions excessives en raison des émotions négatives générées par les comportements de passager clandestin, ce qui peut nuire au bien-être social, du moins à court terme (Dickinson et Masclet, 2015).

Ainsi, la pression des pairs, telle que modélisée dans les expériences de jeux de biens publics, engendre des effets complexes et ambigus, si l'on considère ses conséquences en terme de bien être social.

Littérature sur le leadership et le problème de coordination

Comme mentionné au-dessus, un autre problème associé au travail d'équipe est celui de la coordination. Dans quelle mesure un leader d'équipe peut-il atténuer ce problème et faciliter la coordination au sein de l'équipe ? La littérature économique a modélisé la manière dont l'exemple d'un leader peut influencer ses collègues en utilisant des jeux de bien public séquentiels, dans lesquels le leader montre l'exemple en choisissant sa contribution avant les autres membres de l'équipe. L'analyse théorique de Varian (1994) montre que dans un contexte d'information symétrique, le niveau de coopération devrait être plus faible avec un jeu séquentiel de bien public qu'avec un jeu de bien public classique. Cependant, si les autres membres de l'équipe pensent que le leader détient des informations privées, Hermalin (1998) prouve qu'en théorie, montrer l'exemple favorise la coopération, lorsque le leader peut ainsi induire chez ses coéquipiers des croyances qui l'avantagent et les encouragent à coopérer.

La littérature expérimentale sur les jeux séquentiels de bien public indique que montrer l'exemple ne favorise la coopération que si des conditions complémentaires sont remplies. Selon cette littérature, l'exemple donné par un leader peut renforcer la coopération, sous réserve qu'il existe une identité de groupe (Drouvelis et Nosenzo 2013), ou que le leader a le pouvoir d'exclure les passagers clandestins (Haigner et Wakolbinger 2010), ou encore que

l'historique des contributions passées des participants soit observable (Figueres et al. 2012). Mais donner l'exemple peut également n'avoir aucun effet en l'absence des conditions ci-dessus, voire avoir une influence négative sur la coopération (Gächter et al. 2010).

Par ailleurs, un leader d'équipe peut-il rendre la pression des pairs plus efficace en coordonnant les sanctions et en rendant ainsi la pression des pairs moins coûteuse ? Un leader d'équipe peut avoir le pouvoir de récompenser ou de punir les autres membres de l'équipe, en fonction de leurs comportements (Drouvelis et al., 2013). Un leader diffère d'un principal car, en tant que membre de l'équipe, il participe à la production de l'équipe et à ce titre, il a accès à l'information interne sur les contributions individuelles des membres de l'équipe. Un leader d'équipe sait donc quels membres de son équipe méritent une récompense ou une punition. La nomination d'un leader d'équipe doit pouvoir contribuer à atténuer le problème de coordination en fournissant une orientation claire, en établissant des objectifs communs et en facilitant la communication entre les membres de l'équipe. Cela peut notamment être fait en donnant l'exemple. En outre, on peut raisonnablement penser qu'un leader d'équipe peut jouer un rôle crucial en coordonnant la pression des pairs. En ciblant plus précisément les passagers clandestins, le leader peut décourager les sanctions antisociales ou excessives.

En outre, attribuer à un leader le monopole sur le pouvoir de sanction devrait aussi éviter les risques de représailles, car ceux qui sont punis ne peuvent pas punir eux-mêmes, et le comportement de passager clandestin de second ordre, car le leader ne peut pas s'attendre à ce que ses coéquipiers sanctionnent à sa place. Il s'agit d'un avantage général de l'exercice centralisé du pouvoir de sanction (Markussen et al., 2014 ; Nicklisch et al., 2016).

Une approche par l'économie expérimentale

Alors que la littérature a étudié séparément les effets des mécanismes centralisés, des mécanismes décentralisés et des mécanismes basés sur l'action d'un leader d'équipe, l'ambition de cette thèse est de comparer l'efficacité et l'efficacités de ces différents mécanismes, ce qui, à notre connaissance, n'a pas encore été fait.

Pour cela, nous choisissons une approche économique expérimentale qui offre un contrôle élevé des facteurs susceptibles d'influencer les effets du traitement, d'où un niveau relativement élevé de validité interne de ce type d'étude expérimentale contrôlée en laboratoire. Ainsi, selon Roe

et Just (2009), la validité interne des résultats empiriques est maximisée par le recours aux expériences en laboratoire.

Il est en effet, difficile de mesurer l'efficacité spécifique des mécanismes d'incitation applicables au travail d'équipe, à l'aide de données d'observation. Une solution pourrait être de recourir à des expérimentations de terrain randomisées, menées au sein des entreprises (voir par exemple l'étude de Mas et Moretti (2009) sur les effets de pairs ou Delfgaauw et al., 2013). Cependant, il y a une perte de validité interne et une perte de contrôle lors de la réalisation d'expériences sur le terrain. À notre connaissance, aucune expérience de terrain n'a comparé des mécanismes décentralisés comme la pression des pairs à des mécanismes centralisés comme les objectifs d'équipe ou les tournois d'équipe. Par ailleurs, les mécanismes de pression des pairs s'appuient sur des normes sociales et un groupe de référence, difficilement contrôlables sur le terrain. Pour toutes ces raisons, le recours à des expériences contrôlées en laboratoire semble ici plus pertinent. Les expériences en laboratoire sont apparues au cours des dernières décennies comme une approche puissante pour étudier les comportements (V. Smith, 1982). Et elles semblent particulièrement appropriées pour l'étude des aspects microéconomiques de l'économie du travail et en particulier à l'économie des ressources humaines, comme l'expliquent Charness et Kuhn (2011).

Charness et Kuhn (2011) exposent les principaux avantages des expériences en laboratoire pour les économistes du travail. Les expériences en laboratoire permettent de contrôler les facteurs plus étroitement que dans tout autre contexte. Les données de terrain en revanche, reflètent une variété de facteurs environnementaux difficiles, voire impossibles, à démêler. Par exemple, les prédictions de la théorie des tournois (Lazear et Rosen 1981), les effets sur les travailleurs des options de sortie, du salaire minimum, des indemnités de maladie, de la discrimination, ou encore la théorie du salaire d'efficacité (Akerlof, 1982, Akerlof et Yellen 1990), peuvent être rigoureusement testées en utilisant des expériences en laboratoire, grâce au contrôle supérieur et à la validité interne qu'elles apportent, qui permettent d'identifier des relations causales (Falk et Fehr, 2003). En outre, Falk et Fehr (2003) soulignent que d'autres facteurs, comme la pression des pairs ou le fait qu'une interaction soit unique ou répétée, peuvent très bien affecter les comportements, et sont peu susceptibles d'être connus d'un chercheur utilisant des données de terrain. Charness et Kuhn (2011) considèrent que l'expérimentation en laboratoire peut être considérée comme le premier maillon d'une chaîne plus longue allant de la théorie aux interactions réelles dans les entreprises réelles. Par exemple, le recours à des expériences en

laboratoire pour « pré-tester » des mécanismes d'allocation, avant de les mettre réellement en œuvre, est déjà une pratique bien établie (voir Plott, 1987).

De plus, les expériences en laboratoire sont peu coûteuses par rapport aux expériences sur le terrain, ou à la collecte de données d'enquête : des hypothèses concurrentes peuvent être testées rapidement et à moindre coût avec un nombre modeste de séances. Et si l'on a des doutes concernant les résultats d'une expérience en laboratoire, on peut facilement reproduire l'expérience.

L'approche expérimentale n'est cependant pas dénuée de fragilités et peut soulever des interrogations. Une première interrogation concerne sa validité externe. En effet, on peut se demander si un petit nombre de participants, étudiants pour la plupart, représentent réellement des populations plus larges (Levitt et List, 2007a, 2007b). Cependant, comme le soulignent Falk et Heckman (2009), « aux fins de tester les théories, [les preuves de représentativité] ne constituent pas un problème car la plupart des modèles économiques établissent des prédictions indépendantes des hypothèses concernant les groupes de participants (p. 537) ». Charness et Kuhn (2011) soulignent que les étudiants de premier cycle, en tant que participants aux expériences, présentent plusieurs avantages : leur participation est peu coûteuse, ils apparaissent plus capables que la moyenne (ce qui facilite les procédures expérimentales), et ils sont au moins aussi représentatifs de la main-d'œuvre ayant fait des études secondaires que les populations hautement spécifiques de professionnels généralement impliqués dans des expériences sur le terrain. Ainsi, si l'objectif est d'identifier des principes généraux qui s'appliquent à une large population de travailleurs, les étudiants semblent un choix plus approprié que des travailleurs exerçant dans un secteur d'activité très spécifique.

D'autres objections opposées à la validité des résultats d'expériences en laboratoire, sont que les enjeux financiers des expériences sont faibles, et que la « tâche à accomplir » est souvent simplement le choix d'une somme d'argent à attribuer à une autre partie participant à l'expérience.

Concernant les faibles rémunérations des participants aux expériences en laboratoire, on peut répondre que l'analyse de décisions concernant de petites sommes, mais effectuées au quotidien, sont aussi pertinentes pour les besoins de l'analyse économique que l'analyse de décisions concernant des sommes plus importantes. De plus, des enjeux importants ne conduisent pas nécessairement à de meilleures décisions (Ariely et al., 2009).

Concernant l'objection selon laquelle la tâche à accomplir est abstraite et artificielle, on constate une tendance croissante à réaliser des expériences « à effort réel ». Cependant, l'inclusion de

tâches nécessitant un effort réel dans des expériences en laboratoire, crée le risque que les motivations intrinsèques hétérogènes des participants pour la tâche nécessitant un effort réel, soient inobservables et biaisent les résultats, conduisant à une moindre validité interne.

Pour analyser les possibilités de généraliser les résultats de laboratoire, nous devons aussi définir ce que l'on entend par validité externe. Suivant Kessler et Vesterlund (2015) et Levitt et List (2007a), nous considérons que nos résultats ne peuvent pas déterminer l'ampleur des effets analysés (validité externe quantitative), mais qu'ils peuvent identifier correctement le sens de ces effets (validité externe qualitative).

Par ailleurs, l'expérience doit être considérée comme une première étape qui nécessite d'être reproduite pour améliorer sa validité externe (Camerer, 2015). Lorsqu'un effet a résisté aux tests de robustesse dans l'environnement contrôlé du laboratoire, avec des conditions aux limites identifiées, il peut être testé sur le terrain afin de mesurer son ampleur dans un contexte approprié. Les expériences en laboratoire en économie peuvent être considérées comme l'analogie des tests en soufflerie lors de la conception d'un avion (Schram, 2005, p. 232) ou des expériences in vitro pour l'évaluation d'une nouvelle thérapie médicale.

Nous pouvons conclure sur notre choix méthodologique d'économie expérimentale en citant Falk et Heckman (2009) : « Les expériences en laboratoire sont très puissantes chaque fois qu'un contrôle strict... est essentiel. ... Un contrôle strict... permet également la reproductibilité des résultats, ce qui est généralement plus difficile avec les données de terrain » (p. 537).

Contenu et chapitres

Pour comparer les performances des mécanismes centralisés, des mécanismes décentralisés et des mécanismes basés sur l'action d'un leader d'équipe, nous utilisons l'économie expérimentale appliquée à la modélisation du travail en équipe en entreprise, et nous évaluons l'efficacité et l'efficacité d'un large éventail de mécanismes d'incitation à l'effort, applicables au travail en équipe et destinés à prévenir les comportements de passager clandestin.

Notre traitement de référence est un jeu d'effort avec partage des revenus inspiré de Nalbantian et Schotter (1997). dans ce jeu, chaque traitement se compose de 10 périodes identiques. Chaque participant ne participe qu'à un seul traitement ("Between design"). La composition des équipes ne change pas d'une période à l'autre ("Partner matching"). Pour éviter la formation de

réputations individuelles au fil des périodes, les identifiants des participants sont changés aléatoirement à chaque période. Nous nous sommes inspirés en la matière de Fehr et Gaechter (2000).

Une firme est composée d'un principal et de huit agents répartis en deux équipes de quatre travailleurs chacune. À chaque période, les travailleurs, au sein d'une équipe, choisissent simultanément leur niveau d'effort (entre 0 et 100) pour produire un résultat partagé entre les membres de l'équipe, de telle sorte qu'en l'absence de mécanisme d'incitation, le comportement de passer clandestin est théoriquement une stratégie dominante. La production de chaque équipe est égale à la somme des efforts des membres de l'équipe, plus une variable aléatoire uniforme qui peut être interprétée comme un choc aléatoire de production. Chaque travailleur reçoit un quart de la valeur du travail de son équipe plus une somme forfaitaire. Les travailleurs encourent un coût pour leur effort, qui est une fonction quadratique de leur choix d'effort. On peut montrer que dans ce jeu, le niveau d'effort optimal de Pareto (75) est bien supérieur au choix d'effort correspondant à l'équilibre de Nash (18,75).

Différentes versions de ce jeu d'effort sont ensuite déployées pour comparer les performances de différents mécanismes d'incitation aux chapitres 2, 3 et 4 de la thèse.

Le **premier chapitre** de cette thèse présente une revue de la littérature et décrit comment, au cours du vingtième siècle, l'organisation du travail dans l'industrie a évolué du taylorisme au toyotisme au moment des chocs pétroliers, et plus récemment vers de nouvelles formes, telles que les structures par projet, la prise en compte de la responsabilité sociale d'entreprise, ou l'entreprise libérée, favorisant le travail en équipe. Il détaille les avantages du travail en équipe pour la firme, les gains de productivité, l'entraide et le partage des compétences entre salariés, la flexibilité face aux aléas, de meilleures décisions, mais aussi ses inconvénients, tels que les problèmes de coordination, de sélection adverse ou de passer clandestin. Les différents types de mécanismes proposés par la littérature économique, pour résoudre les problèmes posés par le travail en équipe sont présentés : les mécanismes centralisés fondés sur des objectifs d'équipe ou la concurrence entre équipes, les mécanismes décentralisés de pression des pairs, ou l'action coordinatrice d'un leader d'équipe.

Dans le **deuxième chapitre**, nous concentrons notre attention sur la question de savoir si les mécanismes centralisés sont plus efficaces et efficients que les mécanismes décentralisés de pression des pairs. À cette fin, nous comparons notre traitement de base (le jeu du partage des revenus) avec trois traitements supplémentaires. Le deuxième traitement (« Pression des pairs ») est similaire au traitement de base, sauf qu'une deuxième étape est ajoutée où chaque membre de l'équipe peut attribuer des points de punition coûteux aux autres membres de l'équipe. Le troisième traitement (« Objectif de groupe ») est également similaire au traitement de base, sauf que la production totale de l'équipe est comparée à un objectif exogène, de sorte que les travailleurs ne sont récompensés que si cette production totale atteint l'objectif. Enfin, dans le quatrième traitement (« Concurrence entre groupes »), chaque équipe est en compétition avec une autre équipe, et l'équipe avec la production la plus élevée reçoit un transfert de l'autre équipe. Les effets des traitements sur les efforts et les gains des travailleurs, sur les profits des entreprises et sur le bien-être social sont analysés.

Premièrement, nos résultats montrent qu'en l'absence de mécanismes d'incitation, l'effort est sujet à un phénomène de passager clandestin, mais moindre que prévu en théorie. Deuxièmement, nous observons que la pression des pairs augmente faiblement l'effort par rapport au traitement de base, mais qu'un effet de passager clandestin significatif demeure. La pression des pairs n'améliore pas les gains des travailleurs par rapport au traitement de base. Cela résulte du fait que les bénéfices d'une plus grande coopération sont compensés par le coût social des sanctions. Troisièmement, les mécanismes centralisés sont plus efficaces que le mécanisme de pression des pairs pour accroître l'effort. En particulier, le traitement avec objectif de groupe conduit à un niveau d'effort proche de l'optimum de Pareto, mais au prix de gains plus faibles et plus inégaux pour les travailleurs. Cela résulte principalement du fait que plusieurs équipes ne parviennent pas à atteindre l'objectif. En revanche, ce mécanisme augmente fortement les profits des firmes. Quatrièmement, la concurrence entre groupes augmente les niveaux d'efforts de façon importante, mais engendre de grandes inégalités de gains entre les travailleurs sans augmenter significativement leurs gains moyens. Cela est dû à la grande différence des gains entre membres des équipes gagnantes et perdantes. Cinquièmement, le bien-être social est maximisé avec les mécanismes centralisés, et en particulier le mécanisme d'objectif de groupe. Cependant, l'augmentation du bien-être n'est pas partagée également entre les travailleurs et la firme, car elle profite principalement à la firme.

Le **chapitre 3** se concentre sur les mécanismes centralisés. Ses objectifs sont doubles. Premièrement, le chapitre 3 examine si, grâce à des incitations symboliques plutôt qu'à des incitations monétaires, les mécanismes centralisés préviennent toujours efficacement les comportements de passager clandestin, mais sans les effets négatifs des incitations monétaires sur les gains des travailleurs. Deuxièmement, le chapitre 3 tente d'identifier les effets spécifiques de l'observation des efforts individuels des équipiers, inclus dans tous les traitements avec incitations mais pas dans le traitement de base, par rapport à l'observation des efforts globaux des coéquipiers, inclus dans le traitement de base.

Pour comparer les impacts des incitations monétaires à ceux des incitations symboliques, nous analysons cinq traitements. Notre premier traitement est le traitement de base déjà inclus dans le chapitre 2. Notre deuxième traitement est le traitement avec objectif de groupe, déjà présenté également dans le chapitre 2. Dans le troisième traitement, appelé objectif de groupe à enjeu symbolique, les productions totales des équipes sont comparées au même objectif exogène que dans le traitement précédent, mais les conséquences pour les travailleurs du fait que la production totale de leur équipe atteigne l'objectif, sont symboliques et non monétaires. Le quatrième traitement est le traitement de concurrence entre groupes présenté au chapitre 2. Dans le cinquième traitement, les deux équipes d'une même firme sont en concurrence comme dans le traitement précédent, mais l'équipe ayant la production la plus élevée reçoit des félicitations symboliques et non un transfert monétaire.

Pour répondre à notre deuxième question, isoler l'effet pur de l'observation des efforts individuels par rapport à l'observation de l'effort agrégé, nous avons introduit trois traitements supplémentaires. Dans le premier traitement supplémentaire, au sein d'une équipe, l'observation de l'effort agrégé des coéquipiers est remplacée, dans le traitement de base, par l'observation de leurs efforts individuels. Dans les deux autres traitements supplémentaires, à l'inverse, l'observation de l'effort individuel des équipiers est remplacée, dans les traitements avec objectifs de groupe et avec concurrence entre groupes à enjeux monétaires, par l'observation de leurs efforts agrégés.

Nos résultats sont les suivants.

Premièrement, par rapport au traitement de base, les mécanismes centralisés utilisant des incitations symboliques augmentent effectivement les efforts des travailleurs et le bien-être social, mais nettement moins que lorsqu'ils utilisent des incitations monétaires. Deuxièmement, introduire l'observation des efforts individuels des équipiers dans le traitement de base, au lieu

de l'observation de l'effort moyen, augmente significativement l'effort. Troisièmement, cependant, un tel effet pur de l'observabilité des efforts individuels ne s'avère pas significatif, dans le contexte de mécanismes centralisés utilisant des incitations monétaires.

Dans le **chapitre 4**, nous étudions un deuxième problème qui peut nuire à l'efficacité du travail d'équipe, à savoir le problème de coordination. Le problème pourrait être résolu par l'émergence d'un leader capable d'imposer des décisions. Dans notre étude, nous concentrons notre attention sur le cas où les leaders d'équipe sont membres de l'équipe, ce qui constitue une option intermédiaire entre les mécanismes centralisés et les mécanismes décentralisés analysés au chapitre 2. Nous étudions deux fonctions spécifiques d'un leader d'équipe : coordonner les sanctions et donner l'exemple.

Précisément, la première question de recherche abordée dans ce chapitre est de savoir si déléguer la pression des pairs à un leader choisi parmi les membres de l'équipe peut améliorer son efficacité et réduire ses coûts. Ce problème est abordé expérimentalement en étudiant l'impact sur les efforts et les gains des travailleurs, de la délégation du pouvoir de sanction à un leader choisi parmi les membres de l'équipe. Une autre originalité de notre étude est de comparer les effets de la délégation de la pression des pairs à un leader d'équipe en fonction de la manière dont il est choisi. Les membres de l'équipe peuvent n'avoir aucune influence sur le choix d'un leader parmi eux, situation que nous modélisons par une sélection aléatoire du leader. Ou bien le leader d'équipe peut être choisi par les membres de l'équipe, situation que nous modélisons par une élection du leader par les membres de l'équipe, sur la base de l'observation du choix d'effort de chacun.

Notre deuxième question de recherche dans ce chapitre est de savoir si le fait de permettre au leader d'équipe de donner l'exemple à ses coéquipiers peut aider l'équipe à se coordonner à des niveaux d'effort plus élevés.

Pour étudier ces deux questions, nous analysons les résultats de 6 traitements différents.

Le premier traitement est le même traitement de base que celui des chapitres 2 et 3. Le deuxième traitement est le même traitement de pression des pairs que celui du chapitre 2. Le troisième traitement (« Pression d'un leader tiré au sort ») est similaire au traitement de pression des pairs, sauf que la pression des pairs est centralisée entre les mains d'un leader d'équipe choisi au hasard parmi les membres de l'équipe, à chaque période. Le quatrième traitement (« Pression d'un leader élu ») est comme le traitement précédent sauf que le leader, au lieu d'être choisi au hasard,

est élu par ses coéquipiers à chaque période, sur la base de l'observation des choix d'effort de chacun. L'analyse de ces quatre traitements permet d'analyser notre première question de recherche.

Pour étudier notre seconde question de recherche, les effets de l'interaction de deux fonctions d'un leader d'équipe, montrer l'exemple et concentrer les pouvoirs de sanction, nous comparons quatre traitements. Trois de ces quatre traitements correspondent à trois ensembles de fonctions déléguées au leader d'équipe : sanctionner ses pairs, donner l'exemple, ou donner l'exemple et sanctionner ses pairs. Le traitement par lequel le leader sanctionne ses pairs est la « Pression d'un leader tiré au sort » déjà présentée ci-dessus. Le traitement où le leader montre l'exemple, appelé « Exemple d'un leader tiré au sort », est un jeu d'effort séquentiel dans lequel le leader choisit d'abord son effort, puis ses trois coéquipiers observent l'effort choisi par leur leader et enfin choisissent leur propre effort. Dans le traitement où le leader montre l'exemple et sanctionne ses pairs, appelé « Exemple et pression d'un leader tiré au sort », le leader choisit son effort avant ses pairs comme dans le traitement précédent et a par la suite la possibilité de les sanctionner après avoir observé leur choix d'effort. Ces trois traitements avec un leader sont comparés au même traitement de base que dans les chapitres précédents.

Nos résultats sont les suivants.

Premièrement, l'introduction de leaders d'équipe a un effet positif et durable sur le niveau d'effort, s'ils peuvent à la fois donner l'exemple et sanctionner les passagers clandestins. Deuxièmement, à l'inverse, l'introduction d'un leader a un effet contre-productif si le leader ne peut que sanctionner ou montrer l'exemple. Troisièmement, l'efficacité du leader augmente s'il est élu par ses pairs plutôt que choisi au hasard.

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General Introduction

This thesis aims at contributing to the literature in personnel economics. Personnel economics refers to the application of economic principles and analysis to the management and organization of labor and personnel within firms or organizations. It involves studying various aspects of human resources management, including hiring, compensation, training, promotion, and retention, from an economic perspective. Personnel economics seeks to understand how individuals make decisions regarding their work, how firms structure incentives and compensation schemes to attract and retain talent, and how these decisions ultimately affect productivity, performance, and overall organizational outcomes (Rosen, 1982; Holmstrom, 1982; Holmstrom and Milgrom, 1991; Gibbs, 1995; Hamilton et al., 2003; Bloom and Van Reenen 2007; Lazear and Shaw, 2007). In this thesis, we focus our attention on the effectiveness and efficiency of different mechanisms that may be implemented within firms to mitigate the free riding and coordination problems within teams.

Importance of teamwork in firms

Firms have massively adopted teamwork organization in the USA and in Europe, at the end of the twentieth century. Among the 1000 largest American companies, the adoption of teamwork increased from the 1980s to 1996, when teamwork reached 94% of these large companies (Lazear and Shaw, 2007; Lawer et al., 2001). In Europe, according to the Cedefop and Eurofound's reports (2019)¹, 70% of European companies use some form of teamwork. For Delarue (2008), "Teamwork has emerged in recent years as one of the most important ways in which work is being reorganized".

Therefore, studying teamwork in firms is of particular importance, as most firms have adopted this type of organization. Although there is no universally accepted definition of teamwork, for the purpose of this thesis, we adopt Sundstrom (1999)'s formulation: "A work team is defined as interdependent individuals who share responsibility for specific outcomes for their organization."

Teamwork provides several advantages to firms. It increases productivity, involvement, and worker satisfaction (Alchian et Demsetz, 1972; Osterman, 1994, Delarue 2008; Owan, 2014). For instance, Osterman (1994) finds that teamwork enhances the productivity of firms by around 30%. According to Alchian et Demsetz (1972), the benefits of teamwork result from

¹ See Figure 27 page 47.

complementarities between team members. Delarue et al. (2008) provides three theoretical arguments supporting a positive link between teamworking and performance. One, workers may work harder if team work provides them more discretion, hence more job satisfaction, or if team dynamics stimulate their motivation to achieve together a common goal. Two, workers may work more efficiently, as self-managed teams can solve problems at once, using their private information rather than wait for external interventions, and enjoy involving their intellectual capacities. Three, teamwork is cost effective as it reduces the need for middle-managers. Delarue et al. (2008) also review relevant empirical studies and conclude that this literature confirms the positive effects of teamwork on firm performances.

Teamwork also fosters mutual aid and skill transfers between workers (Ichniowski and Shaw, 2003). When collective rather than individual performance is rewarded, workers have a personal interest in contributing to the success of the team by helping team mates.

Another advantage of teamwork found in the literature is that it provides flexibility to face the hazards of production and the variations of demand (Schippers et al., 2015). Indeed, teamwork makes workers more polyvalent, hence more able to replace absent colleagues. Moreover, authority is less centralized, which increases the reactivity of the organization and saves time (Masclat and Rebières, 2017). Schippers et al. (2015), observe similar benefits of teamwork in the specific context of primary health care teams in the United Kingdom,

Teams also make more rational decisions than individuals (Charness and Sutter, 2012). They learn faster, play with more stakes in advance and more strategically (Cooper and Kagel, 2005; Kocher and Sutter, 2005; Kocher et al., 2006; Sheremeta and Zhang, 2010). They are less prone to cognitive bias (Charness and Levin, 2005; Charness et al., 2010). They balance risks and benefits better (Rockenbach et al., 2007; Masclat et al., 2009).

Although teamwork is associated with numerous benefits, there are nonetheless also limitations to teamwork including problems of coordination, risks of adverse selection and incentives for free-riding.

Previous studies have shown that team decision-making may face information sharing and coordination problems (Driskell and Salas, 1991; Gruenfeld et al., 1996; Alper et al. 1998). Decisions are delayed and teams lack reactivity. This is even more likely that teams often consist of individuals with diverse skills, backgrounds, and expertise.

Teamwork may also generate adverse selection issues. According to Cooper et al. (2019), when agents can choose between a team work organization and an individual work organization, the most productive agents may opt for an individual work organization, to take full advantage of their productivity, while less productive agents may opt for a team work organization in the hope of sharing the benefits of the greater productivity of their colleagues.

Finally, team work creates incentive for free riding, which may plague production. When the workforce is organized in teams, the team production is a unique good that is valued globally (Holmstrom, 1982; Kandel and Lazear, 1992). The individual contribution of team members is not observable from the outside. As a result, the compensation derived from the team production tend to be equally distributed among its members, regardless of their individual contribution. As a consequence, rewards generated by individual efforts are shared with team mates, which dilutes the individual incentive to contribute (Holmstrom, 1982; Kandel and Lazear, 1992).

Evidence of free-riding in team-work has been experimentally shown by Nalbantian and Schotter (1997). In this experiment, the authors find that in absence of specific incentive schemes, revenue sharing leads to low effort level within teams. The huge experimental literature on public good experiments has also shown that free riding occurs in such context (see for instance Ledyard, 1995; Fehr and Gächter, 2000; Zelmer 2003; Toni and Volk, 2018).

In this current thesis we focus our attention on the two main issues associated to teamwork, namely the free riding and the coordination issues. We investigate to what extent centralized mechanisms, decentralized mechanisms, or the introduction of a team leader, allow to alleviate these problems. These different incentive mechanisms are described in detail below.

Centralized vs. Decentralized Incentives in Teams: literature

One way to solve the free-riding issue is to design centralized mechanisms such as target-based schemes or collective tournaments.

In target-based schemes (Holmstrom, 1982), the firm sets a target of team performance. If the target is reached, the workers share the revenue generated. Otherwise, if the objective is not reached by the team, each team member receives a fixed and low compensation. Holmstrom (1982) shows that in theory, it is possible to set the team target and the low fixed compensation so that the socially optimal level of effort is a Nash equilibrium.

Firms can also set up systems where the objective is made endogenous by using collective tournaments, i.e., tournaments between teams, as suggested in Nalbantian and Schotter (1997). In collective tournaments, one team plays against another and the winning team receives a transfer of remuneration from the losing team. With an appropriate value for the transfer of remuneration, the socially optimal level of effort becomes a Nash equilibrium.

Nalbantian and Schotter (1997) use a laboratory experiment to test these centralized mechanisms and compare the efficiencies of target-based and of collective tournament schemes. They observe the inefficiency of the mechanism based on a team target, despite an objective chosen in such a way as to encourage optimal efforts. Indeed, the teams rarely achieve the objective, which discourages their members and leads to very low final levels of effort, lower than in the absence of any incentive mechanism. In contrast, the collective tournament mechanism, when the transfer of remuneration from the losing team to the winning team is chosen appropriately, leads to a maximum level of effort.

A second family of incentives to address the free riding issue consists in implementing decentralized mechanisms based on peer pressure. Peer pressure can be exerted by the simple mutual observation of behavior within a work team (Falk and Ichino, 2006; Mas and Moretti 2009). Beyond the positive effects of mutual observation between team mates, an approach that can be implemented to solve the free rider problem consists for the principal in setting up decentralized mechanisms based on peer pressure between team mates (Coleman, 1990; Varian 1990; Kandel and Lazear 1992; Itoh 1993; Barron and Gjerde 1997; Carpenter et al., 2009). Indeed, even if the principal cannot herself observe the effort of the agents working in a team, the agents can observe and sanction each other. The principal can create an incentive system that encourages workers to agree on the actions desired by the principal and to enforce those agreements using informal sanctions. Such decentralized peer pressure mechanisms correspond to practices observed in the real world. For instance, the role of peer pressure and social norms appears in the literature as essential to the success of Japanese companies: Nahavandi and Aranda (1994) emphasize the importance of Japanese social norms in the success of teamwork in Japan. The success of lean management (Shah and Ward, 2003) in North American and European firms is based, among other things, on the introduction of mutual control between employees within work teams (Delbridge et al., 1992).

Economic analysis has modeled peer pressure effects in general and varied contexts. In the specific case of teamwork in firms, the reference theoretical models of how decentralized peer pressure can effectively deter free rider behavior, are those of Kandel and Lazear (1992) and of

Barron and Gjerde (1997). Because it is difficult to measure the effectiveness of peer pressure from conventional data, empirical studies have mobilized data from laboratory experiments, mainly using public good games. In public goods game experiments, allowing team members to punish the less cooperative individuals in the team is highly effective in raising contribution levels. Individuals do not hesitate to pay from their own earnings to reduce the earnings of free-riders: see for instance, Fehr and Gaechter (2000), Masclet et al. (2003), Carpenter et al. (2004), Noussair and Tucker (2005), Bochet et al (2006), Denant-Boemont et al (2007), Sefton et al (2007), Carpenter et al (2009), Grosse et al. (2011). It is thus clear that, at least under some circumstances, peer pressure mechanisms can represent an effective means of increasing cooperation within teams and thus alleviate the free-rider problem. However, while the ability to punish improves cooperation, punishing is costly for both the punisher and the punished.

In practice, attempting to put pressure on other workers can have negative relational effects, as punished co-workers may accumulate resentment, the punisher may be blamed especially if she has personal ties with the free rider. This raises the issue of the second order free rider problem, i.e., the problem of who will bear the cost of monitoring and punishment among the team members (Yamagishi, 1986). There may exist retaliation against punishers and even blind retaliation (Nikiforakis, 2004; Denant-Boemont et al., 2007), antisocial punishment of contributors (Cinyabuguma et al., 2004, 2005), or over-punishment due to the negative emotions generated by free riders, which may be detrimental to social welfare, at least in the short run (Dickinson and Masclet, 2015).

Thus, peer pressure, as modeled in public goods game experiments, generates complex and ambiguous effects, if we consider its possible ultimate consequences.

Leadership and the coordination problem: literature

As mentioned above, another issue associated with teamwork is the problem of coordination. To what extent can the introduction of a team leader alleviate this problem and facilitate coordination? Economic literature has modelled how the example of a leader can influence her co-workers, using sequential public good games, where the leader chooses her contribution before the other members of the team. Varian (1994), theoretically analyzing a sequential public good game, shows that under symmetric information, leading by example should reduce the levels of cooperation. However, if the other members of the team think that the leader has private information, Hermalin (1998) proves that in theory, leading by example promotes

cooperation, when the leader induces beliefs in her team-mates, that encourage them to cooperate for her benefit.

The experimental literature on sequential public good games shows that leading by example favors cooperation only if complementary conditions are met. According to this literature, the example given by a leader can reinforce cooperation, conditional on the existence of a group identity (Drouvelis and Nosenzo 2013), on the leader's power to exclude free-riders (Haigner and Wakolbinger 2010), or on the observation of the history of each participant's behavior during past periods of the game (Figueres et al. 2012). But leading by example may also have no effect in the absence of the above conditions, or even have a negative influence on cooperation (Gächter et al. 2010).

Additionally, would a team leader make peer pressure more effective by coordinating peer sanctioning activities and thus making peer pressure less costly? A team leader may be given the authority to reward or punish the other members of the team, depending on their behaviors (Drouvelis et al., 2013). A leader differs from a principal because, as a member of the team, she participates in the team production and as such, she has access to internal information on the individual contributions of team members. A team leader therefore knows whose team members deserves reward or punishment. The introduction of a team leader should help alleviate the coordination problem by providing clear direction, establishing common goals, and facilitating communication among team members. This may be done by leading by example. Furthermore, one may reasonably argue that a team leader may play a crucial role in managing peer pressure by coordinating peer sanctioning activities. By targeting more precisely free riders, the leader may discourage harmful, counterproductive or excessive peer pressure.

In addition, assigning to a leader the monopoly of punishing should also prevent reprisals, because those who are punished do not have the possibility to punish themselves, and second-order free-riding, because the leader cannot expect her team-mates to punish in her place. This is a general benefit of centralized exercise of punishment power (Markussen et al., 2014; Nicklisch et al., 2016).

An experimental economics approach

While the literature has investigated separately the effects of centralized mechanisms, of decentralized mechanisms, and of mechanisms based on the action of a team leader, this thesis

attempts to directly compare the respective effectiveness and efficiency of these different mechanisms, which, to the best of our knowledge, has not been yet done.

For this purpose, we choose an experimental economic approach that ensures a high control on the factors influencing treatment effects, hence a high level of internal validity of our empirical results. Indeed, according to Roe and Just (2009), internal validity of empirical results is maximized by the use laboratory experiments.

It is difficult to measure the specific effectiveness of incentive mechanisms supporting team work using observational data. One solution may be to resort to randomized field experiments conducted within companies (see, for example, Mas and Moretti (2009)'s study on peer effects or Delfgaauw et al., 2013). However, there is a loss of internal validity and loss of control when conducting field experiments. To our knowledge, no field experiments have compared decentralized mechanisms such as peer pressure with centralized mechanisms such as team tournaments or collective objectives. Furthermore, peer pressure mechanisms rely on social norms and a reference group, that is difficult to control in the field. For all these reasons, resorting to controlled laboratory experiments seems more relevant here. Laboratory experiments have emerged in the last decades as a powerful approach to investigate behaviors (V. Smith, 1982) . It seems particularly appropriate to investigate microeconomic concerns related to labor economics and particularly personnel economics, as explained in Charness and Kuhn (2011).

Charness and Kuhn (2011) expose the key advantages of laboratory experiments for labor economists. Lab experiment allow to control factors more tightly than in any other context. By contrast, field empirical data reflect a variety of environmental factors which are difficult, if not impossible to disentangle. For example, predictions of tournament theory (Lazear and Rosen 1981), effects on workers of outside options, minimum wages, sick pay, discrimination, or efficiency-wage theory (Akerlof, 1982, Akerlof and Yellen 1990), may be rigorously tested using laboratory experiment, thanks to the superior control and the internal validity they provide, which make it possible to identify causal relationships (Falk and Fehr, 2003). Furthermore, Falk and Fehr (2003) point out that other factors such peer pressure, and whether the interaction is one-shot or repeated, may well affect behavior and are unlikely to be known to a researcher using field data. Charness and Kuhn (2011) consider that lab experiment can be seen as a first link in a longer chain running from theory to actual interactions in real firms. For instance, the use of lab experiments

to 'pre-test' proposed allocation mechanisms before really implementing them already has an established history (see Plott 1987).

In addition, the costs of lab experiments are low, compared to field experiments and survey data collection: competing hypotheses can be tested quickly and inexpensively with a modest number of sessions. Hence, if one has doubts concerning data reported in a laboratory experiment, one can readily replicate the experiment.

The experimental approach is however not without limitations and concerns. A first concern relates to its external validity. Indeed, one may doubt about whether a small number of participants, who are mostly students, truly represent broader populations of interest (Levitt and List, 2007a, 2007b). However, as pointed out by Falk and Heckman (2009), "for the purpose of testing theories, [representative evidence] is not a problem because most economic models derive predictions that are independent of assumptions concerning participant pools (p. 537). And Charness and Kuhn (2011) underline that undergraduate students, as participants to experiments, have several advantages: their participation is inexpensive, evidence suggests that they are more capable than average (which facilitates the experimental procedures), and they are at least as representative of the college-educated labor force than the highly-selected population of professional generally involved in field experiments. Therefore, if the goal is to identify general principles that apply broadly to a large population of workers, college students might be a more attractive choice than workers in a single, narrowly defined occupation or industry.

Other objections to the data obtained through laboratory experiments are that the stakes are low, and the fact that "labor task" is often simply the choice of how much money to assign to another party.

Regarding the limited earnings of participants to laboratory experiments, it is unclear whether decisions involving larger sums of money or smaller sums, but applicable to decisions people make on a daily basis, are more relevant for economic purposes. Moreover, large stakes do not necessarily lead to fewer mistakes (Ariely et al., 2009).

Concerning the objection that the labor task is abstract and artificial, there has been an increasing trend in "real-effort" experiments. However, including real-effort tasks in laboratory experiments creates the risk of heterogeneous intrinsic motivations of participants for the real-efforts task, which may be unobservable, and bias the outcome, resulting in lower internal validity.

To address the generalizability of laboratory findings, we need also define what is meant by external validity. In line with Kessler and Vesterlund (2015) and Levitt and List (2007a), we contend here that our results cannot determine the magnitude of the effects (quantitative external validity) but can correctly identify the direction of the effects (qualitative external validity). Furthermore, this experiment should be seen as a first step that calls for replications (Camerer, 2015) to improve its external validity. Once an effect withstands these robustness checks in the controlled environment of the laboratory, with identified boundary conditions, researchers can then transition to the field to explore the effect size in the desired real-world setting. Laboratory experiments in economy may be seen as the analog of tests in a wind tunnel during the conception of an airplane (Schram, 2005, p. 232) or of in-vitro experiments for a new medical therapy.

We can conclude on our methodological choice of experimental economics by quoting Falk and Heckman (2009): “Laboratory experiments are very powerful whenever tight control ... is essential. ... Tight control ... also allows replicability of results, which is generally more difficult with field data” (p. 537).

Content and chapters

To compare the performances of centralized mechanisms, decentralized mechanisms and mechanisms based on the action of a team leader, we use a unique experimental design, adapted to modeling teamwork in firms, and we evaluate the effectiveness and efficiency of a large range of effort incentive mechanisms applicable for team work and meant to prevent free-riding.

Our experimental design is an effort game with revenue sharing inspired by Nalbantian and Schotter (1997). We give some detail on the baseline version of this revenue sharing game. Each treatment consists of 10 identical periods. Each participant participates only to one treatment (“Between design”). The composition of teams remains constant overtime (“Partner matching”). To prevent the possibility of individual reputation formation across periods, participants identifiers are randomly changed at each period. This design scheme is inspired by Fehr and Gächter (2000).

A firm is composed of a principal and eight agents involved in two teams of four workers each. At each period, workers, within a team, simultaneously choose their effort level (between 0 and 100) to produce an output that is shared among the team members, such that, absent incentive

mechanism, free-riding is theoretically a dominant strategy. The output in each team equals the sum of the efforts of team members, plus a uniform random variable which can be interpreted as a random shock of production. Workers receive one fourth of the value of their team's output, plus a lump-sum. Workers incur of cost for their effort, which is a quadratic function of their choice of effort. It can be shown that in this game, the Pareto optimum level of effort (75) is much higher than the effort choice corresponding to the Nash equilibrium (18.75).

In chapters 2, 3 and 4, different versions of this effort game are used to compare the performances of different incentives mechanisms.

Chapter 1 of this thesis presents a survey of the literature and describes how, during the twentieth century, work organization in the industry evolved from Taylorism to Toyotism, and more recently to new forms of organizations that promote team work. It details the advantages of teamwork for the firm, but also its downsides such as coordination problems, as well as risks of adverse selection and of free-riding. The different types of centralized and of decentralized of mechanisms proposed by economic literature to address coordination and free-riding problems in teamwork are presented.

In **chapter 2**, we focus our attention on the question of whether centralized mechanisms are more effective and efficient than decentralized peer pressure mechanisms. For this purpose, we compare our baseline treatment (the revenue sharing game) with three additional treatments. The second treatment ("Peer Pressure") is similar to the Baseline, except that a second stage is added where each team member can assign costly punishment points to the other team members. The third treatment ("Group Target") is also similar to the Baseline, except that team's total output is compared to an exogenous target such that workers are rewarded only if this total output reaches the target. Finally in the fourth treatment ("Group Competition"), each team competes with another team, and the team with the highest output receives a transfer from the other team. The effects of treatments on workers' efforts and payoffs, on firms' profits, and on social welfare are analyzed.

First, our results show that, in the absence of incentive mechanisms, effort is subject to free-riding, although not as severely as theoretically-predicted. Second, we observe that peer-pressure weakly increases effort compared to the baseline, but substantial free riding remains.

Peer pressure does not improve workers' payoffs compared to the baseline. This results from the fact that the gains of increased cooperation are offset by the social cost of punishment. Third, centralized mechanisms are more effective than a peer pressure scheme to enhance effort. In particular, Group Target based schemes lead to near to a Pareto optimal level of effort, but at the price of lower and more unequal workers' payoffs. This is mainly due to the fact that several teams fail to reach the target. In contrast, this system leads to a strong increase in the profits of firms. Fourth, Group Competition enhances effort significantly but fails to improve workers' payoffs, and results in large payoff inequality between workers. This is due to the large dispersion of payoffs between members of the winner and the loser teams. Fifth, social welfare is maximized under the centralized incentive schemes, and particularly with the Group Target. However, the increase in welfare is not shared equally between workers and the firm, as it mainly benefits to the firm.

Chapter 3 focuses on centralized mechanisms. Its objectives are twofold. First, chapter 3 investigates if with symbolic incentives instead of monetary incentives, centralized mechanisms continue to effectively prevent free-riding, without the negative effects of monetary incentives on the payoffs of workers. Second, chapter 3 attempts to identify the specific effects of the observation of individual efforts of team-mates, included in all treatments with incentives but not in the baseline treatment, compared to the observation of aggregate efforts of team-mates, included in the baseline treatment.

To compare the impacts of monetary incentives to those of symbolic incentives, we analyze five treatments. Our first treatment is the Baseline treatment already included in chapter 2. Our second treatment is the Group Target treatment, already presented in chapter 2 too. In the third treatment, named Symbolic Group Target, teams total outputs are compared to the same exogeneous target than in the Group Target treatment, but the consequences for workers of their team's total production meeting the target are symbolic, not monetary. The fourth treatment is the Group Competition treatment presented in chapter 2. Finally, in the fifth treatment, named Symbolic Group Competition, each team also competes with another team, but teams with the highest output receives symbolic congratulations rather than a monetary transfer

To address our second question, isolating the pure effect of observation of individual efforts compared to the observation of aggregate effort, we introduce three additional treatments. In the first additional treatment, within a team, the observation of the aggregate effort of

teammates is replaced, in the Baseline treatment, by the observation of their individual efforts. In the other two additional treatments, conversely, the observation of the individual effort of team members is replaced, in the Monetary Group Target and Monetary Group Competition treatments, by the observation of their aggregate efforts.

Our results are the following.

First, compared to the baseline treatment, centralized mechanisms using symbolic incentives effectively increase workers' efforts and social welfare, but significantly less than when using monetary incentives. Second, introducing observation of others' individual efforts in the baseline treatment, instead of observation of average effort, significantly increases effort. Third, however, such pure effect of observability is not found to be significant, in the context of centralized mechanisms using monetary incentives.

In chapter 4 we investigate a second issue that may plague the effectiveness of team work, namely coordination problem. The problem may be solved by the emergence of a leader, able to impose decisions. In our study, we focus our attention on the case where team leaders are members of the team, as an intermediate option between the centralized and the decentralized mechanisms analyzed in chapter 2. We investigate two specific functions of such team leader: coordinating punishment decisions and leading by example.

Precisely, the first research question addressed in this chapter is whether delegating peer pressure to a leader chosen among team members can improve its effectiveness and reduces its costs. It is experimentally addressed by investigating the impact on workers efforts and payoffs, of delegating punishment power to a leader chosen among team members. Another originality of our study is the compare the effects of delegating peer pressure to a team leader depending on how the team leader is chosen. Team members may have no influence on the choice of a leader among them, situation that we model by a random selection of the leader. Or the team leader may be chosen by team members, situation that we model by an election of the team leader by team members, on the basis of the observation of their choices of effort.

Our second research question in this chapter is whether extending the role of the team leader to leading by example, may help the team to coordinate on higher effort levels.

To investigate these two questions, we analyze the outcomes of six different treatments.

First, our Baseline treatment is the same than in chapters 2 and 3. The second treatment is the same Peer Pressure treatment than in chapter 2. The third treatment (“Random Leader Pressure”) is like the Peer Pressure treatment except that peer pressure is centralized in the hands of a team leader who is randomly chosen among team members at each period. The fourth treatment (“Elected Leader Pressure”), is like the previous treatment except that the leader, instead of being randomly chosen, is elected by her team mates at each period, based on the observation, within teams, of the effort choices of team members. The analysis of these four treatments allows us to address our first research question.

To study our second research question, the effects of the interplay of two functions of a team leader, leading by example and concentrating punishment powers, we compare four treatments. Three of these four treatments correspond to three sets of functions delegated to the team leader: punishing peers, leading by example, or leading by example and punishing peers. The treatment where the leader punishes her peers is the “Random Leader Pressure” already presented above. The treatment where the leader leads by example, called “Random Leader Example”, is a sequential effort game where the leader chooses her effort first, the three other team members observe the effort chosen by the leader, and choose their own effort afterwards. Finally, in the treatment where the leader leads by example and punishes peers, called “Random Leader Example & Pressure”, the leader chooses her effort before her peers and has thereafter the possibility to punish them. These three treatments with a leader are compared to the same Baseline treatment than in the previous chapters.

Our results are the following.

First, introducing team leaders has a positive and lasting effect if they can both lead by example and sanction free-riders. Second, conversely, introducing leadership has a counterproductive effect if the leader can only either sanction or lead by example. Third, the effectiveness of leadership increases if the leader is elected by peers rather than chosen randomly.

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Chapter 1

Economic analysis of teamwork in firms

1. Introduction

Firms have massively adopted teamwork organization in the USA and in Europe, at the end of the twentieth century. Lazear and Shaw (2007) quote statistics established by Lawer et al. (2001) on the 1000 largest American companies, indicating that the spread of teamwork jumped from the 1980s to reach a maximum in 1996, when teamwork concerned 94% of these large companies, before declining slightly thereafter. In Europe, according to the Cedefop and Eurofound's reports (2019)² 70% of European companies use some form of teamwork. For Delarue (2008), "Teamwork has emerged in recent years as one of the most important ways in which work is being reorganized".

In parallel, the development of corporate policies based on Profit Sharing and on Employee Stock Ownership Plans have introduced collective incentives at firm level. Those corporate policies have been found to increase productivity by 3.5 to 5 percent (Kruse, 1993; Jones and Kato, 1995), also to reduce absence (Brown et al., 1999) and turnover intentions (Buchko, 1993)³.

Although there is no universally accepted definition of teamwork⁴, for the purpose of this thesis, we adopt Sundstrom (1999)' formulation: "A work team is defined as interdependent individuals who share responsibility for specific outcomes for their organization."⁵ More precisely, Cohen and Bailey (1997), distinguish four types of teams: work teams, parallel teams, project teams and management teams. Work teams are continuing work units responsible for producing goods or providing services. Parallel teams pull together people from different work units to perform functions that the regular organization is not equipped to perform well, generally problem solving or improvement-oriented activities. Project teams produce specific outputs in a limited time, such as a new product or service, a new information system or a new

² See Figure 27 page 47.

³ As mentioned in Kruse (1993), "Many proponents viewed profit sharing as a way to integrate workers into the capitalist system by sharing the benefits of capitalism in a more direct and tangible way than allowed by fixed wages. [...] It was also seen by some as a logical extension of political democracy." In France, a similar idea was formulated by Charles de Gaulle (1970), who considered profit sharing as central to his economic policy, and as a decisive democratic progress. However, as Kruse (1993) further notes, "Much of the support for profit sharing [...] has shifted from a broad ideological approach to support based on more narrowly construed economic reasons. [...] By tying worker pay to profits, [...] the incentives of workers and owners can become aligned so that productivity-reducing conflict is minimized and productivity-enhancing cooperation and innovation are encouraged."

⁴ For Delarue (2008) "Over the years, a number of attempts have been made to define teamwork [...] However, there remains no generally accepted definition [...] This all suggests that working with a specific definition of teamwork would be very restrictive."

⁵ This is also compatible with Holmstrom (1982) definition: "a group of individuals who are organized so that their productive inputs are related".

plant. Management teams coordinate and provide direction to the sub-units under their jurisdiction, integrating their activities into coherent business processes.

Firms have introduced teamwork in their organizations because it can increase productivity, stimulate mutual aid and skill transfer between colleagues, provide flexibility to face the hazards of production and of demand, and favor more rational decision-making by employees. However, to generate those benefits, team work must not come alone, but with a set of complementary human resources practices concerning pay, job design, job security, training, and problem-solving organization, and also technical devices, such as information technology (Pil and McDuffie, 1996; Ichniowski and Shaw, 2003).

Teamwork organization also has its downsides. First, coordination problems may emerge in the absence of a clear decision-making process, if team members have diverging views (Masclat and Rebières, 2017). Second, as team work restricts direct outside monitoring of individual workers' contributions, individual piece rate types of compensation can no longer be used. Hence human resources practices associated with team work includes financial incentives at team level (Pardi, 2013). If individual compensations depend on team collective performance, adverse selection and free-riding problems may arise. Adverse selection problems, because firms rewarding team performance are prone to attract lower productivity workers than firms rewarding individual performance (Cooper, 2019). Free-riding problems, because rewards generated by individual efforts are shared with team mates, which dilutes the individual incentive to contribute (Holmstrom, 1982; Kandel and Lazear, 1992).

Economic literature has proposed several incentives mechanisms meant to solve the problem of free-riding in teamwork: centralized mechanisms where teams must achieve an objective or compete with each other (Holmstrom, 1982; Nalbantian and Schotter, 1997), or decentralized mechanisms based on peer pressure (Kandel and Lazear, 1992; Fehr and Gächter, 2000). But those mechanisms have not been directly compared one with the other. This is the object of the next chapters of this thesis: comparing in a unique experimental framework a wide set of centralized and decentralized incentive mechanisms, using monetary or symbolic team incentives, varying conditions of observation of team-mates' behaviors, and introducing a team leader chosen among workers, able to punish and to lead by example.

The rest of this chapter is organized as follows. Section two reviews how industry switched from Taylorism to new forms of organizations that promote team work, and introduces emerging models of work organization. Section three details the pros and cons of teamwork.

Section four focusses on the mechanisms proposed by economic literature to prevent free-riding in teamwork. Section five concludes and introduce the following chapters of the thesis.

2. From Taylorism to new organizations of firms with teamwork

Taylorism, which in theory excludes teamwork, has dominated work organization in the industry, despite multiple critics, before being challenged in the last quarter of the 20th century by Toyotism, which requires teamwork. Principles of Toyotism are summarized. Evidence of its influence on work organizations, at the end of the 20th century, is presented. Finally, recent developments in firms' organization models are mentioned.

2.1. Rise and fall of Taylorism in the industry

Teamwork has not always been a benchmark in management science. The well-known principles of the Scientific Management, formalized and popularized by F.W. Taylor (Taylor, 1910), are based on the contrary on a horizontal division of work into elementary individual tasks, optimization and standardization of execution procedures, optimal quantitative standards for the execution of these tasks, and a strict vertical hierarchical division between design and execution functions. These principles are detailed in the following quote of F.W. Taylor (Taylor, 1910) defining the duties of managers under Scientific Management:

“These new duties are grouped under four heads:

- *First.* They develop a science for each element of a man's work, which replaces the old rule-of-thumb method.
- *Second.* They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could.
- *Third.* They heartily cooperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed.
- *Fourth.* There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men.”

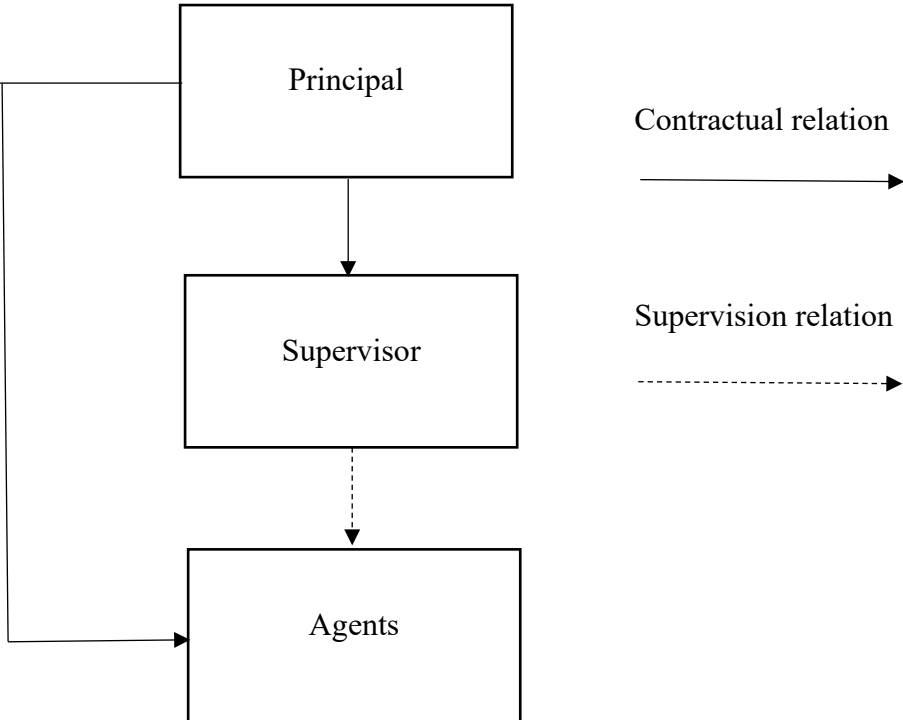
It should be noted that Taylor system directly derives from the principles of economic efficiency uncovered by classical economists, division of labor bundled with specialization from Adam Smith (Smith, 1776) and theory of competitive advantage, here between workmen and managers, from Ricardo (Ruffin, 2002).

In his writings, F.W. Taylor emphasizes the extent to which Scientific Management explicitly excludes the taking of initiative by the workers and the possibilities of varying the tasks imposed on them, considering that they would harm productivity. In fact, this organization brought considerable productivity gains which made it the benchmark organization in industry for most of the 20th century. It characterized industrial societies, both capitalist and socialist, to use the terminology of Raymond Aron (Aron, 1962).

Taylorism is a specific answer to the problem of moral hazard faced by firms. As summarized by Homstrom (1982), moral hazard refers to the problem of inducing agents to supply proper amounts of productive inputs when their actions cannot be observed and contracted for directly. The principle of Taylorism is to eliminate moral hazard problem by making workers' actions directly observable and contractable. Workers' performance is monitored and compared to a precise norm determined by the firm itself.

Figure 1 below, inspired by Macho-Stadler and Pérez-Castrillo (1992) and by Masclet and Rebières (2017), provides a schematic description of Taylorism solution to the moral hazard problem.

Figure 1: Contracting and controlling in a Taylorist firm



Taylorism has imposed itself as a reference in terms of work organization despite strong social opposition from independent workers, whose moral code was the exact opposite of Taylorism (Pinard, 2000): « The tradesman must not lower his back in front of the boss and he must refuse to work when he is watched; it is forbidden to harm a comrade to get favors from the boss. Productive know-how and mutualistic behavior therefore constitute two essential conditions to the exercise of professional autonomy⁶. ». Who should control production know-how was the key stake of the opposition between independent workers and firms: « When the National Metal Trades Association launched its open-shop drive against the machinists' union in 1901, it demanded “full discretion” for employers “to designate the men we consider competent to perform the work and to determine the conditions under which that work shall be prosecuted”. Its declaration of principles added: “We will not permit employees to place any restriction on the management, methods, or production of our shop, and will require a fair day's work for a fair day's pay”⁷. »

Taylorism has also been criticized for treating workers as tools rather than men, using the words of Edward Cadbury, quoted in (Taylor, 1914): “We must keep in mind that a man and his personality is always an end in itself, and working people in the future will have to be treated less as tools and more as men.” Charles Chaplin's “Modern Times” film is the most popular translation of this point of view. In (Taylor, 1914), F.W. Taylor rejects these critics, essentially on empirical grounds, and highlights the guarantees Scientific Management provides to workers in preserving them from management' arbitrariness and in granting them a share of the productivity gains of the system.

Allocating part of productivity gains achieved through Taylorism, to increases in workers' wages, corresponds to what has been called Fordism, based on Henry Ford decision to double the daily wage of his workers up to 5\$ a day the 4th January 1914. Despite Henry Ford's well-known statement that he was “paying workers enough to buy the cars they made”, the direct rationale for this decision has more to do with modern efficiency wage theory (Raff and Summers, 1987), to maintain productivity and prevent high turnover of workers. However, as pointed out in (Boyer and Orléan, 1991), high wages ultimately diffused in the economy thanks

⁶ Author's translation from French.

⁷ Quotations from U. S. Commissioner of Labor, Eleventh Special Report, « Regulation and Restriction of Output» (Washington, 1912)

to collective agreements and State interventions, in the context of the New Deal, generating Keynesian demand effect, rather than endogenously by market forces.

If diffusion of Ford's high wages policy was slow, Ford's technical innovation based on the assembly line, diffused very quickly in the US automotive industry and beyond (Hounshell, 1984 p. 218).

The Human Relation School of Elton Mayo based on the Hawthorne Studies performed at Western Electric Hawthorne Works (Mayo, 1949; Roethlisberger and Dickson, 1939) questions Taylorism less than it enriches its implementation, emphasizing the need for management to acknowledge the role of work teams, and the importance of interpersonal relationships within these teams, to enhance productivity. Hawthorne studies also underlines the "Hawthorne effect", by which workers gain motivation, self-esteem and productivity just by being involved in these studies. Reviewing the original data from Hawthorne studies, S. Levitt and J. List question the original statistical analysis, and reinterpret the Hawthorne effect (List and Levitt, 2011).

In practice, it was Japan's successes in integrating teamwork in the industrial production in an original way, which led to a questioning of the dominant model at the end of the 20th century, in a context where considerations of quality and product differentiation became decisive for the commercial success of firms⁸. This context is historically linked to the two oil shocks of 1973 and 1979 and their impacts on the car industry and on the economy. It is also associated with the intensification of international competition, supported by the successive negotiation rounds of General Agreement on Tariffs and Trade. In particular, the Kennedy (1962-1967) and the Tokyo (1973-1979) rounds resulted in 35% and 34% successive reductions of customs tariffs for industrial goods ultimately concerning 102 countries (Unger, 2017). Demand evolved from standardized to more segmented and differentiated products (Frank et al, 1972).

In this context, Japanese automobile industry doubled its production in the 1970's and had become in 1980 the world leading producer (Dohse et al, 1985), thanks to its quality, flexibility, and cost effectiveness. The Japanese organizational methods, popularized under the name of Toyotism, became a model to be studied or even to copy (Dohse et al, 1985; Horman, 1991).

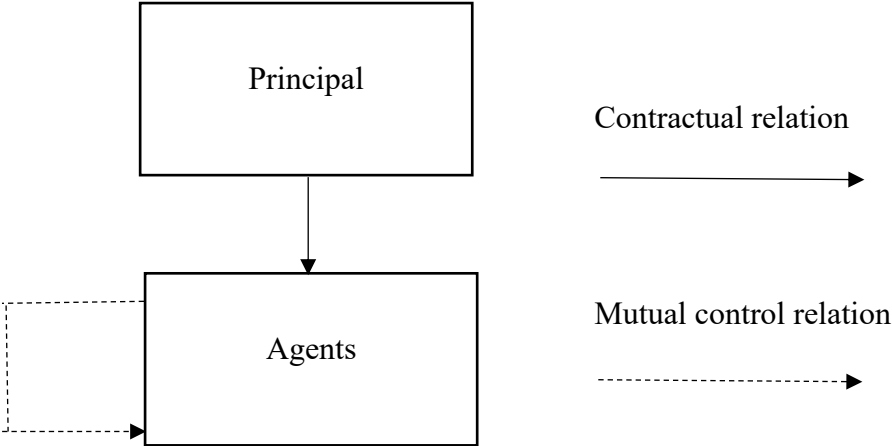
⁸ The socio-economic management model which Henri Savall initiated in the 1970's has underlined the importance of the hidden costs for firms, and for society, generated by Taylorist organization of work (Savall, 2003).

2.2. Characteristics of Toyotism

The general principle of Toyotism is that production is ensured by autonomous teams, within which workers exercise mutual control and punishment. Therefore, in Toyotism, the moral hazard problem is addressed through a complete delegation of authority to production teams, not only regarding productive but also regarding control activities. This principle is illustrated by Figure 2, also inspired by Masclet and Rebières (2017).

Differences between Figure 1 and Figure 2 illustrate differences between Taylorism and Toyotism in addressing the moral hazard problem.

Figure 2: Delegation of authority in a Toyotist firm



However, in Toyotism, delegation of authority to teams is one element of a comprehensive system, including technical characteristics of production, work organization, and incentive mechanisms which are detailed in the following indents.

From a technical point of view, Toyotism retains the principle of the assembly line inherited for Taylorism. But following the Kanban principle, work is not push from one shop to the next downstream the assembly line. On the contrary, the work is pulled from one shop to the previous shop upstream the assembly line. Hence, work is not done upstream unless it can be processed downstream, preventing accumulation of work in progress, buffers, inventories, and delays. This principle ultimately supports the objective of lean production and of Just in Time. The Kanban system allows to follow work flows and their interdependencies, and to identify and correct bottlenecks. It also makes production flexible to changes in demand. Sendil Kumar and

Panneerselvam (2007) provide a comprehensive review of Kanban-JIT technical principles. Kanban technical approach is now used outside manufacturing, for instance in the software development industry (Ahmad et al., 2013).

Toyota work organization also applies the Kaizen principle of constant and systematic improvements of the process (Delbridge et al. 1992). To this end, autonomous teams of workers, within the assembly line, are responsible for the quality of their production. Team members are trained to perform the different tasks performed in their teams, such that team members can support or replace each other if necessary. Defaults must be identified and fixed at once by the work team. Hence, autonomous teams are responsible of the quality of their production, and within teams, workers are incentivized to control each other. Preventing defaults is then analyzed off line within quality circles.

Team production is evaluated and impacts the salaries of all team members, which therefore exercise strong peer pressure among themselves to ensure that all contribute to team performance⁹ (Dohse, 1985; Pardi, 2013). A team leader is designated by the management among team members and contribute to the evaluation of his or her team mates. There is competition between workers to become team leaders and between team leaders to become group leaders. Workers who are not promoted as team leaders ultimately tend to quit the firm under pressure from their supervisors and their peers, despite life-long employment contracts, and to be hired by the firm sub-contractors within the Keiretsu headed by the firm (Pardi, 2013).

As apparent in this description and as acknowledged in articles describing Toyotism in detail (Dohse, 1985; Delbridge et al. 1992; Winfield, 1994; Adler, 1995; Pardi, 2013), Toyotism should not be opposed to Taylorism. On the contrary, in Japan, the system in force in the automobile extends Taylorism by involving workers, through quality and innovation groups, and through peer pressure and competition, in the continuous optimization of their own tasks, thanks to the power that managers have over their subordinates.

In the beginning of 1980's, protectionist barriers restricted the exports of Japanese cars in the USA and in Europe (Winfield, 1994; Pardi, 2013). Toyota strategy to get around this obstacle was to build Toyota plants in the USA (Adler, 1995) and in Europe (Winfield, 1994; Pardi, 2013). In the USA, the NUMMI plant, which started in 1984, was a joint venture between

⁹ The organization of social events within Japanese firms is meant to encourage social ties between employees, favoring the emergence of social norms within work teams. Within teams, the existence of social norms results into peer pressure targeting team members who do not comply with the social norm (Spagnolo, 1999).

General Motors and Toyota, building Toyota cars in the old GM-Fremont plant which GM has closed in 1982. NUMMI plant proved to be very productive, nearly as productive as its Japanese equivalent, showing that Toyotism could be adopted outside Japan (Adler, 1995)¹⁰.

2.3. Toyotism diffusion in the industry

High performance or high involvement working practices, lean production are different names under which Toyotism has inspired manufacturing sectors in the USA and in Europe. The following paragraphs present how and to which extent these practices have diffused in the economy.

Industrial sectors such as cars (Pil and MsDuffie, 1996) or steel (Ichniowski et al., 1997) have evolved from traditional organizations to high involvement work practices at the end of the 20th century, with a high variance in the degree to which plants adopted such practices. Transition towards high involvement work practices implies the adoption of complementary human resources policies, and also depended on technical factors, such as more demanding or new productions, moving towards a greenfield work site, or the adoption of information technologies (Milgrom and Roberts, 1990; Bresnahan and Greenstein, 1997)¹¹.

By contrast, traditional sectors such as the apparel industry, or emerging sectors such as call centers are still massively organized following Taylorist principles. According to Dunlop and Weil (1996), more than 90% of US apparel production still followed Taylorist principles at the end of the 20th century. Transition towards innovative work practices is profitable only when retailers and apparel suppliers invest in complementary information systems, leading to faster throughputs from command to delivery, lower work in progress and 4 to 5% reduction of labor costs. The call centers industry has massively stuck to Taylorist organization (Martí-Audí et al., 2013): “Strict guidelines, standardization, routinization and monitoring are some of the characteristics stemming from the automation of work processes,” despite positive outcomes of an experimentation of innovative work organization in the customer care and sales call

¹⁰ Toyotism was not the only form of teamwork to emerge in the car industry at the end of the twentieth century. Volvo, in Sweden, pioneered an alternative model of teamwork, called the Scandinavian model as opposed to the Japanese model in the management literature (Fuxman, 1999). The Scandinavian model of teamwork breaks up with Taylorism and the assembly line. Teams of workers have the responsibility to assemble a significant part of a car in a dedicated workshop within the plant. The supply of the required pieces is provided by an automatic system. Volvo's motivation to introduce this model was to provide more attractive jobs to the local workers.

¹¹ If the effects of new work organizations on productivity dependent of information technology, reversely the effects of information technology on productivity depend on changes in work organization, as suggested in Brynjolfsson and Hitt (1998) to resolve Solow's productivity paradox.

centers (Batt, 1999). Companies consider that innovative work team organization would prevent future gains from automation and process standardization.

Overall, work organization and human resources practices inspired by Toyotism have become dominant, if not universal, in the USA and the European by the beginning of this century. This is documented in an overview, in Ichinowski and Shaw (2003), of the literature on the adoption in the USA of these practices: “Surveys of firms indicate that since 1980, U.S. businesses have increasingly abandoned traditional human resource management practices and increasingly replaced them with multiple innovative practices”. Ichinowski and Shaw (2003) also underline that switching from Taylorism to Toyotism seems irreversible.

In Europe, the adoption of "High Performance Work Organizations" by European firms became a key element of the Lisbon Strategy adopted by the European Union (Eurofound report, 2007).

2.4. Recent innovations in the organization of firms

The growing complexity firms' competitive, economic, social, or ecological environment, and the growing requirements they face from consumers, workers, and society in general, leads to new ways of organizing work, beyond Toyotism. Following Masclet and Rebières (2017), we review here three important trends which may drive how firms operate in the future: project-based organizations and firms, corporate social responsibility, and freedom-form firms.

2.4.1. Project-based organizations and firms

Project-based organization is a form of flexible organization that is based on projects, evolving as projects appear or disappear. The salaries of different departments are grouped according to their skills, to work together on a project. Once the project is completed, salaries return to their original department. But cooperation between individuals with different background may be difficult. The success of the project critically depends on the quality of project leader and her ability to manage the team.

Whitley (2006) observes that the emergence of project-based organizations in new industries, as well as in more traditional sectors, has been seen as leading to the flattening of organizational hierarchies, the weakening of corporate boundaries in favor of collaborative networks, and the restructuring of competition between firms within and across sectors. Entire companies become

structured around separate projects in which people with different competencies are brought together to develop innovative products and services within specified time frames, and business functions are embodied in the project. Moreover, project-based firms in which the company as a legal and financial entity becomes project specific, and is often dissolved upon successful completion of project goals, seem to be spreading from the feature film and other entertainment industries to new media, and to highly dynamic and innovative sectors such as computer software development or biotechnology.

2.4.2. Corporate Social Responsibility (CSR)

According to the United Nations¹² Industrial Development Organization (UNIDO), “CSR is a management concept whereby companies integrate social and environmental concerns in their business operations and interactions with their stakeholders. CSR is generally understood as being the way through which a company achieves a balance of economic, environmental, and social imperative [...], while at the same time addressing the expectations of shareholders and stakeholders. [...] Key CSR issues are environmental management, eco-efficiency, responsible sourcing, stakeholder engagement, labor standards and working conditions, employee and community relations, social equity, gender balance, human rights, good governance, and anticorruption measures. A properly implemented CSR concept can bring along a variety of competitive advantages, such as enhanced access to capital and markets, increased sales and profits, operational cost savings, improved productivity and quality, efficient human resource base, improved brand image and reputation, enhanced customer loyalty, better decision making and risk management processes.”

2.4.3. Freedom-form company

The concept of Freedom-form company has been popularized by the book by I. Getz and B.M. Carney in 2009 « Freedom Inc ». Its brief presentation in this paragraph is inspired by Poli (2020). The Freedom-form company concept is focused on the empowerment of people, grounded on values of trust and responsibility, with the project to transform the entire organization, and the objective of reconciling employee well-being and performance. This

¹² It should be noted that the United Nations actively encourage the adoption of CSR commitments by firms. Reversely, firms with a CSR program often use the United Nations Development Program as a reference for their own CSR programs.

transformation may involve the radical elimination of the hierarchical link. Since the publication of Getz and Carney's book, this concept has raised high media interest, highlighting both its promises (motivation, well-being, commitment, creativity, performance) and its potential risks (overcommitment, social control, voluntary servitude, manipulation). It has generated an ecosystem of coaching, professional associations and networks, conferences of liberating leaders. However, academic work aimed at evaluating the effects of the implementation of the concept is still rare.

3. Pros and cons of teamwork in firms

New organizations of firms has led to the generalized of teams in the work place. The introducing of teamwork in the work organization is, as such, a subject of academic interest. This section presents the pros and cons of team work, as assessed by the literature.

3.1. Pros of teamwork

The main advantages of team work, according to the literature, are improved productivity, mutual aid between workers, flexible organization, and improved decision making. The following paragraphs provide supporting evidence for these advantages of team work.

3.1.1. Improved productivity

The first advantage of teamwork is that it improves productivity. For Alchian et Demsetz (1972), productivity gains of teamwork result from the complementarities between team members. According to Osterman (1994), teamwork enhances the productivity of firms by around 30%.

Delarue et al. (2008) carry out a critical survey of the literature examining the links between teamworking and performance.

First, they report on the theoretical arguments developed to explain why teamworking might lead to improved performance. A first theoretical argument is that workers may work harder if team work provides them more discretion, hence more job satisfaction, or if team dynamics

stimulate their motivation to achieve together a common goal¹³. A second argument is that workers may work more efficiently, as self-managed teams can solve production problems at once rather than wait for external interventions, use their shopfloor information to improve the production process, and enjoy using their intellectual capacities. A third theoretical argument is that teamwork is cost effective as it reduces the need for supervisors and middle-managers.

Second Delarue et al. (2008) systematically review the existing empirical studies assessing the impact of teamwork on performances. Regarding operational performances, the authors found 23 empirical studies, of which 18 report positive productivity effects of teamwork, and 5 neutral effects. Regarding financial outcomes, among 13 empirical studies, 10 report positive effects of teamwork, and 3 neutral effects. They also found that among 10 studies reporting on behavioral or attitudinal outcomes of teamwork, 9 found positive results and 1 a neutral result. Delarue et al. (2008) conclude that the existing literature tends to confirm the existence of positive effects of teamwork on firm performance¹⁴.

3.1.2. Mutual aid and skill transfers

A second advantage of teamwork is that it supports mutual aid and skill transfers between workers, as underlined in Ichniowski et Shaw (2003). Indeed, when collective rather than individual performance is rewarded, each worker has a personal interest in contributing to the success of the team by helping team mates. This strongly contrasts with individual performance compensation schemes, where the time spend to help co-workers is lost for individual performance. To measure to which extent workers may receive or give mutual support from their co-workers, Ichniowski et Shaw (2003) define the notion of “connective capital” as a worker’s access to the knowledge and skills of co-workers. They find that switching from traditional work organization to team work massively increases the “connective capital” to which workers have access, and therefore their ability to receive aid and to share skills with co-workers.

Beyond these cognitive aspects, Sonnertag et al. (2022) underline that: “A long research tradition shows that social support is a core resource that protects health and well-being. Job-

¹³ Delarue et al. (2008) also mention the potential downsides of strict enforcement of group norms that may lead to group terror or tyranny with negative ultimate outcomes or reversely of social norms which may restrict effort to a certain maximum, impairing productivity.

¹⁴ In their conclusion, Delarue et al. (2008) warn on the limits of their survey research: despite the inclusion of control measures in models, there are always omitted variables, and quantitative studies never explain all the observed variations. The authors recommend to complement quantitative analysis by detailed case studies shedding light on crucial details of how the implementation of teamwork leads to success.

related social support encompasses instrumental (e.g., help with work tasks) and emotional (e.g., appreciation and warmth) aspects¹⁵.”

3.1.3. Flexible organization

According to Masclet and Rebières (2017), a third advantage of teamwork is to make work organization more flexible. Teamwork makes workers more polyvalent, hence more able to replace absent colleagues. In addition, authority is less centralized in a teamwork organization, which increases the reactivity of the organization and saves time.

Globally, teamwork provides more flexibility to face the hazards of production and the variations of consumers' demand, in order to meet customers' deadlines.

As an illustration of teamwork flexibility, Schippers et al. (2012), analyzing the activity of primary health care teams in the United Kingdom, demonstrate that the reflexivity of a team, its ability to think and amend its own functioning, favors its capacity for innovation when the work demands are high, more so as the quality of physical work environment is poor.

3.1.4. More rational decision making

Charness and Sutter (2012) review the experimental economic literature comparing the quality of decisions made by individuals and those of decisions made by teams. All the studies on the subject leads to the same conclusion: teams make more rational decisions than individuals.

Among the studies reviewed by Charness and Sutter (2012), Kocher and Sutter (2005) find that participants playing in teams eventually beat participants playing alone, although their initial decisions are no better, because teams learn faster and play with more strokes in advance. Kocher et al. (2006) introduce in the same design the possibility for participants to choose between playing alone or playing in teams. 60% of participants choose to play in teams, and again, participants playing in teams eventually beat participants playing alone. Charness and Levin (2005) and Charness, Karni, and Levin (2010), show that teams avoid cognitive biases much better than individuals¹⁶. Cooper and Kagel (2005) find that teams are much more prone than individuals to play strategically. Sheremeta and Zhang (2010) experiment bidding games

¹⁵ Sonnertag et al. (2022) also mention that “negative interpersonal processes occurring within teams can also threaten health and well-being. Such processes include interpersonal conflicts, harassment, incivility, and ostracism.”

¹⁶ Insofar as the internal team decision-making process is not affected by the effects of intimidation, disengagement, conformism, and other cognitive biases specific to teams and described in detail in Stevens and Campion (1994). Such effects are generally excluded by the experimental design of team decision making in the laboratory, but are often present in the field.

and find that individuals players are much more prone to the “winner’s curse” than teams. In coordination games with several equilibria of different efficiency, teams coordinate better than individuals, to choose the most efficient equilibria (Charness et al., 2007; Feri et al., 2010)¹⁷.

Economic experiments have also been used to compare team and individual risk preference in decision making under risk. When decisions require unanimity of team members, teams make less risky and more rationale choices (Rockenbach et al., 2007; Masclet et al., 2009). The mechanism is that within each team, to reach unanimity, risk-loving members accept to align their choices on the choice of risk-adverse members. This mechanism makes teams more risk adverse on average than individuals¹⁸. By contrast, Harrison et al. (2013), show no evidence that subjects reveal different risk attitudes in a social setting, within groups. However, Harrison et al. (2013) also find that subjects in groups are significantly more risk averse when they know the risk preferences of other group members, which makes their conclusions consistent with those of Rockenbach et al. (2007) and Masclet et al. (2009).

3.2. Cons of teamwork

Teamwork also generates disadvantages, notably problems of coordination, risks of adverse selection and incentives for free-riding, detailed in the following paragraphs.

3.2.1. Coordination problem

According to Masclet and Rebières (2017), decision making within teams may be plagued by divergences between team members. Decisions may be delayed and teams may lack reactivity. The problem may be solved by the emergence of a team leader, able to impose decisions after consultation of other team members. The charge of choosing of a team leader receiving delegation of formal authority over other team members, is generally in the hands of a supervisor. Supervisors often choose a team leader who already possess a natural authority, thanks to her skills, her experience, or her charism. The leader may be given the authority to

¹⁷ However, Charness and Sutter (2012) also review studies showing that teams have more difficulty than individuals getting out of the profit maximization trap, when the equilibrium it leads to is inefficient, as in the trust game or the prisoner's dilemma. This trap can only be overcome by trust, and this seems to be more difficult to establish between teams than between individuals (Kugler et al., 2007; Charness et al., 2007; Song, 2008; Bornstein et al., 2004).

¹⁸ Masclet et al. (2009) also analyze the impact of socio-demographic variables on risk preference and find that self-employed workers are less risk-adverse than salaried workers, and that among salaried workers, workers from the private sector are less risk adverse than workers from the public sector.

reward or punish the other members of the team, depending on their behaviors (Drouvelis et al., 2013).

3.2.2. A risk of adverse selection

The endogenous choice of teamwork by workers poses problem of adverse selection. As reminded in the introduction of Cooper et al. (2019), when agents can choose between a team work organization and an individual work organization, the most productive agents should opt for an individual work organization, to take full advantage of their productivity, while less productive agents should opt for a team work organization in the hope of sharing the benefits of the greater productivity of their colleagues. Thus, firms with an individual work organization should attract more productive staff than companies with a team work organization, and therefore should prevail on the market.

Hamilton et al (2003) analyze the effects of the gradual transition from an individual organization to a team organization in a garment factory. The study finds that the most productive employees are the first volunteers to move to a team organization although they lose income, and that the first changes from an individual organization to a team organization lead to a strong increase of average productivity. The authors' interpretation is that the presence and influence of the most productive employees in the first teams explain these initial gains in productivity, and that the most productive employees find in teamwork non-monetary compensations, of status among their colleagues and of variety of activities, which compensate for their loss of income. These results could be interpreted as contradicting the predictions of adverse selection attached to teamwork. But as the article points out, the conditions of this field experiments do not allow the choice of teamwork by employees to be considered as endogenous, the firm having decided to eventually impose teamwork to all the staff.

Cooper et al (2019) study in a real effort experiment, the choice of working alone or in pairs, of workers with heterogeneous performances. Different treatments vary the mode of remuneration, individual or shared, and the possibility of communicating and teaching within pairs. The results show that the most able workers are ready to work in pairs when the salary remains individual, or when they can teach the less able, with the perspective of sharing the benefits of the progress that their teaching will have enabled the less able to make. The data indicate that it is this perspective of future benefits that explains the choice to work in pairs of

the most able workers¹⁹. These results show that teamwork can have adverse selection effects if specific provisions preserving the interests of the most able are not taken.

3.2.3. The risk of free riding

Free riding may occur whenever the collective action of more than one agent produces a unique outcome, the benefit of which is shared between the agents. In such a case, each agent has incentives not to contribute: (a) her contribution would not make a difference, (b) as she expects others not to contribute, she has no reason to contribute herself, (c) if she can benefit from the outcome produced by others, why should she incur the cost of contributing?

In its “Free rider problem” entry, the Stanford Encyclopedia of Philosophy (2020), reminds that the philosopher David Hume did grasp the generality of the problem clearly when he wrote:

“Two neighbours may agree to drain a meadow, which they possess in common; because ‘tis easy for them to know each other’s mind; and each must perceive, that the immediate consequence of his failing in his part, is, the abandoning the whole project. But ‘tis very difficult, and indeed impossible, that a thousand persons shou’d agree in any such action; it being difficult for them to concert so complicated a design, and still more difficult for them to execute it; while each seeks a pretext to free himself of the trouble and expence, and wou’d lay the whole burden on others. (Hume [1739–40] 1978, bk. 3, part 2, sect. 8, p. 538).”

The free rider problem is at the heart of the Mancur Olson’s highly influential book “Logic of Collective Action” (Olson, 1965), the central themes of which concern the question of how the size of a group affects its ability to provide itself with a public good, with applications to public economy and political science.

The free rider problem also affects personnel economics and concerns the incentives of team members to contribute optimally to collective production. When the workforce is organized in teams, the production of each team is a unique good that is valued globally (Holmstrom, 1982; Kandel and Lazear, 1992). The individual contribution of team members to this production is not observable from the outside, without incurring significant observation costs. As a result, the compensation derived from the production of the team is assumed to be distributed equally among its members, regardless of their individual contribution.

¹⁹ The article also shows that the possibility given to the more able to teach to the less able has the consequence of improving the performance of the more able, who teach, and not of the less able, who receive the teaching.

According to economic theory, these characteristics prevent team members from optimally contributing to team production. Under standard neoclassical assumptions, each team member chooses a level of effort such that the derivative of her individual compensation, which equals the derivative of the team compensation divided by the number of team members, equals the derivative of her individual cost to effort, whereas the optimum would correspond to equality between the derivative of team compensation and the derivative of the individual cost to effort. The individual choices of effort will therefore be different from the optimal choices, and under classical assumptions (convex effort cost function), the chosen effort will be lower than the optimal effort. In other words, classical economic theory concludes that teamwork leads to suboptimal levels of effort (Holmstrom, 1982; Kandel and Lazear, 1992). Kandel and Lazear (1992) translate this reasoning into the following model:

“Suppose that output from a group of identical workers is some function of each worker’s effort, e_i , given by $f(e)$, where e is an N -dimensional vector of workers’ effort levels and N is the number of workers. [...] Define a partnership as a work situation in which each worker’s compensation is determined as $f(e)/N$. [...] It is painful to put forth effort, and the pain that a worker feel is given by $C(e_i)$, where $C' > 0$ and $C'' > 0$. [...] The worker wants to maximize

$$\max_{e_i} \frac{f(e)}{N} - C(e_i) \quad (1)$$

with first-order conditions

$$\frac{f'_i(e)}{N} - C'(e_i) = 0. \quad (2)$$

Efficiency requires that total surplus be maximized or that

$$\max_{e_1, e_2, \dots, e_N} f(e) - \sum_{i=1}^N C(e_i) \quad (3)$$

with first order conditions

$$f'_i(e) - C'(e_i) = 0 \quad \forall i. \quad (4)$$

Since $C'' > 0$, e^* , defined as the solution to (1.4), exceeds e' , defined as the solution to (2) for $N > 1$. The chosen level of effort in a partnership falls short of the efficient level.”

This theoretical prediction is experimentally confirmed in Nalbantian and Schotter (1997) through a team effort game with revenue sharing: in the absence of specific incentive mechanism, the observed effort is decreasing over time and tends towards an inefficient Nash

equilibrium. This is also a very robust result from the public goods games experimental literature, starting from Fehr and Gächter (2000) and systematically confirmed ever since by hundreds of public good game experiments. Public goods game can be interpreted as modeling the trade-off that team members make between their contribution to the team and their private interests²⁰. The synthesis by Thöni and Volk (2018) of the many publications on the subject shows that this conclusion can be interpreted, in behavioral economics, as resulting from the majority weight in the population of "conditional cooperators", opting for a contribution slightly lower than the average of that of their teammates.

However, the incentive for individuals to provide a suboptimal contribution to teamwork depends on the collective production function. The economic analysis assumes that the collective production depends on the sum of the efforts of the team members, but other functions can be envisaged. Hirshleifer (1983) considers the polar alternatives of a collective production equal to the minimum or to the maximum of individual contributions, and proves that the problem of suboptimal individual contributions is attenuated in the first case and exacerbated in the second.

Similarly, theoretical analysis shows that when games are infinitely repeated, efficient solutions become Nash equilibria (Radner, 1986; Arya 1997).

The fourth part of this chapter, and the rest of this thesis, focus on the economic analysis of mechanisms aimed at addressing the free-riding problem in teamwork.

4. Addressing the free riding problem in teamwork

This section summarizes the literature on incentive mechanism operating at team level, centralized mechanisms, decentralized mechanisms, and mechanisms based on the role of a team leader. This literature is part of the more general economic analysis of the effect of compensation schemes on workers' behaviors.²¹

²⁰ Public goods game experiments are discussed in more detail in the next section of this chapter.

²¹ The study of compensation mechanisms that induce members or parts of an organization to act in the interest of the organization has long been the subject of theoretical work (Groves, 1973). Prendergast (1999) provides a comprehensive review of economic literature on compensation methods and incentive mechanisms in firms. Empirical literature confirms that incentives matter, and that there are strong responses of output to the use of pay-for-performance contracts. But contracts are incomplete and cannot specify all aspects of work behavior. This may lead workers to emphasize only the aspects of performances which are rewarded at the expense of other dimensions of work behavior. Following Holmstrom and Milgrom (1991), this incentive is known as multi-tasking and it may lead firms to prefer fixed wages to performance dependent wages. Alternatively, firms may use subjective rather

4.1. Centralized mechanisms at team level

Addressing the free-riding problem at team level, in the context of a team work organization, we consider as a first family of solutions, suggested by Holmstrom (1982) and Nalbantian and Schotter (1997), centralized mechanisms based on team targets or on collective tournaments.

In team target mechanisms, the firm sets a performance objective for the team. If the objective is achieved, the workers share the compensation generated by team production. Otherwise, when the objective is not achieved by the team, each team member receives a fixed and low remuneration. Theoretical analysis shows that it is possible to set the team target and the low fixed compensation so that the socially optimal level of effort is a Nash equilibrium.

This mechanism, proposed by Holmstrom (1982), can be formally described using the notations of Kandel and Lazear model presented above in §3.4. Holmstrom adds the condition that the output function $f(e)$ should be strictly increasing, concave and differentiable with $f(0) = 0$. First, Holmstrom considers a general budget-balancing sharing rule, in which the compensation of each worker i equals $s_i(f(e))$ ²² such that:

$$\sum_{i=1}^N s_i(f(e)) = f(e) \quad (5)$$

Considering the cost of effort $C(e_i)$, the pay-off of worker i equals:

$$s_i(f(e)) - C(e_i) \quad (6)$$

Holmstrom demonstrates that the condition for Pareto optimality e^* of a Nash equilibrium, conflicts with its first order conditions, where the derivative of equation (6) equals zero, when

than objective measure of performances, to take a more holistic view of workers performances. But subjective assessment give raise to bias and workers are likely to waste time and resources to be well seen by their bosses. Bosses are subject to leniency or centrality bias. White-collar workers are mainly rewarded by promotions. Economic analysis models promotions as tournaments among agents competing for a prize. Tournament theory predicts that larger prizes result in more effort and that more competitors for a single prize imply a larger prize. Empirical research supports these predictions. Competition for promotion can generate dysfunctional behaviors which explains why firms often prefer to base promotions on bureaucratic criteria, such as seniority. Prendergast (1999) also underlines that workers remain in the labor market for a long time and have careers rather than jobs. This fact explains the deferred compensation effect, where firms systematically overpay older workers and underpay their younger counterparts. The return of effort for younger workers is not just in the contemporaneous return, but the perspective of receiving the return of older workers in the future. This effect is confirmed by empirical analysis. Long term career concerns and contract renegotiation perspectives also support honest behaviors in the firm-worker relationship, even though cheating would be rational in the context of a one-shot contract.

²² In Kandel and Lazear (1992) model, $s_i(f(e)) = 1/N$

the budget balancing equation (5) is satisfied. Hence, a Pareto optimal Nash equilibrium requires a budget-breaking sharing rule. Holmstrom suggest the following sharing rule:

$$s_i(f(e)) = \begin{cases} b_i & \text{if } f(e) \geq f(e^*) \\ 0 & \text{if } f(e) < f(e^*) \end{cases} \quad (7)$$

If the values of b_i satisfy $\sum_{i=1}^N b_i = f(e^*)$ and $b_i > C(e_i^*) > 0$, then e_i^* is a Pareto optimal Nash equilibrium.

Firms can also set up systems where the objective is made endogenous by using collective tournaments, i.e., tournaments between teams as suggested in Nalbantian and Schotter (1997). In collective tournaments, one team plays against another and the winning team receives a transfer of remuneration from the losing team. With an appropriate value for the transfer of remuneration, the socially optimal level of effort becomes a Nash equilibrium.

This mechanism, proposed by Nalbantian and Schotter (1997), is formally presented here²³ using again the notations of Kandel and Lazear model presented above in §3.2.3. Nalbantian and Schotter (1997) add to Kandel and Lazear output function $f(e)$, determined by efforts e_i of team members, a uniformly distributed random variable ε . Therefore, the team output is the random variable $y(e) = f(e) + \varepsilon$. In addition, Nalbantian and Schotter (1997) compares the outputs of two competing teams 1 and 2, hence teams' outputs $y_j(e)$ are indexed by $j \in \{1; 2\}$. The team with the highest output wins the tournament and receives from its competitor a transfer TR . The outputs of each team, account taken of the transfer TR , are then equally shared between each team member. Also considering the cost of effort $C(e_i)$, the pay-off of worker i , member of team 1, is given by:

$$= \begin{cases} \frac{y_1+TR}{N} - C(e_i) & \text{if } y_1 > y_2 \\ \frac{y_1-TR}{N} - C(e_i) & \text{if } y_1 < y_2 \end{cases} \quad (8)$$

Nalbantian and Schotter prove that with an appropriate value of transfer TR , the Nash equilibrium of the game is Pareto optimal²⁴.

Nalbantian and Schotter (1997) use a laboratory experiment to test these theoretical predictions and compare the respective efficiencies of target and tournament mechanisms. They observe the inefficiency of the mechanism based on a team target, despite an objective chosen in such a

²³ In the next chapters of this thesis, Nalbantian and Schotter's notations will be used, but in this chapter, notations are inspired by Kandel and Lazear model for sake of homogeneity between the different paragraphs of the chapter.

²⁴ This point will be further developed in Chapter 2 of this thesis.

way as to encourage optimal efforts. Indeed, the teams rarely achieve the objective, which discourages their members and leads to very low final levels of effort, lower than in the absence of any incentive mechanism²⁵. In contrast, the collective tournament mechanism, when the transfer of remuneration from the losing team to the winning team is chosen appropriately, leads to a maximum level of effort.

Tournaments between individuals have been present for a long time in the economic literature of human resources. For instance, Lazear and Shaw (1997) indicate that pay jumps between hierarchical levels in firms are rationalized by tournament mechanisms. The efforts made by candidates of a hierarchical level N-1 to be moved to level N and benefit from the associated salary jump, are all the higher as this pay jump is important. Therefore, the firm benefits from it since all the candidates hoping for a promotion provide efforts up to this pay jump, which only the promoted candidate will obtain. Charness et al. (2014) show, in a fixed-remuneration real-effort experiment where individual performance has no monetary consequence, that informing participants of their ranking increases effort but also promotes unethical behavior, where participants pay to artificially improve their ranking or to sabotage the performance of other participants. Sheremeta (2016) observes that individual tournaments have a strong positive impact on effort, often beyond rational levels, but lead to highly unequal payoffs and promote unethical and socially counterproductive behaviors.

Collective tournaments between teams are used to provide incentives in various organizations, notably in the workplace (Merchant and Van der Stede, 2007). The theoretical literature on collective tournaments between teams indicates that they promote internal cooperation and mitigate free riding behavior (Dragon et al. 1996), but can lead to costly conflicts between teams requiring dispute resolution mechanisms (Sheremeta, 2018). In a real effort experiment, collective tournaments have been shown to promote higher than optimum worker effort (Van Dijk et al., 2001). The experimental literature also shows that collective tournaments can generate very high costs of conflicts between teams, beyond rationality, and the possibilities of sanction between team mates make things worse (Abbink et al. 2010)²⁶.

Bandiera et al (2013) present a field experience in a fruit production firm in the United Kingdom. Seasonal workers who harvest the fruits work in teams of five and are paid based on

²⁵ A team-target mechanism admits a high Nash equilibrium, which can be Pareto with an appropriate choice of parameters, but also admits a low Nash equilibrium with zero effort, lower than in the absence of incentive.

²⁶ This is related to the rent-seeking literature, where teams compete for exogenous rent (Nitzan, 1991; Davis and Reilly, 1999).

the performance of the team to which they belong²⁷. The firm has set up a mechanism allowing employees to choose the composition of the work teams themselves each week. The experiment compares three treatments: the baseline treatment, a treatment where teams are ranked each week according to their performance, and finally a treatment where a monetary prize is added for the best team of the week. In the baseline treatment, the composition of the teams is influenced by the personal ties between employees, which reinforces peer pressure and limits, for the benefit of productivity, free-rider behavior. When teams are ranked by performance, employees organize themselves into consistent productivity levels rather than personal ties, which reduces peer pressure. This harms the productivity of the least productive, without increasing the productivity of the most productive: the balance is negative. Adding a monetary prize for the best team of the week greatly increases the productivity of the most productive without reducing the productivity of the least productive: the balance is positive, including compared to the baseline treatment.

The experiment presented in Bandiera et al. (2012) mobilizes both centralized mechanisms of collective tournaments and decentralized mechanisms of peer pressure, the second family of mechanisms aimed at solving free rider problems and which is discussed in the next paragraph.

4.2. Decentralized peer pressure mechanisms

Still addressing the free-riding problem at team level, in the context of a team work organization, we consider as a second family of solutions, which consists of decentralized peer pressure mechanisms.

Peer pressure can be exerted by the simple mutual observation of behavior within a work team. Falk and Ichino (2006) study a real effort game and compare a “single” treatment, where the subjects work alone, with a “pair” treatment, where two subjects work at the same time in the same room. They observe a significantly higher production when two subjects work at the same time in the same room. Mas and Moretti (2009) analyze the case of supermarket cashiers and find that the effort of a given cashier is positively correlated with the presence and productivity of other cashiers who can observe her activity.

Beyond the positive effects of mutual observation between team mates, an approach that can be implemented to solve the free rider problem consists for the principal in setting up

²⁷ The organization by team of five reduces the administrative and management costs of the firm.

decentralized mechanisms based on peer pressure between team mates (Coleman, 1990; Varian 1990; Kandel and Lazear 1992; Itoh 1993; Barron and Gjerde 1997; Carpenter et al., 2009).

Indeed, even if the principal cannot herself observe the effort of the agents working as a team, the agents can observe and sanction each other. The principal can create an incentive system that encourages workers to agree on the actions desired by the principal and to enforce those agreements using informal sanctions. Such decentralized peer pressure mechanisms correspond to practices observed in the real world. For instance, the role of peer pressure and social norms appears in the literature as essential to the success of Japanese companies: Nahavandi and Aranda (1994) emphasize the importance of Japanese social norms in the success of teamwork in Japan. Peer pressure within teams is part of the Japanese management rules imported by Toyota into its European production sites (Winfield, 1994). The success of lean management (Shah and Ward, 2003) in North American and European firms is based, among other things, on the introduction of mutual control between employees within work teams (Delbridge et al., 1992). This mechanism is not reserved for industrial establishments: Lazega (2000) studies an effective system of peer pressure in a Dutch law firm.

Economic analysis has modeled peer pressure effects in general and varied contexts. Coleman (1990) shows that when a community is structured, individuals have an interest in adopting the social norm of contributing to the public good, so that the satisfaction of being approved by their peers for conforming to the norm encourages everyone to contribute to the public good. Varian (1990) analyzes a mechanism of mutual control between agents inspired by micro-credit techniques popularized by M. Yunus, which earned him the 2006 Nobel Peace Prize. Itoh (1993) demonstrates that in a general multi-agent principal framework, the principal can effectively use collective contracts if the agents control each other.

In the specific case of teamwork in firms, the reference theoretical economic models of decentralized peer pressure mechanisms are those of Kandel and Lazear (1992) and Barron and Gjerde (1997). Kandel and Lazear (1992) provide a theoretical framework for modeling how peer pressure can effectively deter free rider behavior. Kandel and Lazear elaborate on their model of free-riding presented above in §3.2.3. They introduce a “peer pressure” function:

$$\text{peer pressure} = P(e_i; e_i; e_j, \dots, e_N, a_i, a_j, \dots, a_N). \quad (9)$$

Worker i feels a pressure depending on her own effort, e_i , on the efforts of her peers, e_j, \dots, e_N ; and on other actions a_i, a_j, \dots, a_N that she or her peers may take, which have no direct effects

on the output of the firm. These actions may require effort, hence the cost for worker i is redefined as $C(e_i, a_i)$ and the pay-off that she is maximizing is reformulated as:

$$\max_{e_i, a_i} \frac{f(e)}{N} - C(e_i) - P(e_i; e_i; e_j, \dots, e_N, a_i, a_j, \dots, a_N) \quad (10)$$

Using equation (10) the first order condition becomes:

$$\frac{\partial f / \partial e_i}{N} - C_1 - \frac{\partial P}{\partial e_i} = 0 \quad (11)$$

If peer pressure on worker i decreases when her effort e_i increases, then $\frac{\partial P}{\partial e_i} < 0$, then the level of effort that satisfies equation (11), with peer pressure, exceeds the level of effort that satisfies equation (4), absent peer pressure.

Barron and Gjerde (1997) extend the model of Kandell and Lazear to a principal-agent model, but also question the possibility for a principal to set an optimal compensation system when agents incur costs induced by peer pressure.

Because it is difficult to measure the effectiveness of peer pressure from conventional data, empirical studies have mobilized data from laboratory experiments, mainly using public good games. The public good experiment is an elegant construction that permits straightforward measurement of the extent of self-versus group-interested behavior. In a public good experiment, each member of a group of individuals receives an endowment, from which she may contribute any amount to a public good that returns a payoff to everyone. The level of this payoff ensures that at the social optimum, everyone contributes her entire endowment while, in contrast, everyone has a dominant strategy to contribute zero. The contribution to the public good can be interpreted as a measure of cooperative behavior. The main overall pattern observed in public good experiments, without peer pressure, is that initial contributions are substantial, but decline with repetition and cooperation converges to the Nash Equilibrium in the long run (Fehr et Gächter, 2000; Thöni et Volk, 2018).

In public goods game experiments, allowing team members to punish the less cooperative individuals in the team is highly effective in raising contribution levels. Individuals do not hesitate to pay from their own earnings to reduce the earnings of free-riders: see for instance, Fehr and Gächter (2000), Masclet et al. (2003), Carpenter et al. (2004), Noussair and Tucker (2005), Bochet et al (2006), Denant-Boemont et al (2007), Sefton et al (2007), Carpenter et al (2009), Grosse et al. (2011). It is thus clear that, at least under some circumstances, peer

pressure mechanisms can represent an effective means of increasing cooperation within teams and thus alleviate the free-rider problem.

However, while the ability to punish improves cooperation, punishing is costly for both the punisher and the punished. In the short term, the net effect of punishment is to reduce welfare, although it has been found that punishment can increase welfare if the horizon is long enough. The social cost of punishments tends to decrease over time, because actual punishments in the early periods of the game make the threat of punishment credible and the punishment less necessary, as observed by Gächter et al. (2008). The social costs of punishment can also be reduced by non-monetary sanctions instead of monetary sanctions, with however reduced effectiveness in increasing cooperation (Mascllet et al. 2003).

In practice, attempting to put pressure on other workers can be costly in relational terms as punished co-workers may accumulate resentment, the punisher may be blamed especially if she has personal ties with the free rider. This raises the issue of the second order free rider problem, i.e., the problem of who will bear the cost of monitoring and punishment among the team members (Yamagishi, 1986). There may exist retaliation against punishers and even blind retaliation (Nikiforakis, 2004; Denant-Boemont et al., 2007)²⁸, antisocial punishment of contributors (Cinyabuguma et al., 2004, 2005) or over-punishment due to the negative emotions generated by free riders, which may be detrimental to social welfare, at least in the short run (Dickinson and Mascllet, 2015).

Thus, peer pressure, as modeled in public goods game experiments, generates complex and ambiguous effects, if we consider its possible ultimate consequences.

In addition to peer pressure, research on public good games has also experimented the endogenous choice by participants of incentives mechanisms: endogenous choice of superimposition of centralized and decentralized mechanisms (Hilbe et al., 2014 ; Markussen et al., 2014 ; Kamei et al. 2015 ; Rockenbach and Wolff, 2016), endogenous choice of formal or centralized sanctions (Putterman et al., 2010) and endogenous choice between informal and formal sanctions, with or without upfront cost (Kamei et al., 2015). Literature has also analyzed the effects of uncertainties, errors, threats, inequality, or communications between team mates on cooperation and efficiency (Mascllet et al, 2013; Markussen et al, 2016; Nicklisch et al, 2016).

²⁸ If reprisals (even if blind) are possible, it might deter sanctioning, and thus dilute the effectiveness of the system in increasing contribution levels. Nikiforakis (2004) reports an experiment focused on this issue.

4.3. The role of a leader

Between centralized incentive mechanisms set by a principal, and decentralized mechanisms of peer pressure, the problem of free-riding in teamwork may also be addressed by a team leader chosen among the team members. A team leader may be given the authority to reward or punish the other members of the team, depending on their behaviors (Drouvelis et al., 2013). A leader differs from a principal because, as a member of the team, she participates in the team production. As such, and contrary to an external principal, she has access to internal information on the individual contributions of team members. A team leader therefore holds more precise information on whose team members deserves reward or punishment. In addition, when the possibility to punish is centralized in the hands of a team leader rather than decentralized among all team members, risks of second-order free-riding and of retaliation should be limited. A team leader should neither expect someone else to punish in her place, nor fear retaliation from other team members, because she holds the monopoly of punishment within the team.

To the best of our knowledge, the economic literature had not yet specifically studied the case of peer pressure centralized in the hands of a team leader chosen among team members. However, this literature has studied how the example of a leader can influence her team mates in sequential public good games, where the leader chooses her contribution before the other members of the team.

Varian (1994), theoretically analyzing a sequential public good game, shows that under symmetric information, leading by example results in lower levels of cooperation than in the absence of a leader. However, if the other members of the team think that the leader has private information, Hermalin (1998) proves that in theory, leading by example promotes cooperation, when the leader induces beliefs in her team-mates, that encourage them to cooperate for her benefit.

The experimental literature on sequential public good games shows that leading by example favors cooperation only if complementary conditions are met. According to this literature, the example given by a leader can reinforce cooperation, conditional on the existence of a group identity (Drouvelis and Nosenzo 2013), on the leader's power to exclude free-riders (Haigner and Wakolbinger 2010), or on the observation of the history of each participant's behavior during past periods of the game (Figueres et al. 2012). But leading by example may also have

no effect in the absence of the above conditions, or even have a negative influence on cooperation (Gächter et al. 2010).

5. Conclusion

The evolution of work organization from Taylorism towards innovative work and human resources practices has led to the massive diffusion of team work, which has become a dominant mode of organization in firms since the end of the twentieth century.

However, when work is organized in teams, individual contributions of workers cannot be observed from outside the team, which generates a high risk of free-riding.

Economic analysis and in particular experimental economics have analyzed several mechanisms designed to prevent free riding in firms, such as centralized mechanisms based on a team target or collective tournaments, decentralized mechanisms exploiting peer pressure, or mechanisms based on the action of a team leader.

However, the efficiency of those mechanisms has not yet been directly compared in a consistent experimental design. The main contribution of this thesis is to use a unique experimental design, an effort game inspired by Nalbantian and Schotter (1997) relevant for modelling teamwork in firms, to compare the main incentive mechanisms proposed by the literature, or observable in the field, to prevent free riding.

In the remaining chapters of this thesis, we investigate the relative effectiveness and efficiency of those different forms of centralized and decentralized mechanisms meant to deter free riding.

Chapter 2 compares the baseline treatment of revenue sharing, the decentralized mechanism of peer pressure, and centralized mechanisms based on a team target or on collective tournaments. The effects of treatments on workers' efforts and payoffs, on firms' profits, and on social welfare are analyzed. Our results confirm the existence of free-riding in the baseline treatment, although not as severely as theoretically-predicted. Decentralized peer-pressure weakly increases effort but does not improve workers' payoffs because of the cost of punishments. Centralized mechanisms are more effective than a peer pressure scheme to enhance effort and social welfare, but at the price of very low or very unequal payoffs for workers.

Chapter 3 focuses on centralized mechanisms. Its objectives are twofold. First, chapter 3 investigates if with symbolic instead of monetary incentives, centralized mechanisms still

effectively prevent free-riding, without the negative effects of monetary incentives on the payoffs of workers. In this respect, we find that centralized mechanisms with symbolic incentives increase workers' efforts and social welfare, but less than monetary incentives. Second, chapter 3 identifies the specific effects of observation of individual efforts distribution, which is included in all treatments with incentives, but not in the baseline revenue sharing treatment. In this respect, we find that, within teams, observation of the distribution of individual efforts instead of average efforts, significantly increases effort. However, switching from observation of the distribution of efforts, to observation of average efforts does not significantly impact the results of centralized mechanisms with monetary incentives.

Finally, in chapter 4, we investigate whether team leaders are effective in preventing free riding and improving team work efficiency. We focus on leaders chosen among team members, contributing to its production and, as such, benefiting of insiders' information on individual behaviors. Two specific roles of a leader are successively considered: coordinating punishments within the team, and leading by example. In a first stage, we compare the effects of decentralized peer pressure to those of pressure delegated to a team leader, either randomly selected or elected. When pressure is delegated to a randomly selected leader, effort is lower than under peer pressure and not significantly different than in the baseline treatment. When peer pressure is delegated to an elected leader, effort is higher than when the leader is chosen at random, and does not significantly differ from effort under peer pressure. Hence, centralizing peer pressure in the hands of a team leader does not improve the efficiency of team work. However, leaders are not only expected to punish, but also to lead by example. That is why in a second stage, we compare treatments where the role of randomly chosen leaders is to lead by example, to punish, or to do both. Our results indicate that when a randomly chosen leader has a unique function, either leading by example or punishing peers, effort is equivalent than in the baseline treatment. But, when the randomly chosen leader can both lead by example and punish peers, teamwork becomes more effective than in the baseline treatment, and its effectiveness increases overtime.

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Chapter 2

Centralized vs. Decentralized Incentives in Teams:

Experimental Evidence²⁹

²⁹ The study described in this chapter has been published in an article co-written with David Masclet, forthcoming in the “Revue Economique”.

1. Introduction

The use of teams in the workplace has increased dramatically over the last decades (Owan, 2014; Lazear and Shaw, 2007). For instance, according to the European Company Survey 2019, which maps and quantifies information on company practices across Europe collected from human resources managers and employee representatives, about 70% of establishments in the EU27 use teamwork. Firms report several benefits of teams, including higher productivity, greater employee participation, involvement and improved worker satisfaction (e.g., see for instance Guzzo and Dickson 1996; Cohen and Bailey 1997, Merchant and Van der Stede, 2007; Delarue 2008; Owan, 2014). Furthermore, experimental evidence has shown that teams make on average better decisions than isolated workers (e.g. Charness and Sutter, 2012; Kocher et al. 2006; Kocher and Sutter, 2005; Cooper and Kagel, 2005).

However, team work may suffer from important weaknesses including the difficulty of measuring individual contributions to the total output, which can result in free riding that may plague team production (Holmstrom, 1982). Several studies have attempted to design incentive systems to solve this issue. One way to solve free-riding issue is to design centralized mechanisms such as target-based schemes or collective tournaments (Holmstrom, 1982). In target-based schemes, the firm sets a target of team performance. If the target is reached, the workers share all of the revenue generated. If the team fails to reach the target, each team member receives a relatively lower revenue. In collective tournament, the target is endogenized such that one team competes against another. Tournaments are widely used to provide incentives in the workplace (Merchant and Van der Stede, 2007; Sheremeta,2016). Competition between teams is said to foster within-team cooperation, and hence to mitigate free-riding (Drago et al.,1996; Van Dijk et al.,2001; Abbink et al.,2010; Sheremeta,2018).

Another solution to the free riding issue consists in implementing decentralized mechanisms based on peer pressure (e.g. Radner 1986; Coleman, 1990; Varian 1990; Kandel and Lazear 1992; Itoh 1993; Villadsen 1995; Arya et al. 1997; Barron and Gjerde 1997; Prendergast 1999; Towry, 2003; Carpenter et al., 2009). In their model, Kandel and Lazear, (1992) stress the effectiveness of peer pressure to deter free-riding. They show that under certain conditions, team members may have incentives to punish those who deviate from the norm of effort established within the team. Barron and Gjerde, (1997) extend Kandel and Lazear's model to a principal-multi-agent relationship. Indeed, while the principal cannot observe the agents' effort, the agents themselves may be in a better position to observe and sanction each other. Unlike the centralized mechanisms, in the decentralized mechanisms of peer pressure, the principal creates

the conditions that incites workers to agree among themselves to the actions desired by the principal and to enforce these implicit agreements through informal sanctions. Thus, the principal takes advantage of the opportunity for mutual monitoring, through the use of a horizontal incentive system, relying on team self-management and peer monitoring (Towry, 2003). Such practices are commonly observed in the real world. For instance, peer pressure and social norms are often evoked as important factors helping Japanese companies achieve success (Nahavandi and Aranda 1994) and explaining the achievements of lean management in North American and European firms (e.g. Delbridge et al., 1992; Winfield, 1994; Lazega 2000; Shah and Ward, 2003). Lean manufacturing combines techniques such as total quality management (TQM), just-in-time (JIT), employee empowerment and peer pressure (e.g. Shah and Ward, 2003). Such organizations provide employees with information that enables them to participate in decision-making, encourage workers to troubleshoot problems and make quality decisions (Bowen and Lawler, 2006; Patterson et al., 2004). According to Delbridge et al. (1992), “the success of the JIT/TQM manufacturing system is “a result of increased surveillance and monitoring of workers activities, heightened accountability, the harnessing of peer pressure within teams””.

Because it is difficult to measure the effectiveness of peer pressure from conventional data, empirical studies have mobilized laboratory experiments using public good games where the dominant strategy is free riding in absence of peer punishment (e.g., Yamagishi, 1986; Fehr and Gaechter, 2000; Masclet et al., 2003; Carpenter, 2004; Bochet et al., 2006; Noussair and Tucker, 2005; Sefton et al., 2007; Carpenter et al., 2009; Grosse et al., 2011)³⁰. These studies have shown that allowing group members to punish the least cooperative individuals in the group is highly effective in raising contribution levels and that individuals do not hesitate to pay from their own earnings to reduce the earnings of free riders. It is thus clear that, at least under some circumstances, peer pressure mechanisms can represent an effective means of increasing cooperation within teams and thus alleviate the free-rider problem.³¹

³⁰ The public good experiment is an elegant construction that permits straightforward measurement of the extent of self-versus group-interested behavior. Precisely in a public good experiment, each member of a group of individuals receives an endowment, from which she may contribute any amount to a public good that returns a payoff to each individual. The level of this payoff ensures that at the social optimum, each individual contributes his entire endowment while, in contrast, each individual has a dominant strategy to contribute zero. The contribution to the public good can be interpreted as a measure of cooperative behavior. The main overall pattern observed in public good experiments (without peer pressure) is that initial contributions are substantial, but decline with repetition and cooperation converges to the Nash Equilibrium in the long run (e.g. Ledyard, 1995 for a survey).

³¹ Peer effects have also been observed in other contexts such as among college roommates (Sacerdote (2001)), supermarket cashiers (Mas and Moretti (2009)). Falk and Ichino (2006) consider real-effort choices and compare a

However, peer punishment also suffers from limitations. First, peer pressure is socially costly both for the target and for the punisher. Second there may also exist retaliation and even blind retaliation (Nikiforakis, 2004; Denant-Boemont et al., 2007)³², antisocial punishment of contributors (Cinyabuguma et al., 2004, 2005) or over-punishment due to the negative emotions generated by free riders, which may be detrimental to social welfare, at least in the short run (Gächter et al., 2008, Dickinson and Masclet, 2015). Finally, some studies have shown that punishment may also suffer from free riding (called second order free rider problem) since punishment may benefit to the entire group by improving cooperation but at the same time it is costly for the punisher, in particular if she expects retaliation (Nikiforakis, 2004; Denant-Boemont et al., 2007).

While the literature has investigated centralized or decentralized mechanisms separately, this current study attempts to compare their respective effectiveness and efficiency, which, to the best of our knowledge, has not been yet done. Precisely, in this chapter, we aim at contributing to the literature by presenting evidence from a laboratory experiment designed to compare the effectiveness and efficiency of centralized or decentralized schemes on firm performance when the workforce is organized in teams. Are decentralized mechanisms more or less effective and efficient than centralized systems?

Our experiment consists of four treatments. Our Baseline treatment is based on a repeated revenue sharing game inspired by Nalbantian and Schotter (1997). In this game at each period, workers, within a team, simultaneously choose their effort level to produce an output that is shared among the team members such that free-riding is a dominant strategy. The second treatment (“Peer pressure” treatment) is similar to the Baseline, except that a second stage is added where each team member can assign costly punishment points to the other team members. The third treatment (“Group Target” treatment) is also similar to the Baseline except that teams’ total output is compared to an exogeneous target such that workers are rewarded if total output reaches the target. Finally in the fourth treatment (“Group-Competition” treatment),

“single” treatment, where subjects worked alone, with “pair” treatments where two subjects worked at the same time in the same room. They uncover evidence of peer effects in the pair treatment, in which average output is higher. Combining experimental evidence from a gift-exchange game with multi-country ISSP survey data, Clark et al. (2010) analyze how relative income affects an individual's effort. The authors find that an individual's rank in the income distribution among a group of peers more strongly determines effort than does others' average income, which suggests that peer comparisons are more ordinal than cardinal. Charness et al. (2014) show how peer comparisons may incite workers to outperform but also induce unethical activities of sabotage or doping one's own performance within organizations.

³² If reprisals (even if blind) are possible, it might deter sanctioning, and thus dilute the effectiveness of the system in increasing contribution levels. Nikiforakis (2008) reports an experiment focused on this issue.

each team competes with another team and the team with the highest output receives a transfer from the other team.

To anticipate our results, our data confirm the existence of free-riding in the Baseline treatment, although not as severe as theoretically-predicted. We find that peer pressure enhances average effort. However, the effect is weak and there still remains substantial free-riding. We also highlight the fact that peer pressure mechanism is socially costly for workers as it induces costs both for the target and the punisher. Target-based schemes lead to near-Pareto levels of effort, which translates in higher profits for firms but relatively low workers' payoffs due to the fact that many teams fail to reach the target. Team tournaments are second-best in terms of effort, induce relatively high workers' payoffs, but at the price of high payoff inequality among workers.

The remainder of the chapter is organized as follows. Section 2 presents the theoretical model and describes the experimental design. Section 3 presents the experimental procedures. Then Section 4 provides the empirical results. Finally, Section 5 concludes and discusses the implications of our findings.

2. Experimental design

Our experimental design is inspired by Nalbantian and Schotter (1997). The experimental design consists of four treatments that vary in the introduction of an incentive scheme and whether it is decentralized or centralized. Each treatment consists of 10 identical periods, using a "Between" treatment design, one treatment per participant, and under a "Partner" matching, such that the composition of teams remains unchanged overtime. However, to prevent the possibility of individual reputation formation across periods, participants identifiers are randomly changed at each period. Thus, a participant i could not construct a link between individual effort of each subject j across periods. This design feature also rules out that i punishes j in period t for effort decisions taken in previous periods $t' < t$. This design scheme is inspired from Fehr and Gaechter (2000).

Let's consider a principal multi-agents' relationship with a firm composed of a principal and eight agents involved in two teams of four workers each.

In this section, we describe the four treatments, provide the corresponding theoretical predictions under standard assumptions, and propose behavioral hypotheses.

2.1. Baseline treatment: revenue sharing

Our baseline treatment consists of a revenue-sharing scheme for which free-riding is a dominant strategy. The participants play the role of workers who must simultaneously provide a level of effort to produce an output that is shared among all team members.

2.1.1. Treatment description

Let denote $e_{i,j} \in [0, 100]$, the effort level of worker i in team j respectively, $\forall j = (1,2)$ to produce an output Y_j . At the end of each period, each worker is informed of the sum and the average of the effort levels chosen by other group members. Output $Y_j = f(e_{1,j}, \dots, e_{4,j})$ in each team j depends on the effort of the four workers. For simplification, we assume that the output Y_j of each team is produced using a simple stochastic linear technology specified as follow:

$$Y_j = \sum_1^4 e_{i,j} + \varepsilon, \quad \forall j = \{1,2\} \quad (1)$$

Following Nalbantian and Schotter (1997), ε is a uniform random variable defined over the interval $[-40, 40]$, which can be interpreted as a random shock to production or the degree of (positive or negative) synergy created in the team production process. The firm sells the production created by the teams on the market for a price of $P=3$. Total revenue of the firm R_F corresponds to the sum of outputs produced by each team time the price P such that:

$$R_F = P(Y_1 + Y_2) = 3(Y_1 + Y_2) \quad (2)$$

Where Y_1 and Y_2 are team 1 and team 2 's production levels, respectively.

The worker i 's payoff in the experiment is given by:

$$\begin{aligned} \pi_{i,j} &= \frac{\alpha P Y_j}{4} + \Omega - c(e_{i,j}) \\ &= \frac{1.5 \sum_1^4 e_{i,j} + \varepsilon}{4} + 10 - (e_{i,j}^2 / 100) \end{aligned} \quad (3)$$

Where α corresponds to the share of total revenue received by each team (α is set to 0.5 in the experimental design).

If the individual's share of total team revenue is below her cost of effort, the difference is normalized at zero, before the addition of the additional lump-sum of Ω . The truncation at this stage of the individual profit calculation takes place in all our treatments, and is not set out formally in the remainder of the text. Its cost is considered as borne by the firm. Any treatment-specific truncation at other calculation steps is explicitly noted in the text.

Ω is a lump-sum payment (set to 10 in the experiment). This fixed payment is introduced to facilitate the comparison across treatments. It is notably used, in the peer pressure treatment, to allow workers to punish others.

Let $c(e_{i,j})$ denote worker i 's cost function for effort. As in Nalbantian and Schotter, we assume that the cost function is an increasing convex cost function of effort such that $c' > 0$; $c'' > 0$. For simplification, we assume that $c(e_{i,j}) = e_{i,j}^2/100$. In our experiment, preferences are induced as discussed in Smith (1982), which means that the costs of effort are explicitly monetary instead of being “real” as in real effort experiments (see Carpenter and Huet-Vaughn, 2019 for a discussion of real effort experiments versus experiments based on induced preference).

Let's now consider the principal's profit. We assume that the principal is residual claimant such that she receives $(1 - \alpha)$ of the total revenue PY with $\alpha = 0.5$. Thus, we get:

$$\begin{aligned}\pi_P &= (1 - \alpha)R_F - \sum_{i=1}^8 \Omega \\ &= 1.5Y - \sum_{i=1}^8 \Omega\end{aligned}\quad (4)$$

2.1.2. Theoretical prediction under standard assumptions, and behavioral hypotheses

Pareto-optimal effort level for workers, is obtained by setting the derivative of total payoffs of team members, with respect to $e_{i,j}$ equal to zero:

$$1.5 - 2e_{i,j}/100 = 0 \quad (5)$$

which gives the Pareto-optimal effort level of 75.

Regarding Nash equilibrium, if we assume identical agents who are risk-neutral and self-centered, this leads to identical efforts among workers. The first-order condition is obtained from equation (3), by setting the derivative of $\pi_{i,j}$ with respect to $e_{i,j}$ equal to zero:

$$\partial\pi_{i,j}/\partial e_{i,j} = 1.5/4 - 2e_{i,j}/100 = 0 \quad (6)$$

This produces a Nash equilibrium of $e_{i,j}^* = 18.75$. Since the game is finitely repeated, the only subgame perfect equilibrium of the game is for all players to exert effort $e_{i,j}^*$ in each period.

The above predictions are based on the standard assumption that individuals are exclusively pursuing their own material self-interest, irrespective of others. However empirical evidence suggests that this assumption may not always hold. For instance, in a similar context of revenue sharing, Nalbantian and Schotter (1997) observe that effort level remains above the Nash equilibrium level but declines overtime. These findings are also consistent with the literature on public goods experiments that has documented two strong empirical regularities: (1) the fact that people contribute more than predicted by the standard theoretical model; and (2) that average contribution declines steadily over time when the game is repeated under a finite

horizon. (See Ledyard, 1995; Andreoni, 1995; Croson, 1996; Keser and van Winden, 2000; Fehr and Gaechter, 2000; Masclet et al., 2003; Herrmann et al., 2008; Krieg and Samek, 2017). The literature often cites three major traditional explanations for these phenomena: learning effects (Andreoni, 1988)³³, strategic behavior (Kreps et al., 1982)³⁴ and conditional cooperation (Fischbacher et al., 2001). While empirical evidence suggests that learning or strategic motives play only a limited role in explaining the decay of contribution level, most studies have focused their attention on the role played by conditional cooperation, i.e., the fact that individuals condition their decisions on the observation of others' decisions or on beliefs about their decisions (e.g., Keser and van Winden, 2000; Fischbacher et al., 2001; Croson, 2007; Fischbacher and Gaechter, 2010). Compatible with the imperfect conditional cooperation hypothesis of Fischbacher and Gaechter (2010), Figuieres et al. (2013) and Masclet and Dickinson (2019) propose models of behavior of weak moral motivation based on the idea that agents set their moral target by relying on two dimensions: a "morally ideal contribution" (see Brekke et al., 2003) and the observed contributions of others.

Altogether, our reading of this literature is that imperfect reciprocity is the main driving force behind the decay, while learning and strategic behavior reinforce this tendency (Fischbacher and Gaechter, 2010; Figuieres et al., 2013). Therefore, we take as a more empirically relevant behavioural assumption the idea that individuals' decisions are partly affected by the observations of others' actions (conditional cooperation or reciprocity) and that such conditional cooperation may lead to a decline of effort level over time. We state this conjecture as hypothesis H1.

H1: The combined effects of weak moral motivation and conditional reciprocity leads to a decline of contribution over time.

2.2. Decentralized mechanism: Peer-Pressure treatment

³³ The learning hypothesis posits that overcontributions initially stem from subjects' confusion and errors, gradually diminishing as they recognize the potential for higher earnings with reduced contributions. However, the learning hypothesis seems incompatible with the well known "restart effect" first found by Andreoni (1988).

³⁴ The strategic hypothesis, rooted in the 'crazy player' assumption (Kreps et al., 1982), or the absence of common knowledge of rationality, posits that if rational players believe a 'crazy player' exists in the group contributing positively in period 1, it becomes rational for them to adopt a trigger strategy early on, diversifying strategies as the repeated game progresses. However, Andreoni (1988)'s findings tend to undermine this hypothesis as a plausible explanation of the decay in average contributions.

The second treatment (called Peer pressure) is similar to the Baseline, except that a second stage is added after the effort choice where each team member observes the effort level of her co-workers and can use her lump-sum Ω , set to 10 in the experiment, to assign them costly punishment points.

2.2.1. Treatment description

Punishment is costly both for the target and for the punisher. Precisely, if worker i assigns punishment points p_{izj} to worker z , this reduces worker i 's payoff by p_{izj} and worker z 's payoff is reduced by $3p_{izj}$. Worker i cannot use more than her lump-sum of Ω to punish the three other co-workers in her team such that: $\sum_{z \neq i} p_{izj} \leq \Omega$. In the experiment, the payoff cannot be strictly negative. The final payoff of each worker is given by:

$$\pi_{i,j} = \max\left(1.5 \left(\sum_1^4 e_{ij} + \varepsilon\right)/4 - e_{ij}^2/100 + 10 - \sum_{i \neq z} p_{izj} - 3 \sum_{z \neq i} p_{zij}, 0\right) \quad (7)$$

The expression of the principal's profit is in this treatment the same than in the Baseline treatment.

2.2.2. Theoretical prediction under standard assumptions and behavioral hypotheses

Using backward induction, theoretical predictions are straightforward. Because punishment is costly to the punisher, no punishment occurs in the second stage of the game. Anticipating this, workers exert the lowest effort possible in stage one. So, the unique subgame perfect equilibrium is with low effort level ($e_{ij}^* = 18.75$) and no punishment assigned.

Therefore, complete free-riding is a dominant strategy in all periods of the peer pressure treatment. However, as for the revenue sharing treatment, we may relax the selfishness assumption and consider the predictions of models based on the imperfect conditional cooperation hypothesis (Fischbacher et al., 2001; Fischbacher and Gaechter, 2010) and/or weak moral motivation (Figuieres et al., 2013; Masclet and Dickinson, 2019). In those models, there exists some situations where conditional cooperators may be incited to punish, which makes the punishment decision credible and lead to higher effort level. Based on this literature we can state the following hypothesis H2.

H2: Introducing imperfect conditional reciprocity and/or weak moral motivation make punishment credible and cooperation can emerge in stage 1.

2.3. Centralized mechanism: Group Target

2.2.1. Treatment description

The Group Target treatment is similar to the Baseline except that teams' total revenue $1.5Y_j$ is compared to an exogenous target R_T^* . Workers share the team revenue only if their team reach to target. Otherwise, they receive a low fixed revenue of B .

The worker's payoff function is now given by:

$$\begin{cases} \pi_i = 1.5 (\sum_1^4 e_{ij} + \varepsilon)/4 - e_{ij}^2/100 + \Omega & \text{if } 1.5Y_j \geq R_T^* \\ \pi_i = \max(0, B - e_{ij}^2/100) + \Omega & \text{otherwise} \end{cases} \quad (8)$$

The expression of the principal's profit is in this treatment the same than in the Baseline treatment.

2.2.2. Theoretical prediction under standard assumptions and behavioral hypotheses

This game includes a Nash equilibrium with zero effort level. It also includes a Nash equilibrium corresponding to the Pareto solution $e_{ij} = e^* = 75$. The derivations of these Nash equilibria, and of the values of parameters for which the Pareto solution is a Nash equilibrium, are detailed in Appendix A of this chapter.

This is the case for specific values of parameters B and R_T^* . In our experiment, with $B=7.5$ and $R_T^* = 450$, the Pareto-optimal level of effort $e_{ij} = e^* = 75$ is a Nash equilibrium.

With these parameters, the cooperative equilibrium with $e^*=75$ is Pareto-superior, suggesting that players may consider it as a potential focal point. Although, the selection of focal points can be somewhat arbitrary, previous empirical evidence have shown that cooperation can emerge in a similar context. For instance, Nalbantian and Schotter (1997) observe that effort is initially improved in similar treatment ("Target Based Schemes Forcing Contracts") compared to a revenue sharing treatment. But they also observe that it sharply decrease overtime. They explain this latter finding by the fact that considerable risk is associated with the efficient equilibrium in this treatment, which leads participants to opt-out and prefer playing the safer strategy by shirking. Based on this, our conjecture for this treatment is stated as follow:

H3: Average effort is initially higher in the group target treatment but it sharply declines overtime

2.4. Centralized mechanism: Team tournament or Group Competition

2.2.1. Treatment description

In the Group-Competition treatment, the target to reach is endogenously set. Precisely, each team competes with the other team in the same firm and the team with the highest production receives a transfer of TR from the other team.

Let's call the two teams, team 1 and 2. We get for each worker i in team l :

$$\begin{cases} \pi_i(Y_1, Y_2, e_{i1}) = \frac{1.5Y_1 + TR}{4} - \frac{e_{i1}^2}{100} + \Omega & \text{if } Y_1 > Y_2 \\ \pi_i(Y_1, Y_2, e_{i1}) = \max\left(\frac{1.5Y_1 - TR}{4} - \frac{e_{i1}^2}{100}, 0\right) + \Omega & \text{if } Y_2 < Y_1 \end{cases} \quad (9)$$

In case of equal production there is no transfer.

The expression of the principal's profit is in this treatment the same than in the Baseline treatment.

2.2.2. Theoretical prediction under standard assumptions and behavioral hypotheses

It can be shown from eq. (8) that the Pareto-optimal level of effort for workers, $e^* = 75$, can be a Nash equilibrium for a specific value of the transfer TR . The derivation of this Nash equilibrium and of the specific value of the transfer ($TR=180$) for which the Pareto solution is a Nash equilibrium are detailed in Appendix A of this chapter. In our experiments, the value of TR in this treatment is set to 180 to ensure that $e^* = 75$ is a Nash equilibrium.

Based on these predictions and on previous findings by Nalbantian and Schotter (1997) on a very similar treatment, we expect that workers should exert the highest effort among treatments in the group competition treatment. Our prediction is summarized as follow:

H4: *Average effort in the group competition treatment is the highest among treatments.*

3. Procedures and parameters

As already mentioned in section 2, each treatment consists of 10 identical periods under "Partner" matching and using a "Between" treatment design.

The experiments took place from October 20th 2021 to January 11th 2022 at the LABEX-EM laboratory at the University of Rennes with 120 participants, mostly Bachelors or Master students at the University. Among the 120 participants, the Baseline, Peer-Pressure and Group-Target treatments involved 24 participants each, and the remaining 48 participants played the Group-Competition treatment. For each of the four treatments, we therefore obtain 6 independent observations (where an independent observation corresponds to a team of 4, except in the Group Competition treatment where it consists of the two competing teams of 4, i.e. 8 players). With 6 independent observations in each treatment, we have sufficient data to allow

analyses based on nonparametric test statistics (Dugar, 2013; Nikiforakis and Normann, 2008; Nalbantian and Schotter, 1997)³⁵. The experiments were programmed in Z-tree (Fischbacher, 2007). An experimental session lasted about one hour and participants earned on average € 16, including a show-up fee of € 4.

Participants were recruited via the online platform ORSEE. When they registered, they had no information except the time and duration of the session. Participants then were randomly assigned to computers in the lab. Once in the lab, participants were no longer allowed to communicate. The experimenter read a brief text presenting the course of the session. A recording of the instructions for the treatment was broadcast by loudspeakers (see the instructions in appendix B). After reading the instructions, participants answered a comprehension questionnaire. They could ask questions which were answered in private. Then, they played the 10 periods of the game. Afterwards, they answered to a post-experiment questionnaire including administrative data enabling the payment, their socio-demographic characteristics, questions on the clarity of the rules of the game, the strategy they used, and their opinion on the purpose of the experiment (see appendix C). Finally, the amounts due were paid. Table 1 shows the socio-demographic by treatment.

Table 1: Socio-demographics descriptive statistics by treatment

	Baseline	Peer Pressure	Group Target	Group Competition	All Treatments
Number of participants	24	24	24	48	120
Women (%)	54%	71%	62%	58%	61%
Previous participation (%)	4%	8%	29%	33%	22%
Average Age	20.5	21.0	20.4	20.4	20.5
Student in Economics (%)	8%	17%	21%	23%	18%

³⁵ Many experimenters advocate for a minimum of 6 independent observations per treatment to ensure sufficient statistical power in non-parametric data analysis (e.g. Dugar, 2013; Nikiforakis and Normann, 2008; Nalbantian and Schotter, 1997). For example, Dugar (2013)'s public good experiment consists of four treatments (Baseline, Disapproval, Approval, Approval& Disapproval), with a total of 96 subjects, assigned to groups of four with fixed group membership. Each session involved twelve subjects, resulting in six independent observations for each treatment. In Nikiforakis and Normann (2008)'s experiment on the determinants of punishment in public-good experiments, a total of ten sessions with 120 subjects (12 per session) were run. For each treatment, the authors had six groups, providing six statistically independent observations. In the same vein, Nikiforakis (2008)'s experiment on peer pressure in teams composed of four members, a total of 60 subjects participated. Twenty-four subjects were assigned to the partner treatment (VCM and P&CP), resulting in six independent observations, another twenty-four to the stranger treatment (VCM and P&CP), and 12 more to the control session (stranger VCM and One-Sided Punishment). Lastly, Nalbantian and Schotter (1997) conducted experiments with a larger sample of 408 college undergraduate. However, each group consisted of 6 members and they ran much more treatments (9 treatments), which means an average of 7 independent observations per treatment.

18% of participants were studying Economics, and the others were studying various fields such as Law, Management, Medicine, Physics or Chemistry. The average age was 20.5 years. The share of women was 61% and 78% of participants had never taken part in a laboratory experiment before. We performed tests of difference in means (t-test) and frequencies (Fisher exact probability test and chi-square tests) to assess the covariate balance between our different treatments. The results of these tests are presented in Table D1 in section D1 of the appendix. Table D1 shows that for almost all variables no significant differences are observed across treatments, suggesting that our groups of participants are on average very similar on observable characteristics. A notable exception is the frequency of participants having already participated to a previous experiment that differs significantly across some treatments³⁶.

4. Results

This section first analyses workers' decisions in term of: effort, punishment. It then turns to the incidence of these decisions on workers' payoff, firms' profit and the sharing of social welfare.

4.1. Workers 'efforts

Figure 1 shows the evolution of the average effort in each treatment over time.

Figure 1 indicates that the average effort in the Baseline falls slowly overtime but remains clearly above the Nash equilibrium of 18.75. This finding is consistent with Nalbantian and Schotter (1997) and with previous results in the literature on public goods experiments that have reported two strong empirical regularities (1) the fact that people contribute more than the standard theoretical prediction and (2) that average contribution declines over time when the game is finitely repeated (See for instance Fehr and Gächter, 2000; Masclet et al., 2003; Zelmer, 2003; Sefton et al., 2007; Herrmann et al., 2008)³⁷. Figure 1 also indicates that effort level seems higher in the Peer Pressure treatment than in the baseline. Finally, effort is close to the Pareto solution in the centralized incentive schemes.

³⁶ In order to control ex post for this, our estimates presented in section 4 below are run with and without the inclusion of these covariates to check whether our main findings (namely the treatment effects) hold. This seems to be the case. Furthermore, we also ran additional estimates (available upon request) with the inclusion of interaction terms "treatment *economics" and "treatment*previous participation". These interaction variables are insignificant and our conclusions on treatment effects hold after controlling for these variables.

³⁷ Previous studies have attempted to understand these findings. The more plausible explanation relies on conditional cooperation, i.e., the fact that people would be willing to cooperate, depending on previously observed decisions of others or on beliefs about their decisions and would update their future contribution based on these previous observations or beliefs (e.g., Keser and van Winden 2000, Fischbacher and Gächter 2010; Thöni and Volk, 2018). Figuières et al., (2013) provides an alternative explanation based on weak moral motivation.

Figure 1: Average effort over time

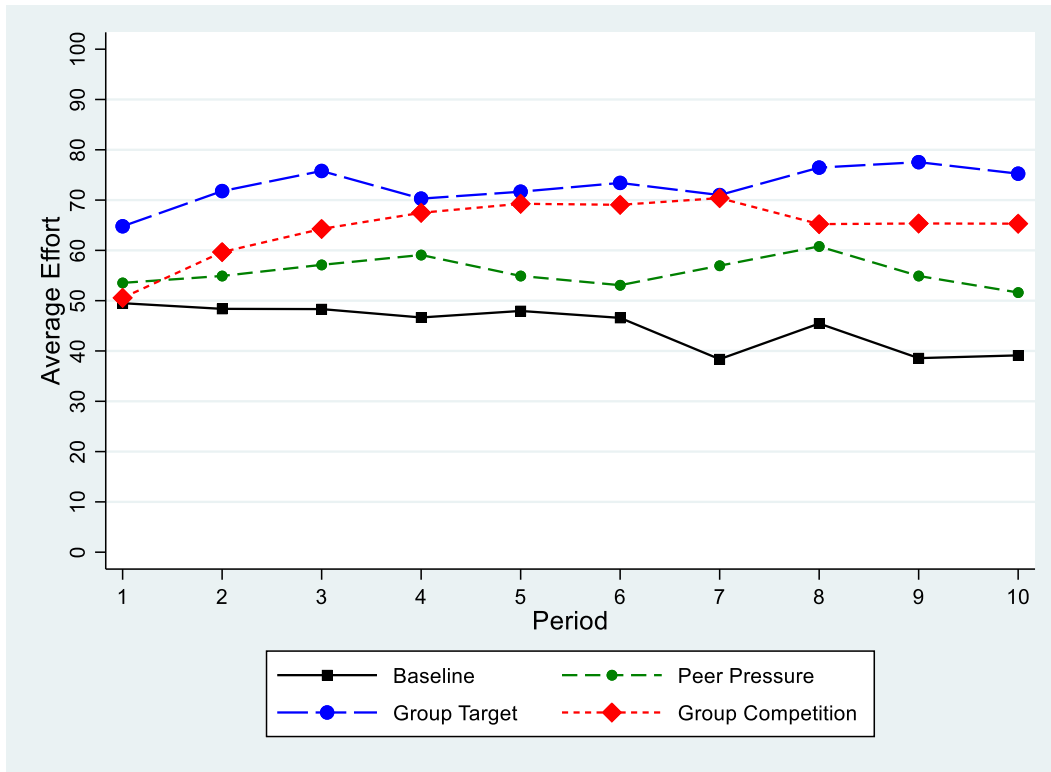


Table 2 reports descriptive statistics for average effort by treatment. It indicates that average effort in the Group-Target treatment, (72.80) is close to the Pareto optimum of 75, and is significantly higher than in the Baseline (44.90).

Table 2: Descriptive statistics by treatment

	Baseline	Peer Pressure	Group Target	Group Competition
Average Effort	44.90 (24.17)	55.70 (23.98)	72.80 (22.97)	64.66 (26.20)
Average Workers' payoff	54.29 (22.35)	50.11 (21.41)	35.58 (31.37)	64.18 (47.82)
Average firms' Profit	474.57 (130.54)	577.51 (110.42)	990.88 (153.73)	646.78 (175.67)
Social Welfare	908.92 (205.06)	978.38 (163.76)	1275.49 (191.92)	1160.18 (209.93)
Nb. of participants	24	24	24	48
Observations	240	240	240	480

Notes: The numbers in parentheses are standard deviations.

A two-tailed Mann-Whitney U test at the independent level (i.e. the group level), indicates that the average effort level in the Group-Target treatment is significantly higher than in the Baseline (two-tailed; $p=0.0065$). Average effort level in the Group-Competition treatment is also significantly higher (64.66) than in the Baseline (two-tailed; $p=0.016$). A similar test indicates

that average effort is also higher in the Peer-Pressure treatment (55.70) than in the Baseline. However, this difference is not statistically significant (two tailed; $p=0.1093$).

To provide formal evidence of our findings, we ran random-effects Generalized Least Squares (GLS) estimates on the determinants of effort level. Random Effects are used to account for the panel dimension of the data³⁸. The results of these estimates are shown in Table 3.

Table 3: Determinants of effort level

	All	All	All except the baseline	All	All	All except the baseline
	With clustered SE					
Dep. Var: Effort level	RE GLS (1)	RE GLS (2)	RE GLS (3)	RE GLS (4)	RE GLS (5)	RE GLS (6)
Baseline	Ref.	Ref.		Ref.	Ref.	
Peer Pressure	10.80** (4.53)	11.01** (4.58)	Ref.	10.80* (6.27)	11.01* (6.09)	Ref.
Group Target	27.90*** (4.53)	27.88*** (4.65)	16.69*** (4.73)	27.90*** (4.97)	27.88*** (4.70)	16.69*** (6.27)
Group Competition	19.76*** (3.92)	19.73*** (4.11)	8.53** (4.17)	19.76*** (4.75)	19.73*** (4.74)	8.53 (6.25)
Period – Trend		0.61** (0.24)	1.06*** (0.26)		0.61 (0.49)	1.06* (0.56)
Male		-0.17 (3.03)	-0.43 (3.49)		-0.17 (2.35)	-0.43 (2.86)
Previous Participation		3.47 (3.69)	3.86 (3.92)		3.47 (3.57)	3.86 (3.86)
Age		0.36 (0.60)	0.19 (0.77)		0.36 (0.58)	0.19 (0.88)
Economics		-6.53* (3.94)	-5.93 (4.32)		-6.53* (3.42)	-5.93 (3.81)
Last Period Dummy		-4.39* (2.29)	-5.39** (2.53)		-4.39 (3.24)	-5.39 (4.00)
Constant	44.90*** (3.20)	35.13*** (12.71)	47.21*** (16.79)	44.90*** (3.62)	35.13** (13.55)	47.21** (20.91)
Observations	1,200	1,200	960	1,200	1,200	960
R-squared overall	0.1292	0.1475	0.08	0.1292	0.1475	0.08
Wald χ^2	44.06	56.58	33.54	34.28	126.18	100.31

Note: The numbers in parentheses are standard errors. *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$.

Table 3 consists of two panels. The left panel reports estimates on the determinant of effort. The right panel replicates those estimates but standard errors are clustered at the team level in order to control for interdependencies within teams. Column (1) indicates that all treatment variables

³⁸ We opted for random effect instead of fixed effect due to the fact that our treatment variables are invariant overtime (See Montmarquette, 2008 for a discussion on the specificities of econometrics using data from experiments).

capture a positive and significant coefficient, suggesting that introducing an incentive mechanism has a positive effect on effort level compared to the baseline revenue sharing treatment. Column (2) replicates estimate (1) with the addition of a trend variable and demographics. The treatment effects are robust to the introduction of these covariates. The trend variable captures a positive coefficient, indicating that average effort increases overtime.³⁹

Most of demographics are insignificant except the “economics” variable that captures a negative coefficient significant at 10%. This finding is consistent with previous studies that have shown that economics graduate students are more inclined to free-ride in public-goods experiments (Marwell and Ames, 1981), more likely to defect in prisoners' dilemma games (Frank, et al., 1993), and in a solidarity game (Selten and Ockenfels, 1998) or offer lower amounts in ultimatum games (Carter and Irons, 1991). One hypothesis to explain this finding relates to self-selection, suggesting that individuals with inherently selfish tendencies may be more likely to choose economics as their major. Another possible reason is indoctrination, positing that the teaching of economics encourages students to adopt the behavior of the rational, self-interested homo economicus depicted in microeconomics textbooks (see Bauman and Rose, 2009 for a discussion).

We also find an end game effect as shown by the negative and significant coefficient associated to the last period dummy variable. Column (3) replicates column (2) but on the restricted sample without the baseline. The omitted variable is the Peer Pressure dummy. Interestingly, both the group Target and Group Competition variables capture a positive and significant coefficient, indicating that centralized systems are more effective than a peer pressure mechanism in enhancing effort level. The estimates shown in the right panel of table 3 report qualitatively similar findings. A notable exception is that the Group competition variable is no more significant in estimate (6). Altogether, our findings are summarized in result 1.

Result 1: *a) In absence of incentive mechanism, profit sharing induces low effort level but higher than theoretically predicted. b) Peer pressure and both centralized mechanisms lead to higher levels of workers' efforts than the baseline (profit sharing) treatment. c) The Group target mechanism induces higher effort levels than the Peer Pressure mechanism.*

4.2. The Peer-Pressure treatment: punishments analysis

³⁹ Note however that this positive trend hides some differences across treatments. Indeed, separate estimates per treatment (available upon request) reveal a positive trend for both centralized and decentralized systems but a negative trend in the baseline.

In this section, we investigate punishments in the Peer Pressure treatment. In a first subsection, we analyze the evolution and the determinants of punishment points received by workers. In a second subsection, we study punishment behavior, with a focus on ultimate punishers, workers who punish in the last period.

4.2.1. Analysis of received punishment points.

Figure 2 shows the evolution of punishment over time. It indicates that the number of points received falls steadily over time. This finding is consistent with previous findings from public good experiments with punishment (e.g. Nikiforakis, 2008; Gächter et al. 2008; Masclet and Villeval, 2008; Nikiforakis and Engelmann, 2011; Dickinson and Masclet, 2015). The reason often evoked in this literature to explain this negative trend is that after a certain number of rounds, once cooperation is established within the group, punishment becomes credible and is no more needed to maintain cooperation (e.g. Gächter et al. 2008). Figure 2 indicates that there remains a substantial punishment level in the last round, suggesting the existence of non-strategic motive for punishing. This question is addressed in more detail in the next subsection.

Figure 2: Average number of points received over time

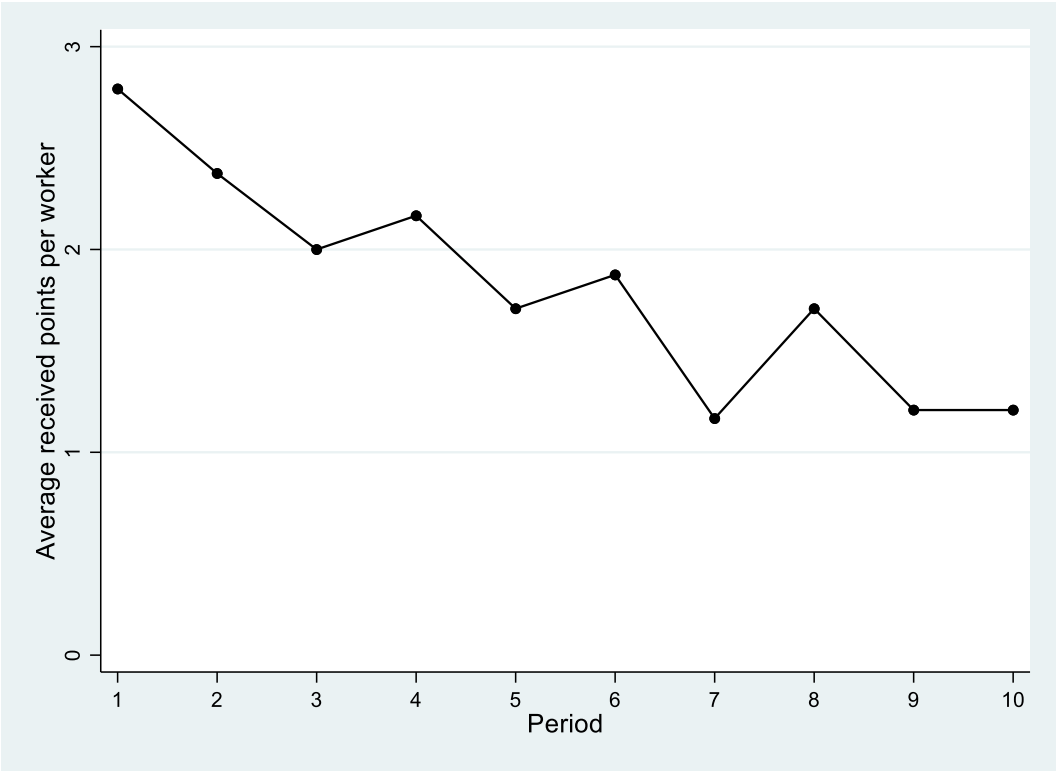
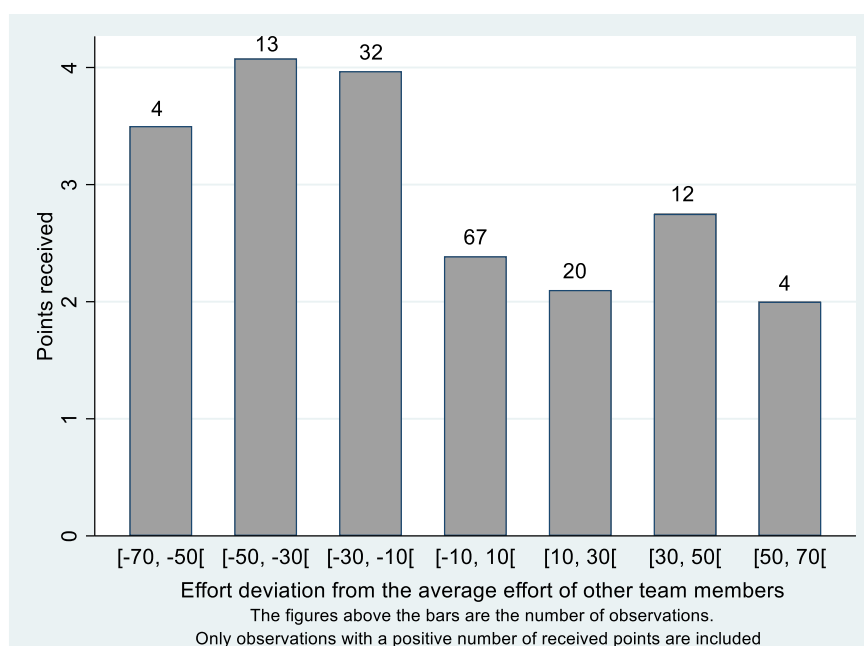


Figure 3 shows the number of punishment points received as a function of the deviation between a worker's effort and the average effort of the other workers in her team. Figure 3 indicates that more punishment points are assigned for negative deviations, which is consistent with previous findings from public good experiments with punishment (e.g. Fehr and Gächter, 2000; Masclet et al. 2003; Herrmann et al. 2008; Masclet and Villeval, 2008). More surprisingly, Figure 3 also indicate that positive deviations are also punished although to a lesser extent. However, such phenomenon has also already been reported in public good experiments (Fehr and Gächter, 2000; Masclet et al. 2003; Herrmann et al. 2008; Masclet and Villeval, 2008). Such punishments have been categorized as 'perverse' or 'antisocial (see for instance ; Cinyabuguma et al., 2005; Herrmann et al. 2008; Nikiforakis et al. 2012, Denant-Boemont et al. 2007; and more recently by Fu and Putterman, 2018)⁴⁰.

Figure 3: Punishment points received and the deviation from others' average effort



⁴⁰ Some studies have attempted to investigate the determinants of antisocial punishment (see Gächter and Herrmann, 2009 for a detailed discussion). Some authors have shed light the desire for (blind) revenge (Denant-Boemont et al., 2007; Nikiforakis, 2008; Herrmann et al., 2008). Other studies have shown the existence of a pure willingness to harm others in absence of material benefits that may be rooted in desire for dominance (Zizzo, 2003). Furthermore, individuals might exhibit aversion towards "do-gooders," punish non-conformists, and penalize displays of conspicuous generosity (Carpenter and Matthews, 2012; Henrich et al., 2006). Interestingly, other studies have shed light on cultural differences in perverse punishment at a macro level. For instance, Herrmann et al. (2008) found that antisocial punishment tends to occur more frequently in societies characterized by weak social norms of cooperation, weak rule of law, and weak democracies. Antisocial punishment seems also predominantly observed in more traditional societies structured along strong private networks. Interestingly in the management literature another motive behind antisocial punishment is often evoked, namely the fact that some team members may be inclined to punish cooperators, in order to avoid that the firm in the future would revise upward its exigences such as a target to reach.

Table 4 shows estimates on the determinants of received punishment points. The dependent variable is the number of received points. Random Effect Tobit model is used to control for left censored observations.

Table 4: Determinants of received punishment points

Dep. Var: Received punishment Points	RE Tobit Model
Average effort of other team members	0.042** (0.018)
Absolute value of negative deviation from average effort of other team members	0.061*** (0.016)
Positive deviation from average effort of other team members	0.008 (0.017)
Period	-0.25*** (0.07)
Last Period (Dummy)	0.20 (0.70)
Constant	-0.77 (1.21)
Observations	240
Uncensored	152
LR χ^2	43.69
Log Likelihood	-416.42

Note: The figures in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1 The “Absolute negative the deviation from others’ effort” variable is constructed as follow: it takes the absolute value of negative deviation of the worker’s effort from the average effort of others within her teams if the worker exerts less effort than the others and zero otherwise. “Positive the deviation from others’ effort” variable is constructed as follow: it takes the value of positive deviation of the worker’s effort from the average effort of others within her teams if the worker exerts higher effort than the others and zero otherwise.

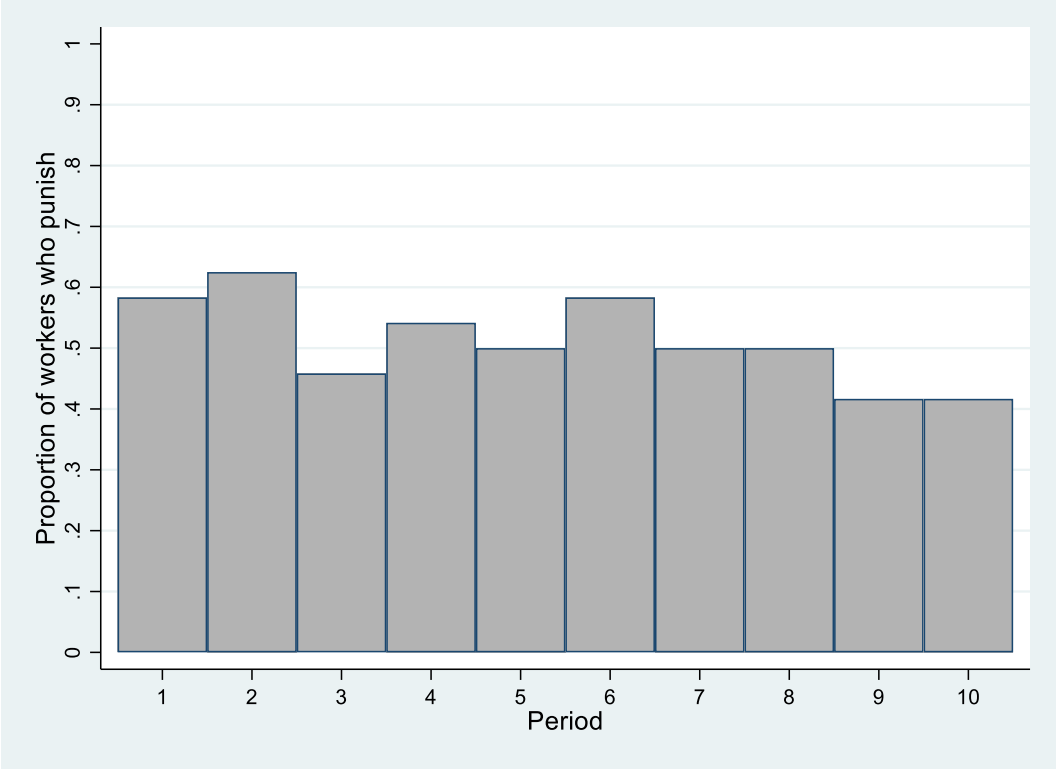
The “Absolute value of negative deviation from average efforts of others” variable captures a positive and significant coefficient, indicating that workers receive more peer punishment when they exert lower effort than the average. In contrast, the “Positive the deviation from others’ effort” variable is not significant. The period variable is negative and significant, indicating that the number of points received decreases overtime. The last period variable is not statistically significant indicating the absence of an end game effect. Our findings on punishment decisions are summarized in result 2.

Result 2: a) *Most of punishment points are assigned to workers exerting lower effort than the average of the team.* b) *Punishment level decreases over time.*

4.2.2. Focus on ultimate punishers

Figure 4 describes the evolution of the proportion of punishers overtime. This proportion of punishers decreases only very slowly. Indeed, difference of punishing frequencies between the first 5 periods, and the last 5 periods, is not significant according to a non-parametric Fisher test ($p=0.439$).

Figure 4: Evolution of the proportion of punishers overtime



Among the 24 participants to the Peer Pressure treatment, 10 out of 24 punish in period 10. We call them ultimate punishers. It is interesting to have a better understanding of these ultimate punishers since they do not punish to enforce future cooperation. A possible explanation is that those ultimate punishers may be driven by non-strategic motives such as reciprocity coupled with the role of emotions induced by free-riding. They may be willing to strongly punish deviators even in absence of any future monetary benefit to do so (since there are no more rounds). Punishing in the last period also avoid risks of blind retaliation.

Previous studies have investigated the relationship between emotions and willingness to punish and particularly how anger accompanies the application of costly punishment in two-person interactions (Bosman and van Winden, 2002; Ben Shakhar et al., 2007) or in public good games with punishment (see for instance Joffily et al. 2014 ; Dickinson and Masclet, 2015). These studies measure emotions by means of self-reports or by using electrophysiological measures of emotional arousal. It could be an interesting question for future research to test whether ultimate punishers are strongly driven by such emotions.

Table 5 provides descriptive statistics regarding efforts, attributed points, and demographics, for the 10 ultimate punishers.

Table 5: Descriptive statistics concerning ultimate punishers

	Observations	Mean	Std. Dev.	Min	Max
Effort	100	58.13	20.69	10	100
Attributed Points	100	2.1	2.35	0	9
Gender	10	0.1	0.32	0	1
Previous Participation	10	0	0	0	0
Economics	10	0.1	0.32	0	1
Age	10	21.1	1.73	18	24

Table 5 can be compared to Table 6 which provides the same descriptive statistics, but for the 14 non-ultimate punishers.

Table 6: Descriptive statistics concerning non-ultimate punishers

	Observations	Mean	Std. Dev.	Min	Max
Effort	140	53.96	26.02	0	100
Attributed Points	140	1.62	2.47	0	10
Gender	14	0.43	0.51	0	1
Previous Participation	14	0.14	0.36	0	1
Economics	14	0.21	0.43	0	1
Age	14	20.86	2.68	18	27

Results shown in Table 7 test whether the differences in effort, attributed points, and demographics between ultimate, in Table 5, and non-ultimate punishers, in Table 6, are statistically significant.

Table 7: Significance of differences between Ultimate and Non-Ultimate Punishers

	Effort [‡]	Attributed Points [‡]	Gender*	Participation*	Economics*	Age [‡]
Ultimate vs Non-Ultimate Punishers	0.18	0.13	0.17	0.49	0.44	0.80

Note: *Fisher exact test. ‡:t-test

Table 7 suggests that those differences are not statistically significant.

Regarding punishments intensity, Figure 5 shows the evolution of the average number of attributed points by ultimate punishers. For these ultimate punishers we observe first a slight decline in average punishment level and a strong increase in the final period. Ultimate punishers attribute on average 2.9 points in period 10.

Figure 5: Evolution of average number of attributed points by ultimate punishers

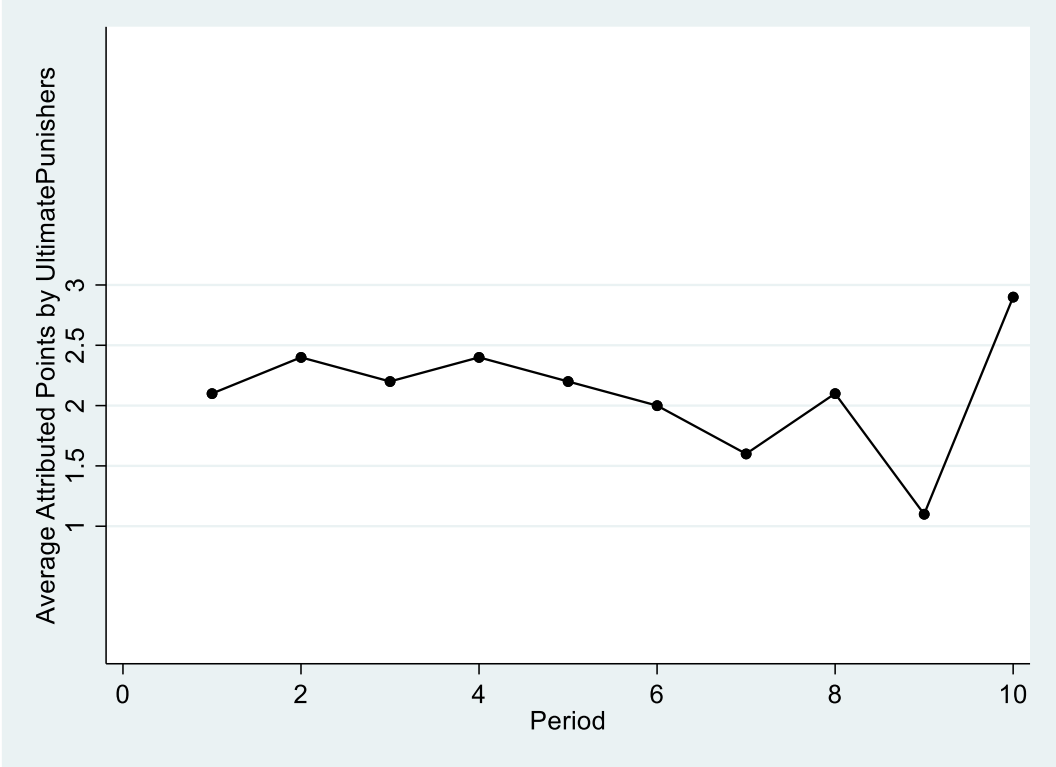
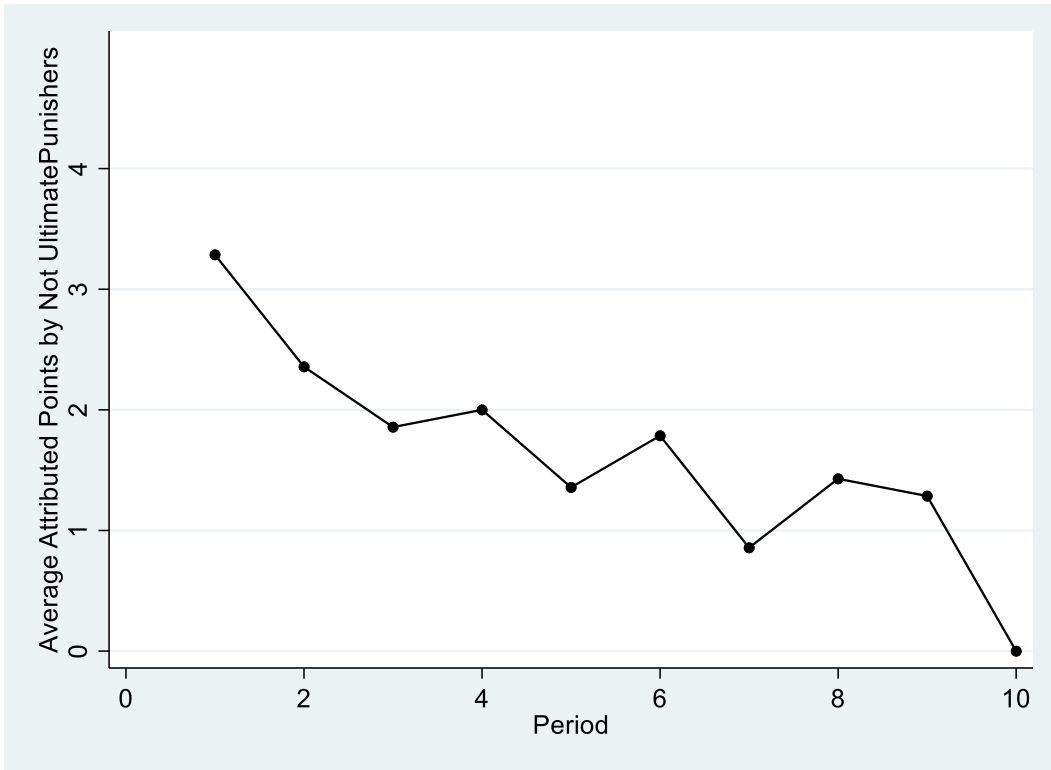


Figure 6 provide the same graphic of the evolution of the average number of attributed points, but for non-ultimate punishers. Contrasting with Figure 5, Figure 6 exhibits a negative trend.

Figure 6: Evolution of average number of attributed points by non-ultimate punishers



4.3. Workers 'payoffs

Figure 7 shows the evolution of average workers' payoffs overtime by treatment.

Figure 7: Average workers' payoffs over time

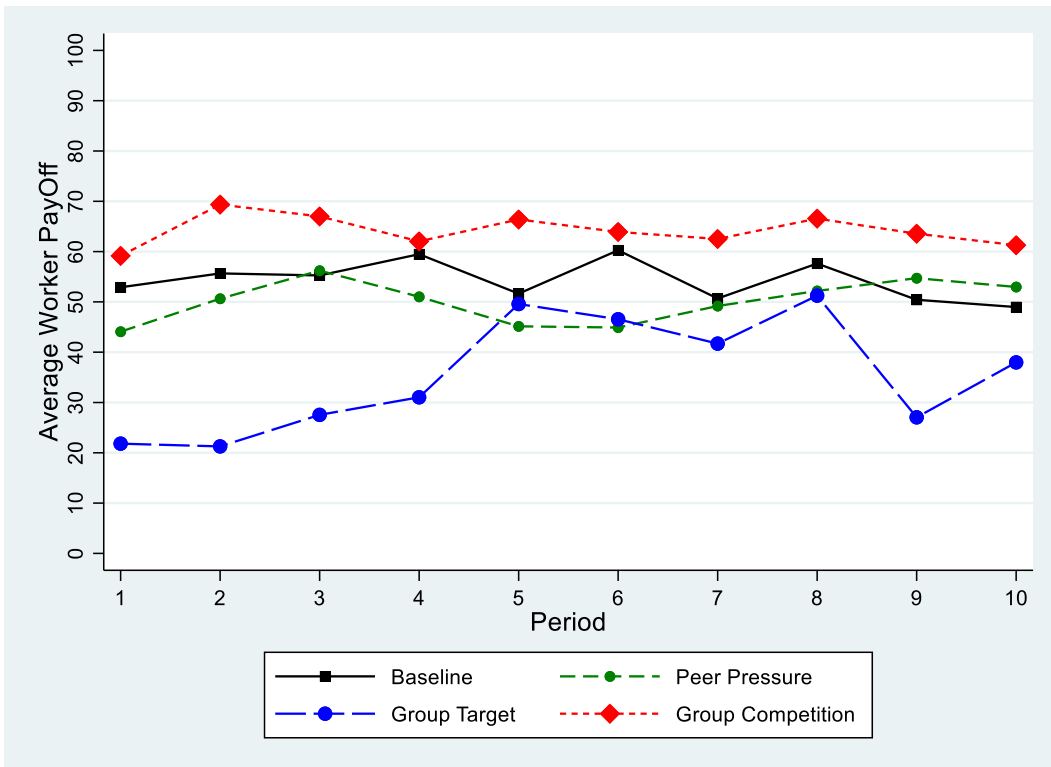


Figure 7 indicates that the Group Target treatment generates the lowest average worker payoffs in almost every period. In sharp contrast, payoffs are the highest in the Group Competition treatment. These findings are confirmed by Table 2. A two-tailed Mann-Whitney tests indicates that workers ‘payoffs are significantly lower in the Group Target treatment than in the Baseline ($p=0.0065$). Workers’ payoffs are slightly higher in the Group Competition than in the Baseline ($p=0.0547$). Finally, applying a similar Mann-Whitney test we cannot however reject the null hypothesis that average payoffs levels are the same in the Peer Pressure treatment and in the Baseline ($p=0.42$). Interestingly Table 2 also reports some differences in standard deviations across treatments. In particular, the standard deviation of workers’ payoffs is higher in the centralized incentive schemes, notably Group Competition, compared to the baseline or the peer pressure treatment. A possible explanation relies on the Group-Competition design and the fact that at each period, the transfer between the winning and losing teams leads to considerable payoff inequality.

Column (1) of Table 8 provides the results of RE GLS estimates on the determinants of workers ‘payoffs.

Table 8: Determinants of Workers’ payoffs, firms’ profits and social welfare⁴¹ (RE GLS)

Dep. Var:	Workers ’payoffs (1)	Firms ’profits (2)	Social welfare (3)
Baseline	Ref.	Ref.	Ref.
Peer Pressure	-5.88 (4.34)	102.94 (68.82)	69.46 (99.90)
Group Target	-22.21*** (5.64)	516.31*** (70.04)	366.58*** (110.99)
Group Competition	6.11 (4.45)	172.21** (70.55)	251.27** (99.65)
Period – Trend	0.58 (0.46)	4.21 (6.77)	8.84 (7.98)
Male	-5.44 (3.52)		
Previous Participation	9.78 (6.14)		
Age	-0.019 (0.50)		
Economics	4.73 (6.41)		
Last Period Dummy	-4.20 (4.59)	-58.34 (51.31)	-91.92 (65.16)
Constant	53.61*** (11.61)	457.25*** (65.43)	869.49*** (96.55)

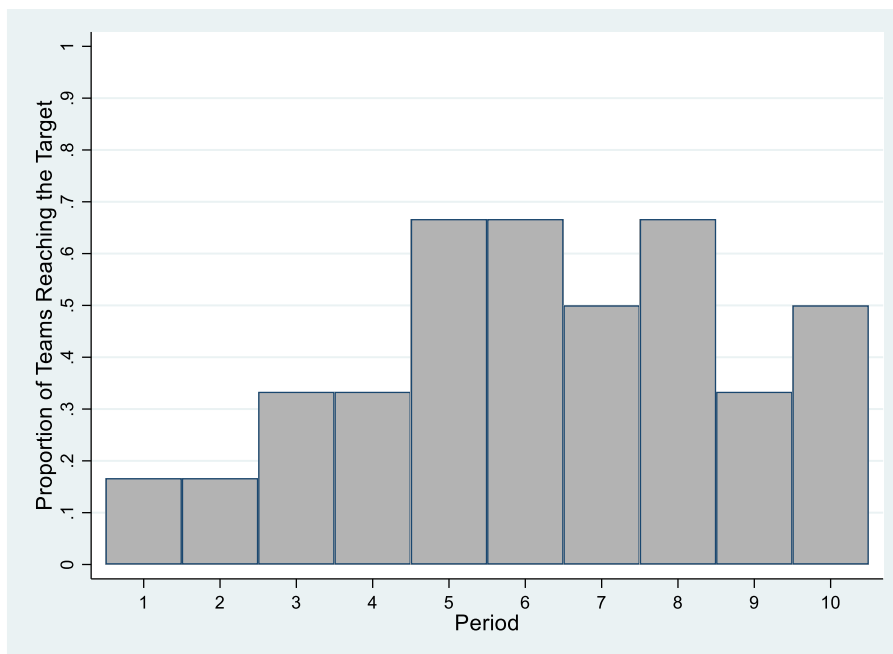
⁴¹ The purpose and the definition of the notion of social welfare are discussed in §4.5 below

Observations	1,200	150	150
R-squared Overall	0.0951	0.5786	0.3331
Wald χ^2	339.94	74.98	21.31

Note: The figures in parentheses are standard errors.***p < 0.01, **p < 0.05, *p < 0.1. In column (1), standard errors are clustered at the group level.

Column (1) of Table 8 indicates that workers' payoffs are not statistically improved by the Peer Pressure treatment. This may result from the fact that peer pressure mechanism involves costly punishment both for the punished and the punisher, which is detrimental to workers' payoffs and may offset the gain obtained by higher cooperation. The Group Competition variable is also insignificant. One possible reason is that if this mechanism incites workers to outperform, it remains that at the end there is only one winner. Finally, the Group-Target treatment variable captures a negative and significant coefficient, indicating that payoffs are significantly lower in this treatment than in the baseline. A possible explanation is that teams may fail to reach the target, which may lead to rather low payoffs in this case. Figure 8 confirms this intuition. It shows that the frequency of teams reaching the target over time in the Group target treatment is relatively low, particularly during the first periods of the game. However, Figure 8 also indicates a weak but positive tendency to reach the target overtime, suggesting that there is no resignation on the part of the workers.

Figure 8: Proportion of teams which reach the target overtime in the group target treatment.



This observation is detailed in section D2 of the appendix, which studies the evolution and the dispersion of efforts in the Group Target treatment, for successful teams who meet the target, and for unsuccessful teams who fail to meet the target.

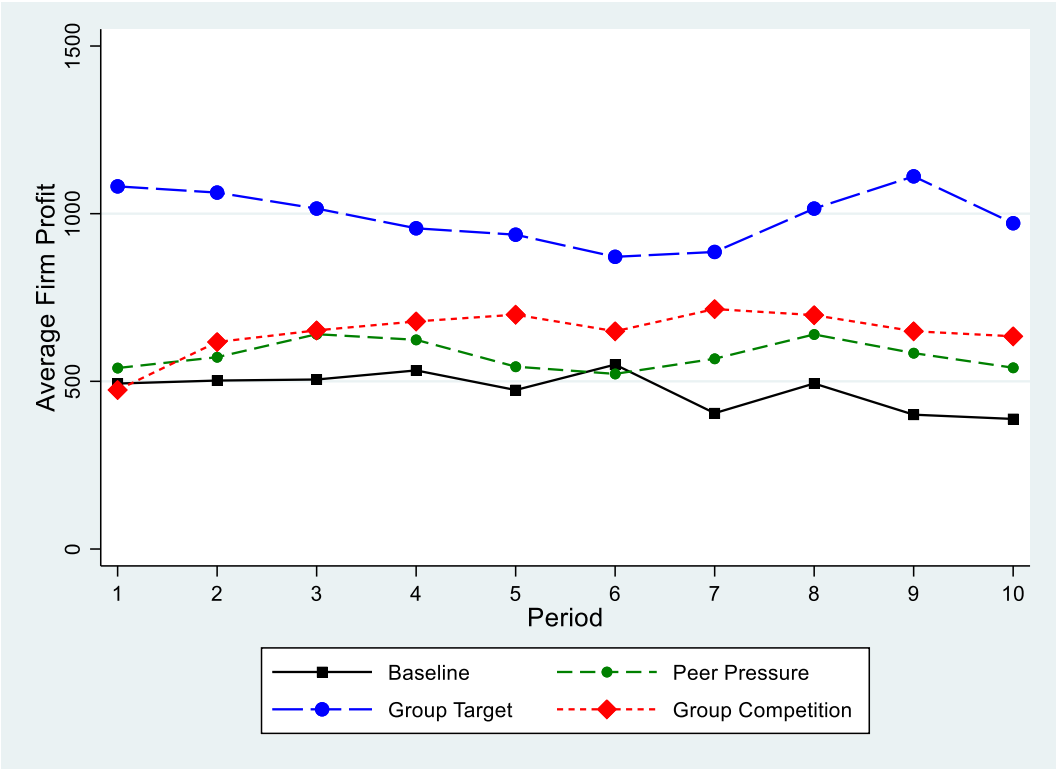
Altogether our findings concerning workers’ payoffs are summarized in result 3.

Result 3: a) Peer Pressure mechanism has no significant effect on average workers’ payoff compared to the Baseline, which reflects the fact that the social cost of peer punishment offsets the gains of higher cooperation. b) The Group Competition mechanism does not improve workers’ payoffs significantly compared to Baseline but it induces high workers’ payoff dispersion. c) Workers’ payoffs are significantly lower in the Group Target and highly dispersed compared to the Baseline, due to the fact that many teams fail to reach the target.

4.4. Firms’ Profits

Figure 9 below shows the evolution of average firms’ profit over time by treatment. Both Table 2 and Figure 9 show that firms’ profits are the highest in the Group Target treatment and the lowest in the Baseline treatment.

Figure 9: Average firms’ profit over time



Column (2) of Table 8 reports the results from an estimate on the determinants of firms’ profit. It indicates that firms’ profit is significantly higher in the Group Target treatment and to a lesser extent in the Group Competition treatment compared to the baseline. The Peer Pressure variable is not significant, indicating that this mechanism does not clearly enhance firms’ profits. Tests on the coefficients of column (2) of Table 8, shown in section D3 of the appendix, find that

firms' profits are significantly higher in the Group Target than in the Peer Pressure and Group Competition treatments, but that difference in firms' profits between Peer Pressure and Group Competition is not significant.

Our findings regarding firms' profits are summarized as follow:

Result 4: *a) Introducing a centralized mechanism improve firms' profits, compared to the Baseline. b) Firms' profits are highest in the Group Target treatment. c) Peer pressure does not lead increase firms' profits compared to the Baseline treatment.*

4.5. Who mainly benefits from the introduction of (de)centralized mechanisms: the firm or the workers?

In this section we investigate who mainly benefits from the introduction of (de)centralized mechanisms. For this purpose, we consider social welfare as the sum of the firm's profit and the workers' payoffs⁴² and investigate how it is shared between the two parties.

Table 2 shows social welfare per treatment. It indicates that social welfare is the lowest in the Baseline treatment and the highest in the Group-Target treatment, where the highest level of firms' profit more than compensates for the lowest level of workers' payoffs.

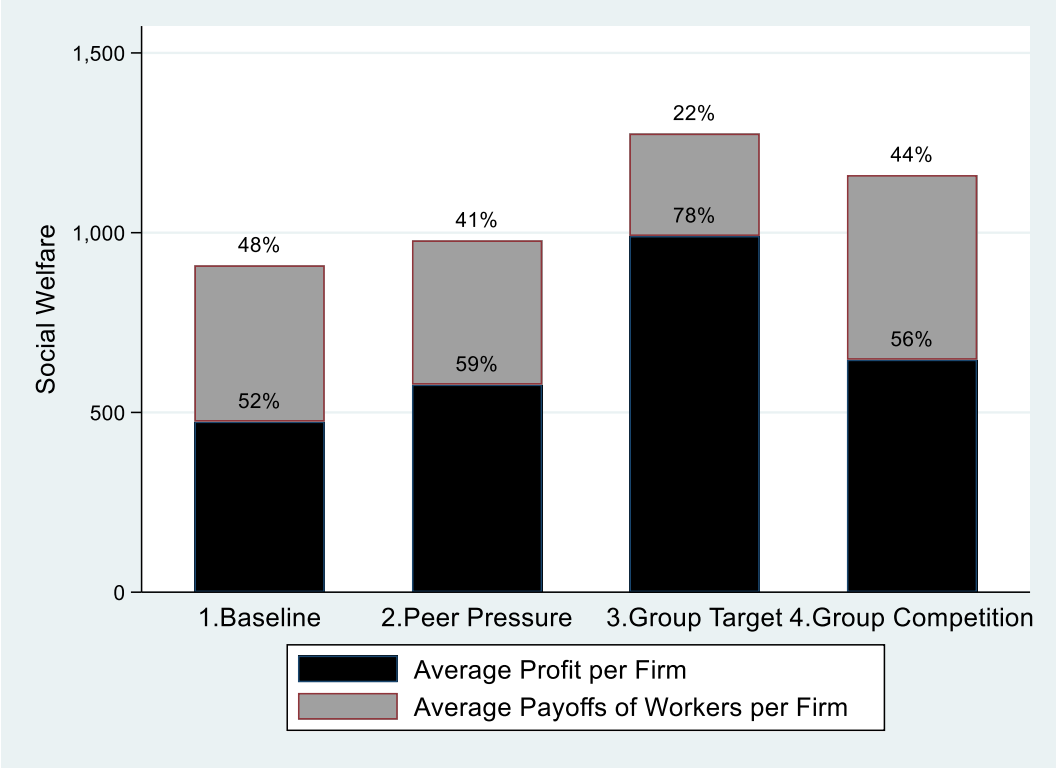
Column (3) of Table 8 shows that social welfare is maximized with centralized incentive schemes. The decentralized mechanism (Peer pressure) has no significant effect on social welfare compared to the Baseline. Tests on the coefficients of column (3) of Table 8, shown in section D3 of the appendix, confirm that social welfare is significantly higher in the Group Target and Group Competition treatments than in the Peer Pressure treatment, but that the difference in social welfare between Group Target and Group Competition is not significant.

Figure 10 exhibits welfare composition by treatments. It indicates that such composition strongly differs between treatments, underlining the trade-offs and policy aspects of the choice of a treatment (see figures D4 in the Appendix, for separate figures on the evolutions of welfare composition overtime for each treatment). Interestingly, Figure 10 shows that while social welfare is shared almost equally in the Baseline and to some extent in the Peer Pressure and

⁴² Our definition of social welfare is a simplified definition of social welfare in line with previous experimental studies (see, for example, Nikiforakis, and Normann, 2008; Güth et al., 2010; Rouaix et al., 2015; Masclet et Villeval, 2008). For instance, in the context of a public good experiment with peer pressure mechanism, Nikiforakis, and Normann, (2008) consider group welfare as the sum of earnings of all group members and investigate the welfare implications of different peer pressure mechanisms.

Group Competition treatments, this share is significantly in favor of the firm in the Group Target treatment.

Figure 10: Composition of Social Welfare



Our main findings concerning the share of social welfare between the firm and workers are summarized as follow:

Result 5: a) *Social welfare (i.e. the sum of the firm’s profit and the workers’ payoffs) is the highest under centralized mechanisms. b) In the Group Target scheme, firms capture the highest share of the social welfare. c) Peer Pressure schemes does not improve significantly social welfare compared to the Baseline treatment.*

5. Discussion and conclusion

We have investigated the effectiveness and efficiency of different mechanisms to deter free-riding in teams by comparing centralized (target-based and team-tournament) and decentralized (peer-pressure) schemes.

First, our results show that, in the absence of incentive mechanisms, effort is subject to free-riding, although not as severely as theoretically-predicted.

Second, consistent with results obtained in public good experiments with punishment, we observe that peer-pressure weakly increases effort compared to the baseline but substantial free

riding remains. Peer pressure does not improve workers' payoffs compared to the baseline. This results from the fact that the gains of cooperation are offset by the social cost of punishment. Third, centralized mechanisms are more effective than a peer pressure scheme to enhance effort. In particular, Group Target-based schemes lead to near to a Pareto optimal level of effort, but at the price of lower and more unequal workers' payoffs. This is mainly due to the fact that several teams fail to reach the target. In sharp contrast, this system leads to a strong increase in the firms' profits.

Fourth, Group Competition enhances effort significantly but fails to improve workers' payoffs and results in large payoff inequality between workers. This is due to the large dispersion of payoffs between the winner team and the loser team.

Fifth, social welfare is maximized under the centralized incentive schemes, and particularly with the Group Target. However, the welfare is not shared equally between workers and the firm as it mainly benefits to the firm.

Altogether these findings shed light on the fact that it is important when considering a remuneration scheme to consider several dimensions including effectiveness, efficiency but also how welfare is shared among workers and firms. Indeed, while two policies may result in similar levels of social welfare, with one emphasizing higher profits and the other prioritizing substantial workers' payoffs, the decision on which policy to implement may necessitate a nuanced political arbitration⁴³.

Our study is of course not without limitations and concerns. A first concern relates to external validity of this study. How far can our results be extended to other populations and real-world contexts beyond the laboratory? Indeed, one may reasonably express skepticism when it comes to extrapolating laboratory results due to the perceived artificiality and lack of realism of laboratory settings (see, e.g., Berkowitz and Donnerstein, 1982; Colquitt, 2008). Furthermore, one may doubt about whether small number of participants, who are mostly students, truly represent broader populations of interest (Levitt and List, 2007a, 2007b).

To address the generalizability of laboratory findings, we need first define what is meant by external validity. In line with Kessler and Vesterlund (2015) and Levitt and List (2007a), we contend here that our study cannot determine the exact magnitude of the effects (quantitative external validity) but can correctly identify the direction of the effects (qualitative external validity)⁴⁴. In other words, the question is not by how much centralized mechanisms outperform

⁴³ We thank here an anonymous reviewer for this helpful comment.

⁴⁴ This was nicely summarized by [Levitt and List \(2007a\)](#) in the following terms: "*it is likely that the qualitative findings of the lab are generalizable, even when the quantitative magnitudes are not.*". The distinction between

the decentralized system but the criterion for evaluating external validity needs to focus on whether the sign of the effect remains consistent across different environments.

Furthermore, this experiment should be seen as a first step that calls for replications to improve its external validity, especially in more realistic contexts. Indeed, one notable advantage of laboratory experiments is their ease of replication (Camerer, 2015). Once an effect withstands these robustness checks in the controlled environment of the laboratory, with identified boundary conditions, researchers can then transition to the field to explore the effect size in the desired real-world setting. Schram (2005, p. 232) discusses this point by using the analogy with tests of new airplane in a wind tunnel: “[a]fter a theoretical design, a test [of a new airplane] in a wind tunnel is the stage of laboratory experimentation. If it does not ‘crash’ in this experiment, the plane is not immediately used for the transport of passengers, however. One will typically conduct further tests in the wind tunnel under extreme circumstances. In addition, further testing including ‘real’ flights without passengers will be conducted.”

Direct developments of the work presented in this chapter consist in addressing the concerns raised by centralized target or competition-based mechanisms, and by decentralized peer pressure mechanism. Centralized mechanisms have shown their effectiveness enhancing effort, but lead to very low or very unequal payoffs for workers. Could this concern be solved by replacing monetary by symbolic incentives in centralized mechanisms? This is the object of chapter 3. The effectiveness of decentralized peer pressure in enhancing effort appears limited, and due to the cost of punishment, peer pressure does not improve workers’ payoffs compared to the baseline. Would efficiency of peer pressure be improved if this pressure was centralized in the hands of a team leader, chosen among team members? This is the object of the chapter 4. Beyond these direct developments, a natural extension may consist in examining whether professionals would exhibit similar behavior in both the lab and their work context. Harrison and List (2004) refers to such experiments as "artefactual field experiments". This would allow us to check whether our findings hold in other environments, and thus to provide more external validity.

Another avenue for future research may consist in running additional treatments in order to disentangle the role played by reputation-building effect from the policy effect⁴⁵. For instance one may compare our treatments under partner and stranger design to isolate the pure role of

quantitative and qualitative findings is strongly related to the question of external validity of experimental findings. Quantitative findings refer to the “size” or “magnitude” of an effect while qualitative findings refer to the “direction” of an effect.

⁴⁵ We thank an anonymous reviewer for this helpful comment.

reputation. One may also enrich our theoretical framework by considering the role played by risk aversion (Holt and Laury, 2002), social preferences (e.g. Fehr and Schmidt, 1999), as well as the role of intentions (Rabin, 1993).

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Appendix:

Appendix A. Theoretical predictions for Group Target and Group Competition treatments

1. Centralized mechanism: Group target

The Group Target treatment is similar to the Baseline except that teams' total revenue $1.5Y_j$ is compared to an exogenous target R_T^* . The worker's payoff function is now given by:

$$\begin{cases} \pi_i = 1.5 (\sum_1^4 e_{ij} + \varepsilon)/4 - e_{ij}^2/100 + \Omega & \text{if } 1.5Y_j \geq R_T^* \\ \pi_i = \max(0, B - e_{ij}^2/100) + \Omega & \text{otherwise} \end{cases} \quad (1)$$

This game has many Nash equilibria including a Nash equilibrium with the lowest effort level $e_{i,j} = 0, \forall i$ which ensures that all workers receive the fixed low revenue B (as the production from teamwork is below the target) plus the additional lump-sum: $B + \Omega > 0$. No worker has any interest in departing from this equilibrium, as it would leave her revenue unchanged (as B and Ω are fixed) but increase her effort cost, therefore reducing her payoff. This equilibrium corresponds to zero effort, below the equilibrium level under the Baseline revenue-sharing mechanism. Interestingly this game has also an equilibrium corresponding to the Pareto solution. This is the case for specific values of parameters B and R_T^* . In our experiment, with $B=7.5$ and $R_T^* = 450$, the Pareto-optimal level of effort $e_{ij} = e^* = 75$ is a Nash equilibrium.

To find these Nash equilibria, following Nalbantian and Schotter, let $P(e_{ij}, \sum_{z \neq i} e_{z,j})$ denote the probability that a team meets the target for a given effort of worker i and of other workers of her team $z \neq i$.⁴⁶ This probability can be expressed as:

$$P(e_{i,j}, \sum_{z \neq i} e_{z,j}) = \frac{e_{i,j} + \sum_{z \neq i} e_{z,j} - 260}{80} \quad (2)$$

and

$$P'(e_{i,j}, \sum_{z \neq i} e_{z,j}) = \frac{1}{80} \quad (3)$$

where $e_{i,j}$ is in the interval $260 - 340$.⁴⁷ Equation (3) is the derivative of equation (2) with respect to $e_{i,j}$. Equation (5) results from the following reasoning:

Let $I(\text{condition})$ be an indicator function that is zero if the condition in the parenthesis is false and one if it is true. The probability for team j to meet the target, for given levels of effort of the four workers of the team, equals the integral of the indicator function of meeting the target over the probability distribution of the random shock of production ε , workers' levels of efforts being fixed:

⁴⁶ As the fixed lump-sum Ω has no influence on workers' decisions under neoclassical hypothesis, it will be omitted in the following developments.

⁴⁷ A Nash equilibrium corresponding to a Pareto level of effort from all workers of the team is necessarily included in the interval $[260, 340]$, as the sum of Pareto efforts is 4 times $75 = 300$ and ε is between -40 and $+40$. P is differentiable everywhere when the sum of workers' efforts is in the interval $[260, 340]$. At the two limits of the interval, the differential should be interpreted as the right-side derivative at 260 and the left-side derivative at 340.

$$P(e_{i,j}, \sum_{z \neq i} e_{z,j}) = \int_{-40}^{+40} I((e_{i,j} + \sum_{z \neq i} e_{z,j} + \varepsilon) > 300) \times \frac{d\varepsilon}{80} \quad (4)$$

When the value of the random shock is between -40 and the target 300 minus the sum of efforts of the workers of the team, then the target is not met and the indicator function equals 0 . When the value of the random shock is between the target 300 minus the sum of efforts of the workers of the team and $+40$, then the target is met and the indicator function equals 1 . This reasoning allows to decompose the above integral into the expressions below:

$$\begin{aligned} P(e_{i,j}, \sum_{z \neq i} e_{z,j}) &= \int_{-40}^{300-(e_{i,j}+\sum_{z \neq i} e_{z,j})} 0 \times \frac{d\varepsilon}{80} + \int_{300-(e_{i,j}+\sum_{z \neq i} e_{z,j})}^{+40} 1 \times \frac{d\varepsilon}{80} \\ &= 0 + \frac{40 - (300 - (e_{i,j} + \sum_{z \neq i} e_{z,j}))}{80} \\ &= \frac{e_i + \sum_{j \neq i} e_j - 260}{80} \end{aligned} \quad (5)$$

This justifies equation (2). Equation (2) allows to write the expression of the payoff $\pi_{i,j}$ of worker i of team j as a function of her effort $e_{i,j}$, the effort of the other workers $\sum_{z \neq i} e_{z,j}$ being considered as fixed. It can be written as the weighted sum of the probability that the target is not met, multiplied by the worker's payoff when her revenue is B , plus the probability that the target is met, multiplied by the expected value of the worker's payoff, conditional on the target output being met. This expected value of worker's payoff itself, depends on the expected value of team's production, conditional on the target output being met, which takes the following expression taken from Equation (8) of Nalbantian and Schotter:

$$E(Y_j | Y_j \geq Y^*) = \frac{(e_{i,j} + \sum_{z \neq i} e_{z,j} + Y^* + 40)}{2} \quad (6)$$

This expression can be derived as follows:

The definition of team output Y_j allows to write:

$$E(Y_j | Y_j \geq Y^*) = E((\varepsilon + e_{i,j} + \sum_{z \neq i} e_{z,j}) | Y_j \geq Y^*) \quad (7)$$

Expectation being a linear operator and expectations of efforts of workers being equal to their values, as there are as fixed, we can write:

$$E(Y_j | Y_j \geq Y^*) = E(\varepsilon | Y_j \geq Y^*) + e_{i,j} + \sum_{z \neq i} e_{z,j} \quad (8)$$

The unconditional law of ε is a uniform random variable the support of which is $[-40, +40]$. Hence, the conditional law of ε , subject to $Y_j \geq Y^*$, is a uniform variable the support of which is $[Y^* - e_{i,j} - \sum_{z \neq i} e_{z,j}, +40]$, and the conditional expectation of which is in the middle of this interval. Therefore:

$$E(\varepsilon | Y_j \geq Y^*) = \frac{40 + Y^* - e_{i,j} - \sum_{z \neq i} e_{z,j}}{2} \quad (9)$$

And

$$E(Y_j | Y_j \geq Y^*) = \frac{40 + Y^* - e_{i,j} - \sum_{z \neq i} e_{z,j}}{2} + e_{i,j} + \sum_{z \neq i} e_{z,j}$$

$$E(Y_j|Y_j \geq Y^*) = \frac{40+Y^*+e_{i,j}+\sum_{z \neq i} e_{z,j}}{2} \quad (10)$$

The expression of the expected payoff $\pi_{i,j}$ of worker i can now be expressed as:

$$\begin{aligned} \pi_{i,j} \left(e_{i,j}, \sum_{z \neq i} e_{z,j} \right) = \\ \left(1 - P(e_{i,j}, \sum_{z \neq i} e_{z,j}) \right) \left(B - \frac{e_{i,j}^2}{100} \right) + P(e_{i,j}, \sum_{z \neq i} e_{z,j}) \left(\left(\frac{1.5}{4} \right) E(Y_j|Y_j > Y^*) - \frac{e_{i,j}^2}{100} \right) \end{aligned} \quad (11)$$

Which can be rewritten as:

$$\begin{aligned} \pi_{i,j}(e_{i,j}, \sum_{z \neq i} e_{z,j}) = \\ \left(1 - P(e_{i,j}, \sum_{z \neq i} e_{z,j}) \right) B + P(e_{i,j}, \sum_{z \neq i} e_{z,j}) \left(\frac{1.5}{4} \right) \left(\frac{40+Y^*+e_{i,j}+\sum_{z \neq i} e_{z,j}}{2} \right) - \frac{e_{i,j}^2}{100} \end{aligned} \quad (12)$$

We can rearrange the right side of this equation as in N&S:

$$\begin{aligned} \pi_{i,j}(e_{i,j}, \sum_{z \neq i} e_{z,j}) = \\ B + P(e_{i,j}, \sum_{z \neq i} e_{z,j}) \left[\frac{\left(\frac{1.5}{4} \right) (40+Y^*+e_{i,j}+\sum_{z \neq i} e_{z,j})}{2} - B \right] - \frac{e_{i,j}^2}{100} \end{aligned} \quad (13)$$

The first order condition of Nash equilibrium is met when the derivative $\pi_{i,j}$ with respect to $e_{i,j}$ equals 0. This derivative of $\pi_{i,j}$ can be derived from the above equation, allowing to write the following first-order condition:

$$\frac{\partial \pi_{i,j}}{\partial e_{i,j}} = -P'(\cdot)B + P'(\cdot) \left[\frac{1.5}{4} \frac{(40+Y^*+e_{i,j}+\sum_{z \neq i} e_{z,j})}{2} \right] + P(\cdot) \left(\frac{1.5}{4 \times 2} \right) - \frac{2e_{i,j}}{100} = 0 \quad (14)$$

We use Equation (14) above to assess if, and under which conditions regarding B , the Pareto-optimal level of effort $e_{i,j} = e^* = 75$ can be a Nash equilibrium. Formally, this is equivalent to finding the value of B for which the above equation holds if $e_{i,j} = e^* = 75 \forall i$.

If the first-order conditions are satisfied for $e_{i,j} = e^* = 75 \forall i$ in Equation (14), taking $P(\cdot)$ and $P'(\cdot)$ from Equations (2) and (3) and replacing Y^* and $e_{i,j}$ by their numerical values, we find:

$$-\frac{B}{80} + \frac{1}{80} \left[\frac{1.5}{4} \frac{(40+300+4 \times 75)}{2} \right] + \frac{4 \times 75 - 260}{80} \times 0,1875 - \frac{2 \times 75}{100} = 0 \quad (15)$$

Which leads to:

$$B = 7.5 \quad (16)$$

Thus, in our experiment, the Pareto superior equilibrium $e_{i,j} = e^* = 75$ is a Nash equilibrium for a value of B set to 7.5.

2. Centralized mechanism: Team tournament (or Group Competition)

In the Group-Competition treatment, the target to reach is endogenously set. Precisely, each team competes with the other team in the same firm and the team with the highest production receives a transfer of TR from the other team. Let $R_{T1} = 1.5Y_1$ and $R_{T2} = 1.5Y_2$. The payoff of the members of team G_1 is then:

$$\begin{aligned} \pi_{i,1}(Y_1, Y_2, e_{i,1}) &= \frac{R_{T1}+TR}{4} - \frac{e_{i,1}^2}{100} + \Omega && \text{if } Y_1 > Y_2 \\ \pi_{i,1}(Y_1, Y_2, e_{i,1}) &= \max\left(\frac{R_{T1}-TR}{4} - \frac{e_{i,1}^2}{100}, 0\right) + \Omega && \text{if } Y_1 < Y_2 \end{aligned} \quad (17)$$

In case of equal production there is no transfer.

It can be shown that for some specific values of transfer, namely for $TR=180$, the Pareto-optimal level of effort for workers, $e^* = 75$, is a Nash equilibrium of this game.

To demonstrate this, let's assume that all team members of each team choose an effort level of $e^* = 75$ and let's check that there is no incentive for any worker to deviate from this Nash equilibrium. Given these choices, the expected revenue for each team is 450 and the probability of each team winning the transfer is 0.5.

Now consider one worker i deviates by a marginal change in her effort level. By increasing her effort marginally, this will increase the probability of winning the tournament by $\partial Pr(.)/\partial e_{i,j}$ where $Pr(.)$ is the probability that the team to which worker i belongs wins the tournament.

The benefit of winning the tournament is $[(2 \cdot TR)/4] + (\partial R_{Tj}/\partial e_{i,j})/4$. The first term corresponds to the difference between winning the transfer and losing it, $2TR$; the second term is worker i 's share in the marginal revenue generated for the team. The marginal cost of changing one's effort is $2e_{i,j}/100$.

Consequently, worker i will not deviate from the Nash equilibrium if the following condition is satisfied:

$$\partial Pr(.)/\partial e_{i,j} \cdot [(2 \cdot TR)/4] + (\partial R_{Tj}/\partial e_{i,j})/4 = 2e_{i,j}/100 \quad (18)$$

It is clear that $(\partial R_{Tj}/\partial e_{i,j}) = 1.5$. Therefore, to find the value of TR for which this equation holds, we have to estimate $\partial Pr(.)/\partial e_{i,j}$ at $e_{i,j} = e^*$, $\forall i$, knowing that at this point $Pr(.) = 0.5$, as the game is symmetric.

To find $\partial Pr(.)/\partial e_{i,j}$ at $e_{i,j} = e^*$, $\forall i$, we need to estimate the value of the probability of team G_1 winning when worker i infinitesimally increases her effort by $de_{i,j}$, which we denote by $Pr(. + de_{i,j})$. This can be calculated as follows⁴⁸:

$$Pr(. + de_{i,j}) = \int_{-40}^{+40-de_{i,j}} \frac{1}{80} \left(\int_{-40}^{x+de_{i,j}} \frac{1}{80} dy \right) dx + \int_{+40-de_{i,j}}^{+40} \frac{1}{80} dx \quad (19)$$

The first term corresponds to the situation where team G_2 has a probability of winning because the output of team G_1 is below $4 \times e_{i,j}^* + 40$. The second term corresponds to the situation where team G_1 is sure to win because the output of team G_1 is above $4 \times e_{i,j}^* + 40$ and cannot be matched by team G_2 . The expression can be written as follows:

$$\begin{aligned} Pr(. + de_{i,j}) &= \frac{1}{80^2} \int_{-40}^{+40-de_{i,j}} \left(\int_{-40}^{x+de_{i,j}} dy \right) dx + \frac{1}{80} de_{i,j} \\ Pr(. + de_{i,j}) &= \frac{1}{80^2} \int_{-40}^{+40-de_{i,j}} (x + de_{i,j} + 40) dx + \frac{1}{80} de_{i,j} \\ Pr(. + de_{i,j}) &= \frac{1}{80^2} \left[\frac{x^2}{2} + x(de_{i,j} + 40) \right]_{-40}^{+40-de_{i,j}} + \frac{1}{80} de_{i,j} \\ Pr(. + de_{i,j}) &= \\ \frac{1}{80^2} &\left[\left(\frac{(40-de_{i,j})^2}{2} + ((40 - de_{i,j})(de_{i,j} + 40)) \right) - \left(\frac{40^2}{2} + 40 \cdot 40 \right) \right] + \frac{1}{80} de_{i,j} \end{aligned} \quad (20)$$

As we are carrying out a first-order calculation, the second-order terms in $de_{i,j}^2$ can be ignored.

The equation therefore becomes:

$$Pr(. + de_{i,j}) = \frac{1}{80^2} \left[\left(\frac{40^2 - 2 \cdot 40 \cdot de_{i,j}}{2} + 40^2 \right) - \left(\frac{40^2}{2} - 40de_{i,j} - 40^2 \right) \right] + \frac{1}{80} de_{i,j} \quad (21)$$

Which can be written as

$$Pr(. + de_{i,j}) = \frac{1}{80^2} [2 \cdot 40^2] + \frac{1}{80} de_{i,j} = 0.5 + \frac{de_{i,j}}{80} \quad (22)$$

Now we can calculate:

$$(\partial Pr(.)/\partial e_{i,j}) de_{i,j} = Pr(. + de_{i,j}) - Pr(.) = 0.5 + \frac{de_{i,j}}{80} - 0.5 = \frac{de_{i,j}}{80} \quad (23)$$

Therefore:

$$(\partial Pr(.)/\partial e_{i,j}) = \frac{1}{80} \quad (24)$$

Substituting this figure into Equation (18) yields the value of TR for which $e^* = 75$ is a Nash equilibrium:

⁴⁸In equation (19), the differential dy is used to integrate on the uniform distribution of the random shock concerning the production of Group G_2 , dx is used to integrate on the uniform distribution of the random shock concerning the production of Group G_1 .

$$TR = 180$$

In our experiments, the value of TR in this treatment is set to 180 to ensure that $e^* = 75$ is a Nash equilibrium.

Once the value of TR is set to 180, the first order conditions given in equation (18) for symmetric equilibrium can be rewritten:

$$\frac{1}{80} \cdot [(360)/4] + 1.5/4 = 2e_{i,j}/100$$

which has a unique solution. Hence, for $TR = 180$, the game has a unique symmetric solution.

1.5

Appendix B. Instructions for participants in the experiment (translated from French)

[instructions for Baseline Revenue Sharing treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

$$1 \text{ Euro} = 45 \text{ tokens}$$

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

At the beginning of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.

Periode 1 sur 10

Temps restant [sec]: 7

Choisissez votre effort entre 0 et 100

OK

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the sum and average of the efforts of the other players in your group

After all members of your group have made their effort decision your screen will show you the sum of group effort and average of the efforts chosen by the other three players in your group. The screen below shows an example where the sum of the efforts chosen by the other 3 players in your group is 140, corresponding to an average effort of $140 / 3 = 46.67$ from the other 3 players in your group.

Periode 1 sur 10

Temps restant [sec]: 8

Somme des efforts choisis par les 3 autres membres de votre groupe	140
Moyenne des efforts choisis par les 3 autres joueurs de votre groupe	46.67

Continuer

Click "Continue" to move on.

Calculation of your payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of effort**. **We will call the resulting number the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

Each group member will receive one quarter of total group revenue. This is your **individual revenue**.

For example, if you choose an effort of 60 and the sum of the efforts of the other players in your group is 140, then the **Sum of group efforts** is $(60 + 140 = 200)$. If the random shock is $(- 40)$, the total group production is $(200 - 40) = 160$, the total group revenue is $(1.5 \times 160) = 240$ and your individual revenue, as well as that of the 3 other players in the group is $(240 / 4 = 60)$. In other word each group member receives an equal share of total group revenue, i.e., one quarter of 240.

Your individual revenue in each period is therefore: $[1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40) / 4]$

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

Your payoff for each period = Individual Revenue-Cost of effort+10 tokens

$$= (1.5 * (\text{Sum of group efforts} + \text{Random shock between } -40 \text{ and } +40) / 4) - \text{cost of effort} + 10$$

Please note that if the costs of effort exceed your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the previous example where you choose an effort of 60 and your individual revenue is also 60, your cost of effort is 36 according to Table A, and the difference is $(60 - 36) = 24$ tokens. By adding 10 additional tokens, your gain for the period is 34 tokens.

Your payoff for the period is calculated by the computer and displayed on the screen:

Résultats pour la période	
Effort que vous avez choisi	60
Somme des efforts du groupe	200
Choc aléatoire (entre -40 et +40)	-40.0
Production totale du groupe	160
Revenu total du groupe	240.00
Votre revenu de production	60.00
Votre coût de production	36.00
Votre gain de production	24.00
Votre dotation additionnelle	10
Votre gain pour la période	34.00

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

[instructions for the Peer Pressure treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

$$1 \text{ Euro} = 45 \text{ tokens}$$

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

Each period consists of two stages. These instructions present the sequence of the first stage, then that of the second.

First stage

At the beginning of the first stage of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.

Periode 1 sur 10 Temps restant [sec]: 7

Choisissez votre effort entre 0 et 100

OK

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the efforts of other players

The next screen displays the efforts chosen by the other players in your group in a random order that changes each period. The screen below shows an example where these 3 other players have chosen efforts of 20, 40 and 80:

Periode 1 sur 10 Temps restant [sec]: 0

Les efforts des autres joueurs de votre groupe cités dans un ordre aléatoire différent à chaque période :

Un des autres joueurs de votre groupe a choisi un effort de	20
Un des autres joueurs de votre groupe a choisi un effort de	40
Un des autres joueurs de votre groupe a choisi un effort de	80

Continuer

Click "Continue" to move on.

Calculation of your first stage payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of effort**. We will call the resulting number **the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

Each group member will receive one quarter of total group revenue. This is your **individual revenue**.

For example, if you choose an effort of 60 and the sum of the efforts of the other players in your group is 140, then the **Sum of group efforts** is $(60 + 140 = 200)$. If the random shock is $(- 40)$, the total group production is $(200 - 40) = 160$, the total group revenue is $(1.5 \times 160) = 240$ and your individual revenue, as well as that of the 3 other players in the group is $(240 / 4 = 60)$. In other word each group member receives an equal share of total group revenue, i.e., one quarter of 240.

Your individual revenue at first stage each period is therefore:
[$1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40) / 4$]

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your first-stage payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

Your first stage payoff for each period = Individual Revenue-Cost of effort+10 tokens

$$= (1.5 * (\text{Sum of group efforts} + \text{Random shock between } -40 \text{ and } +40) / 4) - \text{cost of effort} + 10$$

Please note that if the costs of effort exceed your individual revenue, the difference is set to zero by the computer. Therefore, your first stage payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the previous example where you choose an effort of 60 and your individual revenue is also 60, your cost of effort is 36 according to Table A, and the difference is $(60 - 36) = 24$ tokens. By adding 10 additional tokens, your first stage payoff for the period is 34 tokens.

Your first stage payoff for the period is calculated by the computer and displayed on the screen:

Résultats pour la période	
Effort que vous avez choisi	60
Somme des efforts du groupe	200
Choc aléatoire (entre -40 et +40)	-40.0
Production totale du groupe	160
Revenu total du groupe	240.00
Votre revenu de production	60.00
Votre coût de production	36.00
Votre gain de production	24.00
Votre dotation additionnelle	10
Votre gain pour la période	34.00

Click "Continue" to move on.

Second stage

In this second stage, you, like the other players in the group, can use all or part of your 10 additional tokens to reduce the gains of the other three players in your group by distributing them disapproval points.

A screen appears where you need to enter the disapproval points you distribute to other players in your group, as in the example below:

Periode 1 sur 10 Temps restant [sec]: 6

Le total des points que vous attribuez aux 3 autres joueurs de votre groupe doit être inférieur ou égal à 10

Points que vous attribuez au joueur qui a choisi l'effort 20

Points que vous attribuez au joueur qui a choisi l'effort 40

Points que vous attribuez au joueur qui a choisi l'effort 80

OK

The order in which the efforts of other players are displayed is random and varies from period to period. It is therefore on the sole basis of the efforts chosen during the first stage of this period that you decide on the points that you distribute to them. The total number of points distributed to the other three players must be less than or equal to 10. Validate your choice by clicking on “OK”.

Payoffs at the end of the second stage

Each point you distribute to a particular player lowers his or her first stage payoff by 3 tokens. So, if you distribute 0 points to a player, you do not change his gain, if you distribute 1 point, you reduce his first stage payoff by 3 tokens, if you distribute 2 points you reduce his first stage payoff by 6 tokens and so on.

Distributing points to other players costs you in tokens the total of the points you distribute. This total cannot exceed 10 tokens. For example, awarding 2 points to each of the other 3 players costs you 6 tokens. You could not award 5 points to each of the other 3 players because that would be 15 points, above the maximum of 10.

Your first stage payoff is also reduced by three times the total number of disapproval points that you receive from other players. If you receive 0 points, your first stage payoff is unchanged, if

you receive 1 point, it reduces your first stage payoff by 3 tokens, if you receive 2 points, it reduces it by 6 tokens, etc.

For example, if your first stage payoff is 34 tokens, and if during the second stage you distribute 2 points to each of the 3 other players, and if you receive 3 points in total from the other players, your final payoff for this period will be $(34 - 3 \times 2 - 3 \times 3) = 19$ tokens.

More generally, your final payoff for the period is calculated as follows:

Final payoff for each period =

First stage payoff - Total number of points distributed - 3 * Total number of points received

Note that the points you receive can cancel your payoff but not make it negative. If your number of points received exceeds one third of your initial gain minus the number of points you distribute, then your gain for the period will be considered to be zero.

Calculation of final payoff

The calculation of your final payoff is made by the computer and displayed on the screen:

Periode		Temps restant [sec]:
1 sur 10		4
Résultats pour la période après la seconde étape		
Gain à l'issue de la première étape		34.00
Total des points attribués aux autres joueurs du groupe		6
Coût des points attribués aux autres joueurs		6
Nombre de points que vous avez reçus des autres joueurs du groupe		3
Réduction des gains du fait des points reçus		9
Gain théorique une fois déduits le coût des points attribués et la réduction liée aux points reçus		19.00
Gain à l'issue de la période, sachant que le gain ne peut pas être négatif		19.00
<input type="button" value="Continuer"/>		

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

[Instructions for the Group Target treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

At the beginning of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.



The screenshot shows a software interface for an experiment. At the top left, it says "Periode" and "1 sur 10". At the top right, it says "Temps restant [sec]: 7". In the center, there is a prompt: "Choisissez votre effort entre 0 et 100" followed by a blue rectangular input field. At the bottom right, there is a red button labeled "OK".

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the efforts of other players

The next screen displays the efforts chosen by the other players in your group in a random order that changes each period. The screen below shows an example where these 3 other players have chosen efforts of 20, 40 and 80:

The screenshot shows a game window with a title bar containing "Periode" and "1 sur 10" on the left, and "Temps restant [sec]: 0" on the right. The main content area displays the following text:

Les efforts des autres joueurs de votre groupe cités dans un ordre aléatoire différent à chaque période :

Un des autres joueurs de votre groupe a choisi un effort de	20
Un des autres joueurs de votre groupe a choisi un effort de	40
Un des autres joueurs de votre groupe a choisi un effort de	80

A "Continuer" button is located in the bottom right corner of the window.

Click "Continue" to move on.

Calculation of your payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of group effort**. **We will call the resulting number the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

The total group revenue is compared to a certain threshold. Precisely, if your total group revenue is greater than or equal to a threshold set at 450 tokens, then each group member of your group will receive one quarter of total group revenue. This is your **individual revenue**.

Otherwise, if **your total group revenue is lower than the threshold set at 450 tokens** your individual revenue equals a fixed minimum amount of 7.5 tokens.

For example, if you choose an effort of 60 and the other players in your group 20, 40 and 80, the **Sum of group efforts** is $(60 + 20 + 40 + 80 = 200)$. If the random shock is (-40) , the **total group production** is $(200 - 40) = 160$ and the **total group revenue** is $(1.5 \times 160) = 240$. The

total group revenue being lower than the threshold of 450, your **individual revenue**, as well as that of the other 3 players in the group, is 7.5 tokens.

If you still choose an effort of 60 but the other players in your group, choose 40, 80 and 100, respectively, the **Sum of group efforts** is $(60 + 40 + 80 + 100 = 280)$. If the random shock this time is $(+ 40)$, the total group production is $(280 + 40) = 320$ and the total group revenue is $(1.5 \times 320) = 480$. The total group revenue being greater than the threshold of 450, your individual revenue, as well as that of the 3 other players in the group, is $(480/4) = 120$ tokens.

Your individual revenue is thus calculated as follow:

Your individual revenue in each period is therefore:

$[1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40) / 4]$ If the group's total revenue is greater than or equal to 450

7.5 otherwise

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

Payoff for the period

= Individual Revenue – Cost of effort + 10

=

If the group's total income is greater than or equal to 450, then

**[(1.5*(Sum of group efforts + Random shock between -40 and +40)/4)
- Cost of effort] + 10**

If the total group income is less than 450, then

[7.5 - Cost of effort] + 10

Please note that if the costs of effort exceed your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the first example above where you choose an effort of 60 and your group's total income is 240, below the threshold of 450 your individual revenue is set to 7.5. Your cost of effort, equal to 36 according to Table A, exceeds your individual revenue of 7.5. As a result, the computer sets the difference to 0. By adding 10 additional tokens, your payoff for the period is 10 tokens.

In the second example above where you still choose an effort of 60 but the total income of your group is equal to 480, above the threshold of 450, your individual revenue is worth a quarter of the income of the group or 120. Your cost of effort is equal to 36 according to Table A. Therefore, the difference is $120 - 36 = 84$. By adding 10 additional tokens, your payoff for the period is 94 tokens.

Your payoff for the period is calculated by the computer and displayed on the screen:

Période		Temps restant [sec]:
1 sur 10		4
Résultats pour la période		
Effort que vous avez choisi	60	
Somme des efforts du groupe	200	
Choc aléatoire (entre -40 et +40)	-40.0	
Production totale du groupe	160	
Revenu total du groupe	240.00	
L'objectif de revenu groupe de 450 jetons n'est pas atteint. Vous touchez le revenu minimal de 7,5 jetons.		
Votre revenu de production	7.50	
Votre coût de production	36.00	
Votre gain de production	0.00	
Votre dotation additionnelle	10	
Votre gain pour la période	10.00	
<input type="button" value="Continuer"/>		

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

[Instructions for Group Competition treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

At each period, the results of your group are compared to those of a competing group that remains the same throughout the experiment. The winning group of this comparison receives 180 tokens from the defeated group.

At the beginning of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the efforts of other players

The next screen displays the efforts chosen by the other players in your group in a random order that changes each period. The screen below shows an example where these 3 other players have chosen efforts of 20, 40 and 80.

Click "Continue" to move on.

Calculation of your payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of group effort**. We will call the resulting number the **sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

The total group revenue of each group is compared to that of another group within the session. If your total group revenue is greater than that of the other group, then 180 tokens are added to your Total group revenue. In the opposite if your total group revenue is lower than that of the other group, then your total group revenue is reduced by 180 tokens that are given to the winning group.

In case of a tie, no transfer takes place.

Each group member will receive one quarter of total group revenue (after transfer). This is your **individual revenue**.

For example, if you choose an effort of 60 and the other players in your group 20, 40 and 80, the **Sum of group efforts** is $(60 + 20 + 40 + 80 = 200)$. If the random shock is $(- 40)$, the **total group production** is $(200 - 40) = 160$ and the **total group revenue** is $(1.5 \times 160) = 240$.

If, in this example, the other group has a total group revenue greater than 240, therefore greater than yours, your group transfers 180 tokens to the other group, which are deducted from your total group revenue: there are therefore only $240 - 180 = 60$ tokens left to distribute among the 4 players in your group. Hence each group member receives his individual revenue of $(60/4) = 15$ tokens.

In the opposite case, if, in this example, the other group has a total income lower than 240, therefore lower than yours, it transfers to your group 180 tokens which are added to the total group revenue of your group: there are therefore $240 + 180 = 420$ tokens to be divided between the 4 players in your group. Hence each group member receives his individual revenue of $(420/4) = 105$ tokens.

Your individual revenue is thus calculated as follow:

Your individual revenue in each period is therefore:

$[1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40 + 180) / 4]$ If your total group revenue is higher than that of the other group

$[1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40 - 180) / 4]$ If your total group revenue is lower than that of the other group

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A : effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e. at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

Payoff for the period

= **Individual revenue – Cost of Effort + 10**

= $[(1.5 * (\text{sum of group efforts} + \text{random production shock between } -40 \text{ and } +40) + 180) / 4]$
- **Cost of Effort**) + 10 *if your group's total income is higher than that of the competing group*

= $[(1.5 * (\text{sum of group efforts} + \text{random production shock between } -40 \text{ and } +40) - 180) / 4]$
- **Cost of Effort**) + 10] *if your group's total income is less than that of the competing group*

Please note that if the costs of effort exceed your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the first example above, where you choose an effort of 60 and your group's total income by 240 is less than that of the competing group, your individual revenue is reduced to $(240 - 180) / 4 = 60 / 4 = 15$ tokens due to the transfer of 180 tokens to the competing group. Your cost of effort resulting from your effort of 60 is worth 36 according to Table A. Since your individual revenue of 15 is less than your cost of effort of 36, the difference is set to 0. With 10 additional tokens, your payoff for the period is 10 tokens.

In the second example above, where you choose an effort of 60 and your group's total income by 240 is greater than that of the competing group, your individual revenue is increased to $(240 + 180) / 4 = 420 / 4 = 105$ tokens thanks to the transfer of 180 tokens from the competing group. Your cost of effort resulting from your effort of 60 is worth 36 according to Table A: the

difference is equal to the difference between 105 and 36 equals 69. With 10 additional tokens, your payoff for the period is 79 tokens.

Your payoff for the period is calculated by the computer and displayed on the screen:

Periode		1 sur 10		Temps restant [sec]: 11	
Résultats pour la période					
Effort que vous avez choisi		60			
Somme des efforts du groupe		200			
Choc aléatoire (entre -40 et +40)		-40.0			
Production totale du groupe		160			
Revenu total du groupe		240.00			
Revenu total du groupe concurrent		270.00			
Le revenu total de votre groupe est			inférieur à celui de votre concurrent.		
			Votre groupe lui transfère 180 jetons.		
Revenu total de votre groupe après transfert		60.00			
Votre revenu de production		15.00			
Votre coût de production		36.00			
Votre gain de production		0.00			
Votre dotation additionnelle		10			
Votre gain pour la période		10.00			

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

Appendix C. Post Experiment questionnaire

[for all treatments – Translated from French]

Questions regarding socio demographics

How old are you?

What is your gender? *Male/Female*

Is French your native language? *Yes/No*

Are you a foreign student? *Yes/No/I am not a student/I prefer not to answer*

What is your academic level?

Bachelor1/Bachelor2/Bachelor3/Master1/Master2/>Master/Others

What is your current major?

*Economics/Social and Economic Administration/Law/Business/Politics/Literature/Chemistry/
Physics/Medicine/Others*

What is your University or your School?

University/Business School/Engineering School/Other

To how many experimental paid sessions have you participated before this session

Never/Once/More than once

Questions concerning the game (open questions)

Did you find the rules of the game clear?

What was your strategy in the game?

In your opinion, what was the objective of the experience?

Appendix D. Supplementary statistical material

Supplementary statistical material concerns on the following points:

- D1. Significance of demographic differences between participants to different treatments
- D2. Evolution of effort dispersion within teams in the Group Target treatment.
- D3. Significance of firms' profits and social welfare differences between treatments
- D4. Evolution of the composition of social welfare overtime per treatment

D1. Significance of demographic differences between participants to different treatments

Table D1. Results of tests on socio-demographics differences between treatments.

	Gender*	Participation*	Economics*	Age [‡]
Baseline vs Pee Pressure	0.371	1.000	0.666	0.5905
Baseline vs Group Target	0.770	0.048	0.416	0.8892
Baseline vs Group Competition	0.803	0.007	0.196	0.8978
Peer Pressure vs Group Target	0.760	0.137	1.000	0.4223
Peer Pressure vs Group Competition	0.439	0.023	0.759	0.3103
Group Target vs Group Competition	0.803	0.794	1.000	0.9416

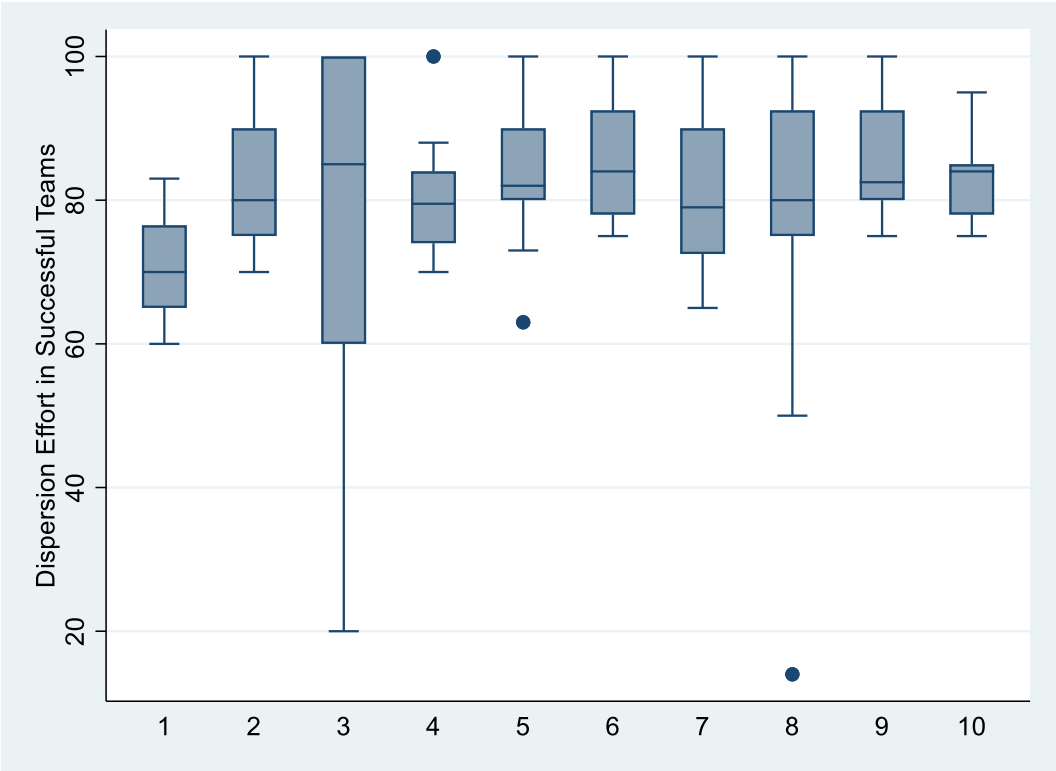
Note: *Fisher exact test; chi-squared tests provide similar qualitative findings. [‡]:t-test

D2. Evolution of effort dispersion within teams in the Group Target treatment

The analysis of the dispersion of effort and its evolution overtime is done graphically, using box plots. It is done separately for teams successfully reaching the target, and for teams which are unsuccessful in reaching the target. Note that teams succeeding or failing to reach the target may change across periods.

Figure D2.1. exhibits the evolution of the dispersion of efforts among all workers in successful teams.

Figure D2.1. Evolution of dispersion of efforts, in successful teams



Note1.: Box-plots indicate quartiles. The line in the middle of each box corresponds to the median. The lower limit of each box corresponds to the first quartile and the upper limit to the third quartile. The lower whisker equals the max between the min of the distribution and the first quartile minus 1.5 times the difference between the third and the first quartiles. The higher whisker equals the min between the max of the distribution and the third quartile plus 1.5 times the difference between the third and the first quartiles. Dots correspond to outliers, either below the lower whisker, or above the higher whisker.

Figure D2.1 does not exhibit any clear trend of reduction of effort dispersion among workers of successful teams.

Figure D2.2. analyzes more in detail the evolution of the dispersion of efforts among workers by successful teams.

Figure D2.2. Evolution of dispersion of efforts, by successful teams

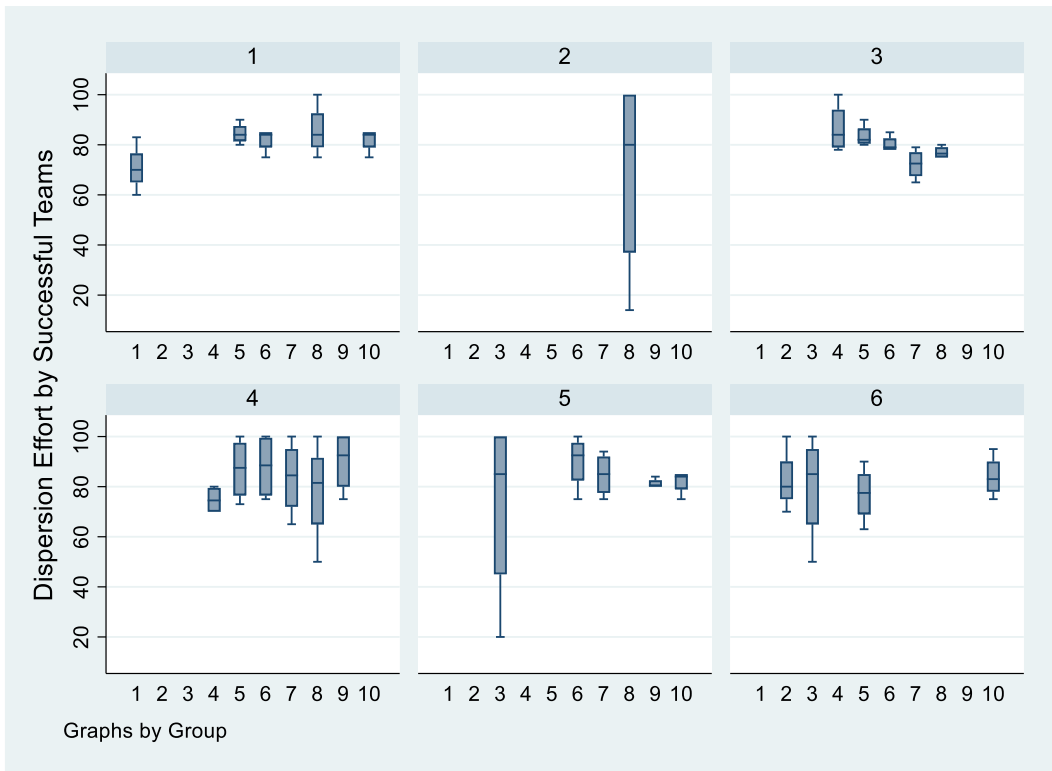
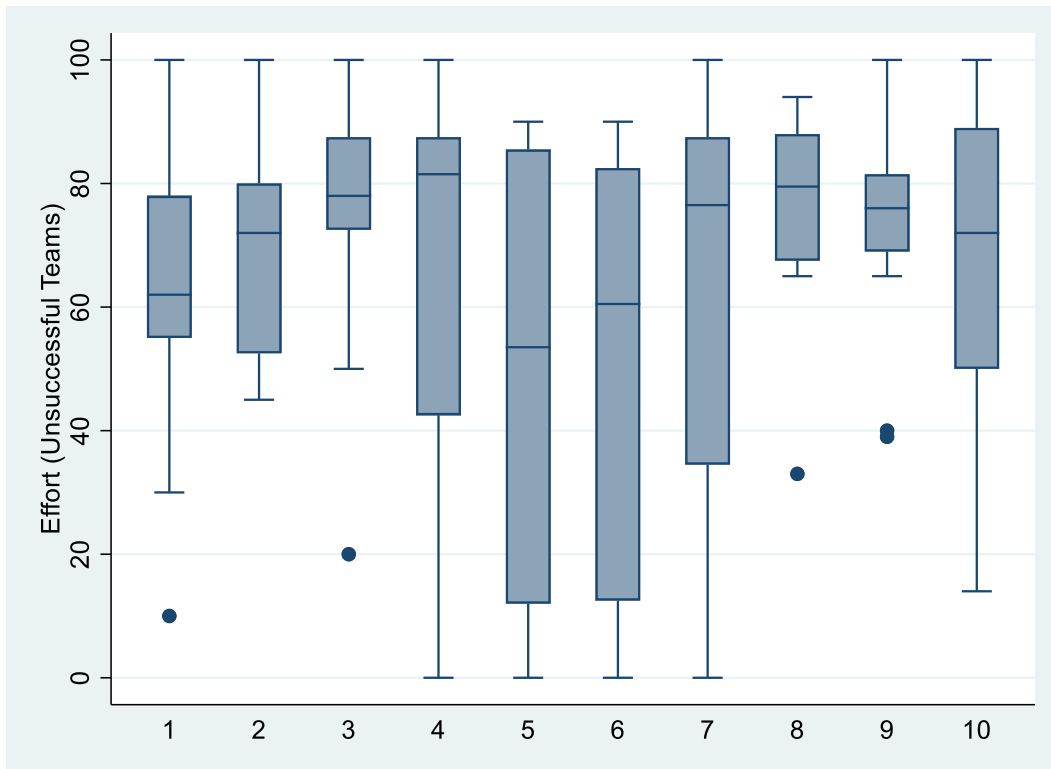


Figure D2.2. does not either exhibit any clear trend of reduction of effort dispersion among workers in successful teams.

D2.2. Unsuccessful teams, not reaching the target

Figure D2.3. exhibits the evolution of the dispersion of efforts among workers of unsuccessful teams.

Figure D2.3. Evolution of dispersion of efforts, in unsuccessful teams



Note: Box-plots indicate quartiles. The line in the middle of each box corresponds to the median. The lower limit of each box corresponds to the first quartile and the upper limit to the third quartile. The lower whisker equals the max between the min of the distribution and the first quartile minus 1.5 times the difference between the third and the first quartiles. The higher whisker equals the min between the max of the distribution and the third quartile plus 1.5 times the difference between the third and the first quartiles. Dots correspond to outliers, either below the lower whisker, or above the higher whisker.

Figure D2.3 indicate that the level of dispersion of effort is high in unsuccessful teams. It is higher than in successful teams. Note that unsuccessful teams may miss the target despite high general efforts of their members, because of a negative random production shock. The figure does not exhibit general signs of discouragement of workers, neither reduction of dispersion of efforts.

Figure D2.4. analyzes more in detail the evolution of the dispersion of efforts among workers by unsuccessful teams.

Figure D2.4. Evolution of dispersion of effort by unsuccessful teams

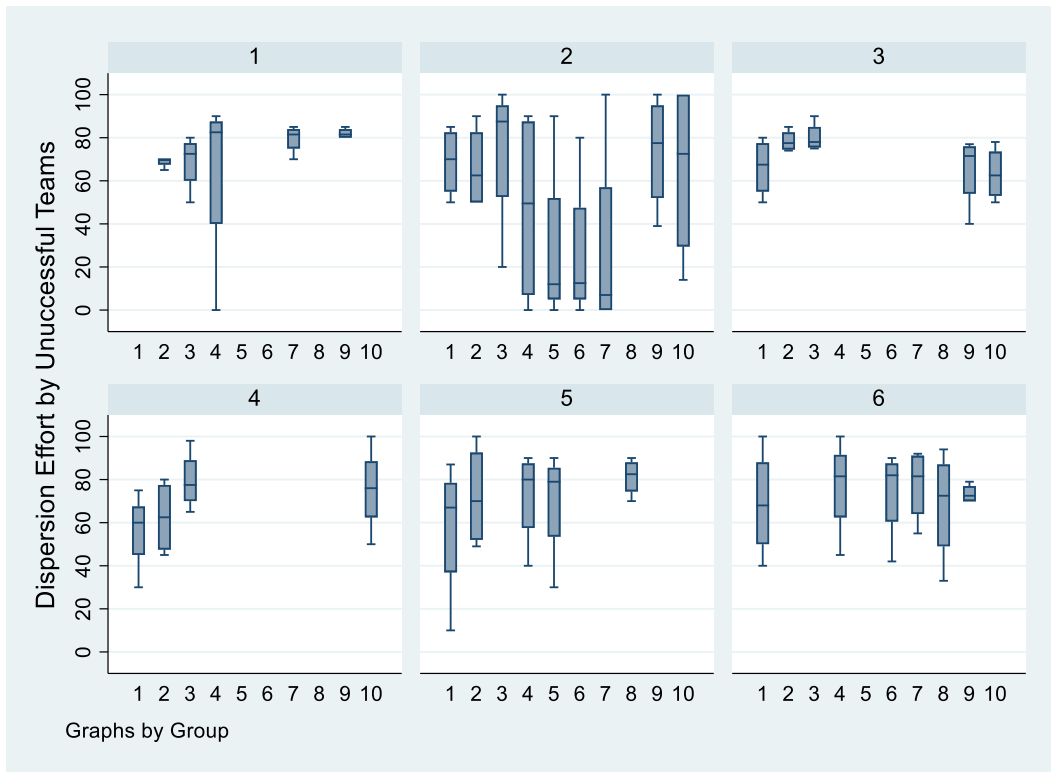


Figure D2.4. do not exhibit signs of discouragement of workers, neither any trend of reduction of dispersion of efforts, in unsuccessful teams.

D3. Significance of firms' profits and social welfare (sum of firm's profit and workers' payoffs) differences between treatments

Table D3. Significance of coefficient differences between treatments

	Peer Pressure vs. Group Target	Peer Pressure vs. Group Competition	Group Target vs. Group Competition
Firms' Profit	0.0000	0.2423	0.0000
Social Welfare	0.0004	0.0075	0.1669

Note: Test on equality of regression coefficients

D4. Evolution of the composition of social welfare overtime per treatment

Figure D4.1: Evolution of the composition of social welfare in the Baseline treatment

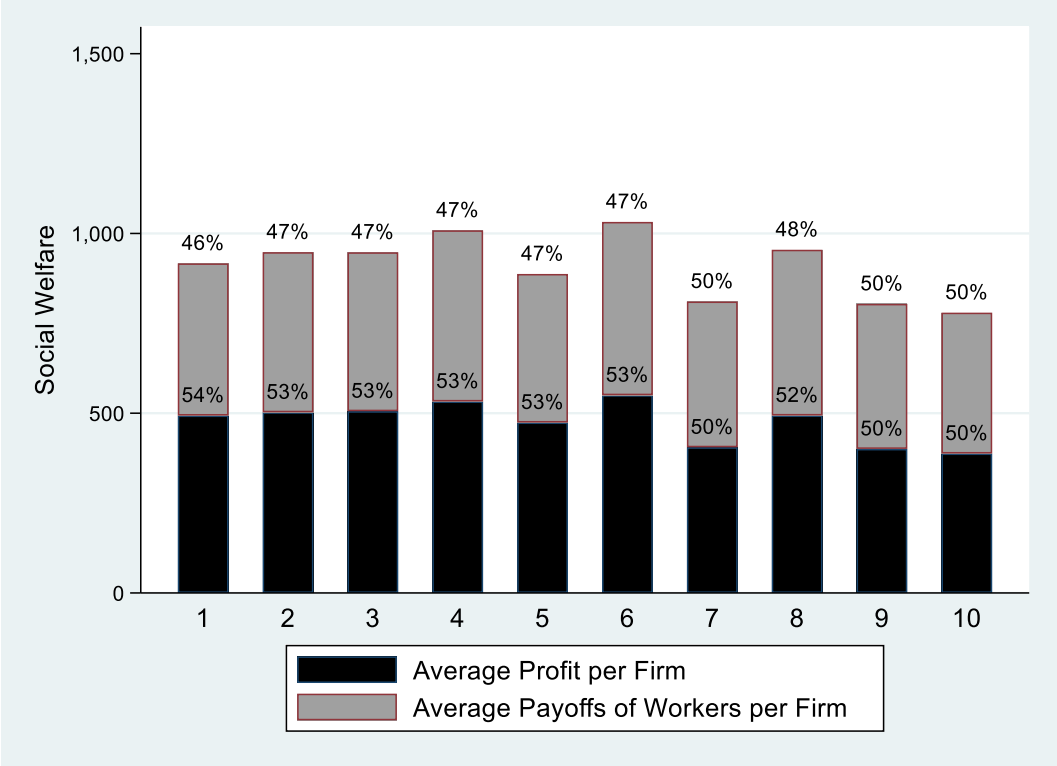


Figure D4.2: Evolution of the composition of social welfare in the Peer Pressure treatment

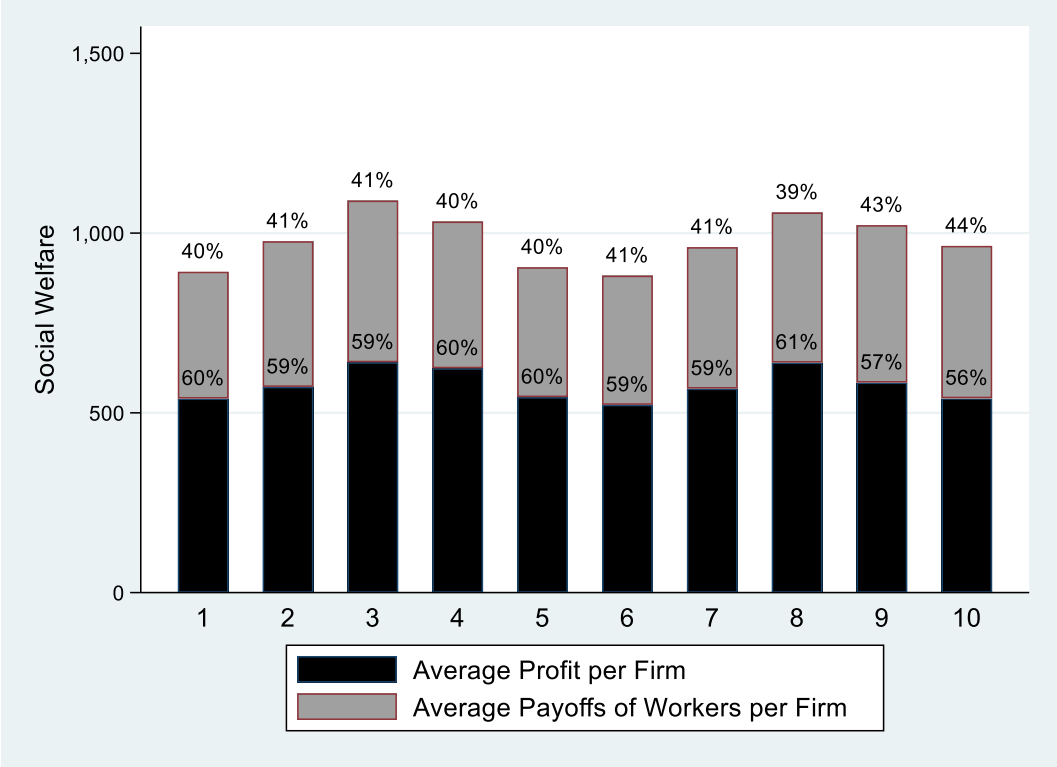


Figure D4.3: Evolution of the composition of social welfare in the Group Target treatment

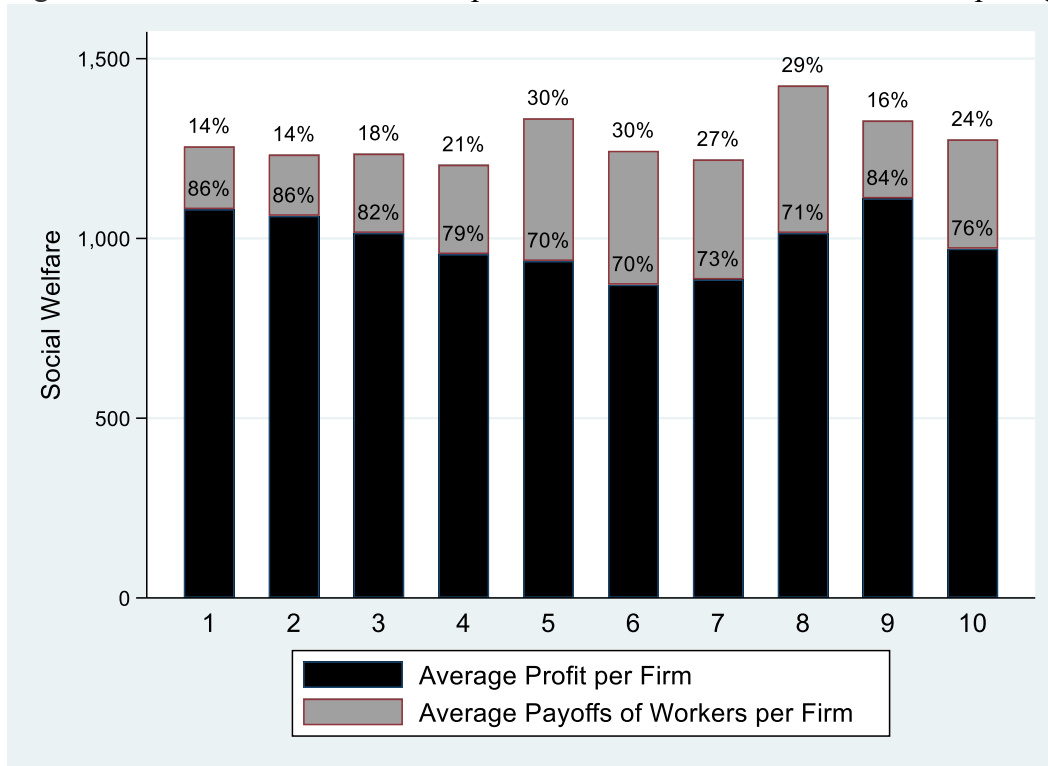
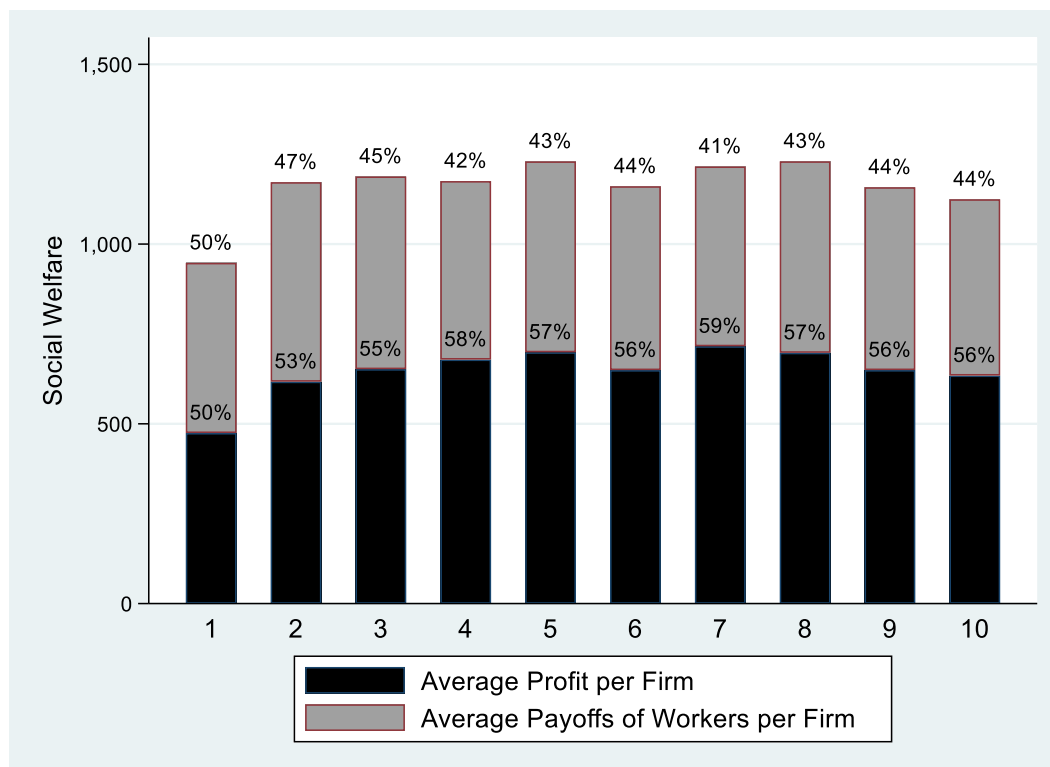


Figure D4.4: Evolution of the composition of social welfare in the Group Competition treatment



Chapter 3

Monetary vs. Symbolic Incentives at Team level:

Experimental Evidence

1. Introduction

When the workforce is organized in teams, introducing centralized incentive mechanisms such as team target or competition between teams, with monetary impacts on workers' payoffs, can be very effective in preventing free-riding and fostering effort. This was theoretically predicted by Holmstrom (1982) and it has been experimentally shown by Nalbantian and Schotter (1997) as well as in chapter 2 of this thesis. However, our findings in chapter 2 indicate that centralized monetary team incentives also lead to very low or very unequal payoffs for workers, which questions the sustainability of such centralized mechanisms. Indeed, when incentives are based on a team target, workers' payoffs are relatively low because most teams fail to reach the target. When incentives rely on team competition, such mechanism may induce strong payoff disparities among workers between the winner teams who receive extra money (the monetary transfers) and the loser teams. In this chapter we investigate whether replacing monetary incentive by symbolic incentives may help mitigate this issue.

Precisely the objectives of this chapter are twofold. First, we investigate to what extent replacing monetary incentives by symbolic incentives in centralized mechanisms, may provide sufficient incentives for workers to perform. Our motivation is to assess if centralized mechanisms using symbolic team incentives, could effectively prevent free-riding, without generating the negative effects of monetary incentives on the payoffs of workers. The existing literature on incentive mechanism has extensively studies monetary incentives at individual level (e.g., Prendergast, 1999), monetary incentives at team level (e.g., Holmstrom, 1982; Nalbantian and Schotter, 1997), symbolic incentives at individual level (e.g., Masclet et al., 2003; Dugar, 2013; Charness et al., 2014), but rarely symbolic incentives at team level, one exception being Delfgaauw et al. (2013), which is based on a field experiment. Therefore, experimentally comparing monetary and symbolic team incentives in the laboratory, as we do in this chapter, is an original contribution to the literature.

Second, we investigate whether there may exist a pure effect of observability even in absence of monetary incentive. We conjecture that this may be the case if workers compare each other and are incited to outperform others even in absence of monetary benefits to do so. A vast economic literature has investigated the impact on behaviors of observing or being observed by others: for instance, Rege and Telle (2004) in Public Good Game, Mas and Moretti (2006) in a real effort game, Falk and Ichino (2009) in a field experiment, de Hooge et al. (2007) in a laboratory experiment contrasting the effects of guilt and of shame emotions on behaviors, Fortin et al. (2007) or Casal and Mittone (2016) among numerous studies concerning tax

evasion. However, in these papers, not only the distribution of individual behaviors, but also individuals associated to these individual behaviors are identified, which engage the reputation or social image of individuals. This is not the case in our design, where the distribution of individual efforts is observed, but not the identity of the individuals associated with these individual efforts. Our motivation to study the effects of disclosing the distribution of individual behaviors, without disclosing the identities of the corresponding individuals, is that public disclosure of the identities of authors of behaviors encourages prosocial choices, but generates high social costs and may not be welfare enhancing, as shown in Butera et al. (2022).

To investigate the two research questions mentioned above, we ran a laboratory experiment where, first, we compare monetary and symbolic team incentives, and second, we attempt to isolate the pure effect of observability. Precisely, to compare monetary and symbolic team incentives, we use a set of five treatments. Our first treatment is the Baseline revenue sharing game inspired by Nalbantian and Schotter (1997) already included in chapter 2. The second treatment is called Monetary Group Target⁴⁹. It is similar to the Baseline treatment, except that teams' total outputs are compared to an exogenous target, such that workers are rewarded if total output reaches the target. In the third treatment, named Symbolic Group Target, teams total outputs are compared to the same exogenous target than in the previous treatment, but workers' rewards, if total output of their team reaches the target, are symbolic and not monetary. The fourth treatment is called Monetary Group Competition⁵⁰. In this treatment, each team competes with another team and the team with the highest output receives a transfer from the other team. Finally, in the fifth treatment, named Symbolic Group Competition, each team also competes with another team, but teams with the highest output receives symbolic congratulations rather than a monetary transfer.

To isolate the pure effect of observation, we analyze how the observation of individual efforts within teams modifies workers' behaviors, compared to the observation of the aggregate efforts of team mates. This question is experimentally addressed, first, by comparing our Baseline treatment with a variant of the same treatment, where information on average effort of others is replaced by information on individual effort levels of other group members⁵¹. Conversely, the

⁴⁹ The Monetary Group Target treatment in this chapter is the same than the Group Target treatment presented in chapter 2.

⁵⁰ The Monetary Group Competition treatment in this chapter is the same than the Group Competition treatment presented in chapter 2.

⁵¹ In reference papers such as Fehr and Gächter (2000), differences between the baseline treatment and the peer pressure treatment also includes not only the peer pressure mechanism itself, but also the introduction of

question of the impact of observation is also addressed by comparing our Monetary Group Target and Monetary Group Competition treatments, with variants of those two treatments, where information on individual effort levels of other group members, is replaced by information on average effort of other group members.

To anticipate our results, we observe that compared to the baseline treatment, symbolic incentives are effective for increasing workers' efforts, and social welfare, but less than monetary incentives. The corresponding increase of social welfare mostly benefits to firms, via an increase of firms' profits. Regarding our second research question, we find that introducing observation of individual effort levels instead of average effort, significantly increases effort in the baseline revenue sharing treatment. However, we find that this effect is not significant in the context of centralized mechanisms with monetary incentives.

The remainder of the chapter is organized as follows. Section 2 reviews the literature to which this chapter aims to contribute. Section 3 presents our experimental design and the corresponding theoretical predictions. Section 4 describes the experimental procedures. Section 5 provides the results and Section 6 concludes the chapter.

2. Literature review

This literature review is split into two sub-sections, respectively focused on the two research questions addressed in this chapter: the effects of symbolic and non-monetary incentives on effort and cooperation, and the effects of observation on behaviors.

2.1. Literature on the effects of symbolic versus monetary incentives

The literature of symbolic and non-monetary incentives includes studies which compares non-monetary to monetary incentives, and others which analyzes the effects of non-monetary incentives by themselves. Overall, this literature concludes on the effectiveness of non-monetary incentives in increasing effort, cooperation, and productivity.

Concerning the direct comparison between monetary and non-monetary incentives, Delfgaauw et al (2013) compare the impacts of monetary and non-monetary incentives in sales competition

observation of individual behaviors. Experimental designs used in this chapter and in chapter 2 have been chosen in order to be consistent in this respect with those references.

between different stores of a chain store, and find that non-monetary incentives are as efficient as monetary incentives for enhancing productivity⁵². Erkal et al. (2018) observe, in a real effort competition game providing intrinsic motivation to participants, that, absent opportunity costs, non-monetary incentive are sufficient to generate effort and that adding monetary incentives does not increase effort. However, they also find that when the opportunity cost of the game increases, or if game provides less intrinsic motivation, monetary incentives become efficient in increasing effort. Masclet et al. (2003) compares monetary to non-monetary punishments in a Public Good Games with Peer Pressure, and find that non-monetary punishments are effective in increasing cooperation, but not as efficient as monetary punishment.

Studying non-monetary incentives, Dugar (2013) finds that expression of disapproval among group members enhances cooperation, which can be further increased if group members may also express approval. Charness et al. (2014) experiment a real effort game with flat wage, where individual performances have no monetary consequence. Providing feedback to participants on their individual rankings significantly enhances effort, but also triggers unethical behaviors, such as cheating or sabotaging others 'production.

All the literature on nudges, as popularized by R. Thaler (Thaler, 2018) also provides evidence that symbolic or non-monetary incentives can be effective in changing behaviors.

2.2. Literature on the effects of observing others

Our chapter also belongs to the literature on the influence of observation of peers 'behavior on work performance. The effects of being observed by others are distinguished from the effects of observing others.

The literature on how being observed affects behaviors, detailed in the following indents, analyzes situations where not only behaviors are observed, but where individuals are observed behaving. In this literature, what matters to an individual and affects her behavior, is that others observe her and that she can be identified and associated with her behavior.

Bernheim (1994) develops a theory of the emergence of social norms, where individuals behave following a balance of intrinsic motivation and of social status concerns. The social status of

⁵² Delfgaauw et al (2013) also study the impact of gender on performance in the context of store competition. They find that gender as such has no influence, but gender homogeneity between staff and management has a positive impact on productivity.

individuals depends on the public perception of their predispositions inferred from the observation of their actions. When social status is sufficiently important, most people conform to a single social norm. Field and laboratory experiments confirm that being observed influences behaviors. Falk and Ichino (2006) consider real-effort choices and compare a “single” treatment, where subjects worked alone, with “pair” treatments where two subjects worked at the same time in the same room with potential peer effects: in the pair treatment, average output is higher. Mas and Moretti (2009) analyze the case of supermarket cashiers, and find that a given worker's effort is positively related to the presence and speed of the other workers with whom she works, and who may observe her activity. Rege and Telle (2004) find that in a Public Good Game experiment, when participants must publicly announce their choices of contribution, cooperation increases.

Several articles analyze the relation between tax compliance and public policies of disclosing the identities tax evaders. The fact that tax evasion is lower than predicted by the neoclassical model of Allingham and Sandmo (1972), is explained by the reputation costs, shame or stigma associated to tax evasion in social interactions (Gordon, 1989; Fortin et al., 2007; Casagrande et al., 2015) and reversely the social esteem attached to complying with the tax payment norm (Myles and Naylor, 1996; Casal and Mittone, 2016). Bethencourt and Kunze (2020) evaluate the positive macroeconomic impact of the emergence of such social norms of tax compliance.

However, if social monitoring of individuals behaviors positively impacts prosocial choices, it also generates costs. Butera et al. (2022) experimentally assess how much individuals value public recognition of behaviors which may earn them pride or shame, and what are the welfare impacts of such public recognition. They find that public recognition motivates socially desirable behaviors but creates highly negative image payoffs and may not be welfare enhancing.

Not only being observed but also observing others may impact one's choices, as others' behavior can be interpreted as a social norm to which not complying may generate feelings of guilt. De Hooge et al. (2007) evaluate the differential effects of guilt and of shame, in supporting cooperation. They confirm preceding results that feelings of guilt increase cooperation, but find no such effect for shame. Rustichini and Villeval (2014) find that individuals with low prosocial preferences can manipulate their feelings of guilt, to minimize their emotional cost of sustaining selfish behaviors.

Integrating the effects of being observed and of observing, Benabou and Tirole (2006) develop a comprehensive theoretical model where individuals are motivated by a mix of intrinsic motivation, of social-image concerns and of self-image concerns. They find that extrinsic rewards, including public recognition, can spoil reputational benefits of good deeds. Prosocial norms may appear endogenously if avoidance of social stigma is a dominant concern. But publicizing prosocial behaviors can generate negative reputational spillovers which are not internalized, leading to socially inefficient outcomes.

In our design, the detailed distribution of the behaviors of team-mates is observed in most of our treatments, but the identities of the corresponding team-mates are not disclosed. Hence, the reputation and social image of individuals, and the associated feelings of pride or shame, are not at stake. This is an important difference between our design and the situations analyzed in the literature mentioned above.

Another difference between our design and situations analyzed in the literature, is that in our design, we compare the effects of observing the detailed distribution of the behaviors of team-mates, to the effects of observing only the average and aggregate behaviors of team-mates. In our design, in both cases, workers are informed on the average norm within the team. But in the former case, observation also informs on the dispersion of team-mates behaviors around the norm, which is not the case in the latter case.

3. Experimental design and theoretical predictions

Our design is inspired by the article of Nalbantian and Schotter (1997). We consider a principal multi-agents' relationship with a firm composed of a principal and eight agents involved in two teams of four workers each. Each worker chooses her work effort which contributes to the production of her team, determining team remuneration. Team remuneration is equally shared among all team members. The principal is residual claimant of the market value of team production. Each treatment consists of 10 identical periods under “Partner” matching.⁵³

In the following subsections, we describe the eight treatments used to analyze our two research questions. Then, we present the corresponding theoretical predictions under standard hypothesis. In the last subsection, we present our behavioral hypotheses.

⁵³ Within each team, worker identifiers change randomly from one period to another, to prevent individual reputation-building. Each participant participates in only one experiment.

3.1. Treatments descriptions

3.1.1. Baseline treatment: revenue sharing

Our Baseline treatment is the same than in the previous chapter. It consists of a revenue-sharing scheme for which free-riding is a dominant strategy.

At each period, all workers of the firm simultaneously choose their effort level denoted $e_{i,j} \in [0, 100]$, where the subscript i and j denote worker i in team j respectively, $\forall j = (1,2)$, to produce an output Y_j . The output Y_j of each team is produced using a simple stochastic linear technology specified as follow:

$$Y_j = \sum_1^4 e_{i,j} + \varepsilon, \quad \forall j=\{1,2\} \quad (1)$$

where ε is a uniform random variable defined over the interval $[-40, 40]$.

The firm sells the production on the market for a price of $P=3$. The total revenue of the firm R_F corresponds to the sum of output produced by each team times the price P :

$$R_F=PY = 3(Y_1 + Y_2) \quad (2)$$

Where Y_1 and Y_2 are team 1 and team 2 's production levels, respectively.

The worker i 's payoff function is:

$$\begin{aligned} \pi_{i,j} &= \frac{\alpha PY_j}{4} + \Omega - c(e_{i,j}) \\ &= \frac{1.5 \sum_1^4 e_{i,j} + \varepsilon}{4} + 10 - (e_{i,j}^2/100) \end{aligned} \quad (3)$$

Where α is the share of total revenue received by each team, and is set to 0.5 in the experimental design. Ω is a lump-sum payment set to 10 in the experiment. Let $c(e_{i,j})$ denote worker i 's cost function for output effort. It is an increasing convex cost function of effort such that $c' > 0$; $c'' > 0$. Following Nalbantian and Schotter (1997), we assume that $c(e_{i,j}) = e_{i,j}^2/100$.

The principal's profit corresponds to:

$$\pi_P = 1.5Y - \sum_{i=1}^8 \Omega \quad (4)$$

And the social welfare of the firm's activities is given by:

$$SW = \pi_P + \sum_{j=1}^2 \pi_j \text{ with } \pi_j = \sum_{i=1}^4 \pi_{i,j} \quad (5)$$

3.1.2. Monetary Group Target

The “Monetary Group Target” treatment is like the Baseline treatment with two notable changes.

First, each worker observes the detailed distribution of efforts chosen by the other workers in her team. Only values of individual efforts of team mates are provided, not workers’ identifiers. Hence, the information on the distribution of effort choices is anonymous and there is no way for a participant to know whom, among other participants, has chosen a given effort level, neither to relate an effort chosen in a period, to efforts chosen in previous periods by the same participant⁵⁴. Reversely, participants know that, although their choices of effort will be observed by their team mates, they will not be personally identifiable by other participants as having chosen this level of effort. These characteristics of the observation of distribution of individual choices in our design are true not only in the Monetary Group Target treatment, but also in all treatments considered in this chapter, and more generally in this thesis, where distribution of individual efforts within teams is observed.

Second, in the “Monetary Group Target” treatment teams’ total output Y_j is compared to an exogeneous target R_T^* such that the worker’s payoff function is given by:

$$\pi_i = 1.5(\sum_1^4 e_{ij} + \varepsilon)/4 - e_{ij}^2/100 + \Omega \quad \text{if } 1.5Y_j \geq R_T^*$$

and (6)

$$\pi_i = \max(0, B - e_{ij}^2/100) + \Omega \quad \text{otherwise}$$

Equation (6) shows that workers share the revenue of their team if the target R_T^* is met, and a fixed and low compensation B if not. In the latter case, workers’ profit is truncated at zero before addition of the lump-sum Ω , the cost of truncation being borne by the firm.

The expressions for the total payoffs of workers, the profit of the firm and of social welfare are the same as in the baseline treatment.

⁵⁴ First, participants to experimental sessions do not know who, among other participants of the session, are the other members of their team. Second, the values of individual efforts of team mates are presented to each participant without any information on the identity of whom has chosen which level of effort. Third, these values are presented in an order which randomly changes each period.

3.1.3. Symbolic Group Target

In the “Symbolic Group Target” treatment as in the Monetary Group Target treatment, each worker observes the distribution of efforts chosen by her team-mates, without knowing whom has chosen which effort level, as detailed in §3.1.2. But, as in the baseline treatment, workers always equally share the total team revenue from their teamwork. However, if the total team output Y_j is such that team revenue $1.5Y_j$ is greater than or equal to a target R_T^* , corresponding to the Pareto optimum for team members, team members receive the following congratulations message:

“Congratulations! Your group's total revenue reaches or exceeds 450 tokens! Your group's total payoffs are maximized thanks to an exemplary cooperation.”⁵⁵

Otherwise, if the total team output Y_j is such that team revenue $1.5Y_j$ is smaller than R_T^* , workers still equally share the total team revenue from their teamwork, but they receive the following warning message:

“Your group's total revenue is below 450 tokens! The total payoffs of players in your group would be higher if everyone contributed enough for your group's total revenue to reach this threshold.”⁵⁶

Hence, in this treatment, team members have a symbolic rather than a monetary incentive to reach the team revenue target R_T^* . The message addressed to team members can be interpreted as a nudge to choose a Pareto optimal level of effort (Thaler, 2018).

The expressions of the payoffs and of the revenues of workers, of the profits of firms and of social welfare, are given by the same equations than for the baseline treatment.

3.1.4. Monetary Team tournament (or Monetary Group Competition)

⁵⁵ Original French version: “Félicitations ! Le revenu total de votre groupe atteint ou dépasse 450 jetons ! Le total des gains de votre groupe est maximisé grâce à une coopération exemplaire. “

⁵⁶ Original French version: “Le revenu total de votre groupe est inférieur à 450 jetons ! Le total des gains des joueurs de votre groupe serait plus élevé si chacun contribuait assez pour que le revenu total de votre groupe atteigne ce seuil..“

In the Monetary Group Competition treatment, in each period of the game, each team competes with the other team in the firm. The team with the highest production receives a transfer of TR from the other team such that we get for each worker i in team I :

$$\begin{aligned} \pi_i(Y_1, Y_2, e_i) &= \frac{1.5Y_1 + TR}{4} - \frac{e_{i1}^2}{100} + \Omega && \text{if } Y_1 > Y_2 \\ \pi_i(Y_1, Y_2, e_{i1}) &= \max\left(\frac{1.5Y_1 - TR}{4} - \frac{e_{i1}^2}{100}, 0\right) + \Omega && \text{if } Y_1 < Y_2 \end{aligned} \quad (7)$$

In case of equal production there is no transfer.

In the Monetary Group Competition treatment also, each worker observes the distribution of efforts chosen by her team-mates, without knowing whom has chosen which effort level.

The expressions for workers' payoffs, firm profit and social welfare are the same as in the baseline treatment.

3.1.5. Symbolic Team tournament (or Symbolic Group Competition)

In the Symbolic Group-Competition treatment, as in the Monetary Group Competition treatment, in each period of the game, each team competes with the other team in the firm via their respective outputs Y_1 and Y_2 . Each team receives the revenue corresponding to its output. In addition, the members of the team that wins the competition (*i.e.*, that with the larger output) receives the following congratulations message:

“Won! Your group's total revenue is higher than your competitor's. Well done! The total payoffs of the members of your group must exceed that of your competitor thanks to a better cooperation.”⁵⁷

The members of the team that loses the competition receives the following warning message:

“Lost! Your group's total revenue is lower than your competitor's. The total payoffs of the members of the competing group must exceed that of yours. You need to cooperate better to increase your payoffs.”⁵⁸

⁵⁷ Original French version : “Gagné ! Le revenu total de votre groupe est supérieur à celui de votre concurrent. Bravo ! Le total des gains des membres de votre groupe doit dépasser celui de votre concurrent grâce à une meilleure coopération.”

⁵⁸ Original French version : “Perdu ! Le revenu total de votre groupe est inférieur à celui de votre concurrent. Le total des gains des membres du groupe concurrent doit dépasser celui du vôtre. Il vous faut mieux coopérer pour augmenter vos gains.”

Hence, in this treatment, team members have a symbolic rather than a financial incentive to win the competition against the other team.

3.1.6. Observation treatment

As mentioned in the introduction, our motivation to introduce the Observation treatment is that the observation of the distribution of efforts of team mates is included in all the previous treatments, except in the Baseline treatment where only average and aggregate efforts of team mates are observable. This implies that moving from the baseline to the other treatments involved two changes: i) introduction of incentives and ii) observation of the distribution of efforts⁵⁹. Since observation of the distribution of efforts is included in all treatments other than the Baseline, differences in outcomes between those treatments and the Baseline treatment may result not only from the different incentives included in those treatments, but also of the pure effect of observation of the distribution of efforts.

Indeed, the literature reviewed in section 2 of this chapter suggests that observing others, or being observed by others, influence workers' behavior. In our design, contrary to the situations analyzed in the literature, only the distribution of team mates' efforts is observable. The identities of who choose which efforts are not disclosed. Hence, the effects may be different in our design. However, it remains necessary to disentangle the effects of observation of distribution of efforts and the effects of team incentives introduced in our treatments.

The Observation treatment is the same than the Baseline treatment described in § 3.1.1 of this section, except that each worker observes the distribution of the three values of the levels of efforts chosen of her team mates. When workers observe the detailed distribution of individual efforts in their team, they have no information on the identity of whom has chosen which level of effort. Reversely, workers know that they will not be personally identified by their team mates as having chosen the level of effort that they have chosen.

3.1.7. Variants of Monetary Group Target and Monetary Group Competition

Our motivation for introducing these additional treatments is disentangle the effects of observation of the distribution of efforts, as opposed to the observation of the average and

⁵⁹ Interestingly, the comparison of public good with and without punishment in Fehr and Gächter (2000) also induces these two changes.

aggregate level of efforts, from the effects of target-based and competition-based monetary team incentives.

The Monetary Group Target treatment with Aggregate Observation is the same than the original Monetary Group Target treatment described in §3.1.2. of this section, except that each worker observes only the average and aggregate efforts of her team mates. Similarly, the Monetary Group Competition treatment with Aggregate Observation is the same than the original Monetary Group Competition treatment described in §3.1.4. of this section, except that each worker observes only the average and aggregate efforts of her team mates.

3.2. Theoretical predictions under standard hypotheses

For the Baseline treatment, as detailed in chapter 2 and its appendix, the Nash equilibrium of the game under standard hypotheses, corresponds to $e_{ij}^* = 18.75$, far below the Pareto-optimum, maximizing workers payoffs, effort level of 75. Theoretical predictions for the Observation, the Symbolic Group Target, and the Symbolic Group Competition treatments, are the same than in the Baseline treatment, because the additions of observation of the distribution of efforts and of congratulations and warning messages, do not affect behaviors under standard neoclassical hypotheses.

Concerning the Monetary Group Target treatment, as detailed in chapter 2 and its appendix⁶⁰, this scheme has a low, and a high, Nash equilibria.

The low equilibrium corresponds to the situation where all players choose to provide no effort: $e_{ij} = 0, \forall i$.

In the high equilibrium, the level of player effort is Pareto optimal for team members. This holds for a certain value of B . In our experiment, with $B=7.5$, the Pareto-optimal level of effort for team members $e_{ij} = e^* = 75$ is a Nash equilibrium (see the Appendix of chapter 2). The same prediction holds for the variant of Monetary Group Target treatment with observation of aggregate effort instead of observation of individual efforts, because under standard hypotheses, this modification has no effects on theoretical predictions.

⁶⁰ This treatment corresponds to the Group Target treatment in chapter 2.

Finally, regarding Monetary Group Competition treatment, as detailed in chapter 2 and its appendix⁶¹, the Pareto-optimal level of effort for team members $e^* = 75$ is a Nash equilibrium if, for this value, the first-order condition holds, which is the case for a specific value of the transfer ($TR=180$). And same prediction holds for the variant of Monetary Group Competition treatment with observation of aggregate effort instead of observation of individual efforts, because under standard hypotheses, this modification does not change theoretical predictions.

3.3. Behavioral hypotheses

No behavioral hypotheses are presented regarding Baseline, Monetary Group Target, and Monetary Group Competition treatments, for which experimental results have already been presented in chapter 2.

Regarding Symbolic Group Competition, the most relevant reference is Delfgaauw et al. (2013) which compare, in a field experiment, two competition-based mechanisms between teams, one with monetary incentive, the other with non-monetary incentive. Delfgaauw et al. (2013) observe that the latter is as effective as the former to foster productivity. Based on this reference, we can formulate our first behavioral hypothesis for this chapter.

Hypothesis 1. Effort in the Symbolic Group Competition treatment should be as high as in the Monetary Group Competition treatment.

Regarding Symbolic Group Target, the congratulation and alert messages can be considered as nudges meant to encourage participants to provide an optimal level of effort. Nudge literature (Thaler, 2018) posits that nudges are effective in incentivizing people to behave as suggested by the nudge. This leads us to our second behavioral hypothesis for this chapter.

Hypothesis 2: Effort in the Symbolic Group Target treatment should be higher than in the Baseline treatment.

Regarding the Observation treatment, we investigate the potential effects on workers' behaviors of the observation of the distribution of effort choices of team-mates. Two potential effects should be distinguished. The workers may be influenced first, by the perspective of having their

⁶¹ This treatment corresponds to the Group Competition treatment in chapter 2.

level of effort observed, and second, by observing the distribution, rather than the average, of the choices of their team-mates.

More precisely; the first potential effect would result, for the workers, of knowing that their specific choices of effort will be observed by their team-mates, as part of the distribution of effort choices of team-mates that each team member observe, without being personally identified as having made this choice. The second potential effect results, for the workers, of observing the detailed distribution of effort choices of their team-mates rather their team-mates average and aggregate efforts.

Regarding the first effect, the literature mentioned in section 2 of this chapter does not seem to be directly applicable. All the papers consider situations where not only the behaviors of individuals are observed, but individuals themselves are also identified by others. Being observed and identified impacts the behavior of individuals, because in that case, good behavior generates social esteem and positive feelings of pride, and bad behavior generates social stigma and negative feelings of shame. No such effect should be at work in our design: as participants are not identified by their peers, their effort choices will not earn them pride nor shame.

Regarding the second effect, the literature review in section 2 of this chapter does not allow either to predict different efforts between the Baseline and the Observation treatments. In this literature, observing others influences individuals because it informs them on social norms, with which complying may generate positive feeling of self-esteem, and from which departing may generate negative feelings of guilt. In our design, both the Baseline treatment and the Observation treatment inform workers on the social norm within their team: in the Baseline treatment, workers observe the average and aggregate efforts of their team-mates, in the Observation treatment, workers observe the distribution of efforts of their team-mates. To our knowledge, there is no evidence in the literature indicating that the former is more, or less informative than the latter, regarding the social norm within the team.

Hence, the effects documented in the literature do not support different behavioral predictions regarding effort between the Baseline and the Observation treatments. This leads us to the following behavioral hypothesis 3:

Hypothesis 3: Efforts should not be significantly different between the Baseline and the Observation treatments.

If hypothesis 3 holds, in the baseline treatment, switching from the observation of average and aggregate efforts of team-mates, to the observation of the distribution of efforts of team-mates, should have no significant effect on the level of effort. Reversely, switching from observation of the distribution of efforts of team-mates to the observation of their average and aggregate efforts, in treatments with monetary team incentives, can be expected to have no significant impact either on the level of effort. Hence, we formulate the following two behavioral hypotheses:

Hypothesis 4: Efforts in the Monetary Group Target treatment with aggregate observation of efforts should not be significantly different than in Monetary Group Target treatment with observation of the distribution of efforts.

Hypothesis 5: Efforts in the Monetary Group Competition treatment with aggregate observation of efforts should not be significantly different than in Monetary Group Competition treatment with observation of the distribution of efforts.

4. Procedures and parameters

Experiment has taken place from October 20th 2021 to October 13th 2022 at LABEX-EM laboratory within University of Rennes and involved 264 participants, 20.98 years old on average. 21% of participants were majors in Economics, and the others in various subjects such as Law, Management, Medicine, Physics, or Chemistry. 57% of participants were women and 43% men. 78% of participants had never taken part in an Economics laboratory experiment before.

Baseline, Observation and all Group-Target treatments involved 24 participants each, and Group-Competition treatments involved 48 participants each, to accommodate for 6 independent pairs of competing teams. The experiments were programmed in Z-tree (Fischbacher, 2007). The detailed instructions for the participants were in French, and their English translations are available in the Appendix of this chapter.

Table 1 lists, for the five treatments used to compare monetary and symbolic incentives in centralized mechanisms, the socio-demographic descriptive statistics of the participants.

Table 1: Socio-demographics descriptive statistics for treatments comparing monetary and symbolic incentives

	Baseline	Monetary Group Target	Symbolic Group Target	Monetary Group Competition	Symbolic Group Competition
% Women	54%	62%	42%	58%	60%
% Students in Economics	8%	21%	29%	23%	17%
% No previous participation	96%	71%	71%	67%	73%
Age	20.5	20.4	20.7	20.4	21.9
Number of Participants	24	24	24	48	48

We performed tests of difference in means (T-test) and frequencies (Fisher exact probability test) to assess the covariate balance between our different treatments. The results of these tests are presented in Table B1 in the appendix. Table B1 shows that for almost all variables no significant differences are observed across treatments, suggesting that our groups of participants are generally similar on observable characteristics. However, there are significant differences in frequencies of participants without previous participation to laboratory experiment, between Baseline and respectively Monetary Group Target ($p = 0.048$), Symbolic Group Target ($p = 0.048$), Monetary Group Competition ($p = 0.007$) and Symbolic Group Target ($p = 0.026$).

Table 2 gives the socio-demographic statistics of the participants to the Observation treatment, and those of the three other treatments to which it is compared in section 6 of this chapter.

Table 2: Socio-demographics descriptive statistics of treatments for section 5.2

	Observation	Baseline	Symbolic Group Target	Symbolic Group Competition
% Women	58%	54%	42%	60%
% Students in Economics	21%	8%	29%	17%
% No previous participation	87%	96%	71%	73%
Age	23.88	20.5	20.7	21.9
Number of participants	24	24	24	48

We performed tests of difference in means (t-test) and frequencies (Fisher exact probability test) to assess the covariate balance between Observation and the three other treatments considered in section 5.2. The results of these tests are presented in Table B2 in the appendix. Table B2 shows no significant differences of the demographics of participants between Observation and the three other treatments.

Table 3 gives the socio-demographic statistics of participants to the two variants of treatments with monetary incentives and observation of aggregate efforts, and those of the three other treatments to which they are compared in section 5.3 of this chapter.

Table 3: Socio-demographics descriptive statistics of treatments considered in section 5.3

	Baseline	Monetary Group Target – Distribution Observation	Monetary Group Target – Aggregate Observation	Monetary Group Competition – Distribution Observation	Monetary Group Competition – Aggregate Observation
% Women	54%	62%	58%	58%	58%
% Students in Economics	8%	21%	21%	23%	25%
% No previous eco experiment	96%	71%	79%	67%	85%
Age	20.5	20.4	20.7	20.4	20.0
Number of Participants	24	24	24	48	48

We performed tests of difference in means (t-test) and frequencies (Fisher exact probability test) to assess the covariate balance between the two variants and between those two variants treatments and the three other treatments considered in section 5.3. The results of these tests are presented in Table B3 in the appendix. Table B3 shows that for almost all variables no significant differences are observed across treatments. One exception is the frequency of participants without previous experience in economic experiment between the two Monetary Group Competition treatments ($p = 0.054$).

5. Results

5.1. Monetary vs. Symbolic Incentives: Experimental Results

This section first presents the results concerning efforts and payoffs of workers. It then presents the results regarding profits of firms and the associated social welfare.

5.1.1. Workers ‘effort

Table 4 presents worker efforts and payoffs by treatment.

Table 4: Descriptive statistics for workers ‘effort and payoffs by treatment

		Baseline	Monetary Group Target	Symbolic Group Target	Monetary Group Competition	Symbolic Group Competition
Workers	Effort:	44.90	72.80	60.10	64.66	56.78
	Average	(24.17)	(22.97)	(24.67)	(26.20)	(21.03)
Workers	Payoffs:	54.29	35.58	58.44	64.18	59.04
	Average	(22.35)	(31.37)	(21.78)	(47.82)	(21.74)
Number	of	240	240	240	480	480
Observations						

Notes: The numbers in parentheses are standard deviations.

Table 4 shows that average effort is the lowest in the Baseline treatment. Symbolic incentives treatments are above Baseline and below Monetary incentive treatments.

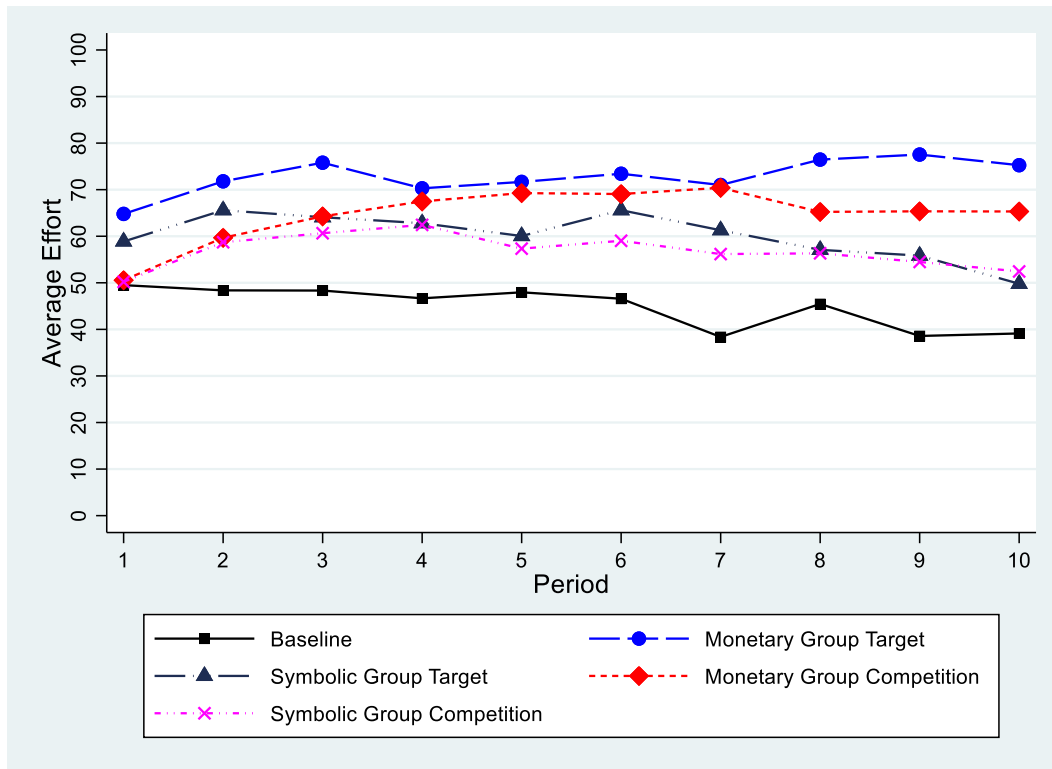
According to Mann-Whitney tests applied to effort per team of workers, averaged over all periods⁶², efforts under Baseline treatment are significantly below efforts under Symbolic Group Target ($p = 0.0782$) and under Symbolic Group Competition ($p = 0.0374$) treatments. Differences in average efforts between Symbolic and Monetary Group Target treatments are below significance ($p = 0.2002$), but differences in average efforts between Symbolic and Monetary Group Competition treatments are significant ($p = 0.0374$). Differences in average efforts between Symbolic Group Target and Symbolic Group Competition are not significant ($p = 0.4233$).

Figure 1 shows the evolution of average effort over time for each treatment.

Figure 1 shows that treatments using symbolic incentives lead to levels of efforts which are higher than in the baseline treatment, but lower than in treatments using monetary incentives.

Figure 1: Average effort over time

⁶² Six independent teams of four workers participated to the Baseline, Symbolic Group Target, and Monetary Group Target treatments. Six independent teams of eight workers participated to the Symbolic Group Competition and the Monetary Group Competition treatments This gives six independent values of average effort per team over all periods for each treatments, which are used for Mann-Whitney tests.



To formalize our findings, we ran random-effects Generalized Least Squares (GLS) estimates on the determinants of effort level. Random Effects are used to account for the panel dimension of the data. The results of these estimates are shown in Table 5.

Table 5: Determinants of effort level

Dep. Var: Effort level	RE GLS (1)	RE GLS (2)	RE GLS (3)	RE GLS (4)
	With clustered SE			
Baseline	Ref.	Ref.	Ref.	Ref.
Monetary Group Target	27.90*** (4.14)	28.56*** (4.20)	27.90*** (4.95)	28.56*** (4.71)
Symbolic Group Target	15.2*** (4.14)	16.18*** (4.22)	15.2** (6.34)	16.18*** (5.95)
Monetary Group Competition	19.76*** (3.58)	20.51*** (3.68)	19.76*** (4.73)	20.51*** (4.64)
Symbolic Group Competition	11.88*** (3.58)	11.97*** (4.66)	11.88*** (3.91)	11.97*** (3.75)
Period – Trend		-0.026 (0.17)		-0.026 (0.37)
Male		0.26 (2.31)		0.26 (1.75)
Previous Participation		0.23 (2.61)		0.23 (2.13)
Age		0.23 (0.27)		0.23 (0.18)
Economics		-5.34* (2.88)		-5.34** (2.62)
Constant	44.90*** (2.93)	40.37*** (6.24)	44.90*** (3.60)	40.37*** (5.76)
Observations	1680	1680	1680	1680

R-squared overall	0.1032	0.1125	0.1032	0.1125
Wald χ^2	53.26	58.44	37.38	80.79

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

Table 5 consists of two panels. The left panel reports estimates on the determinant of effort, without controls in column (1) and controlling for trend and demographics in column (2). The right panel replicates those estimates but standard errors are clustered at the team level to control for interdependencies within teams. All four columns provide consistent sign, size, and significance regarding treatment effects on efforts. Effort is lowest in the Baseline treatment, and highest under Monetary Group Competition and Monetary Group Target. Symbolic incentives retain more than half the effectiveness of monetary incentives in increasing workers' efforts compared to baseline treatment. Hence, table 5 confirms our findings from Mann-Whitney tests.

The conclusion which can be derived from the experimental results is summarized in result 1.

Result 1: *Symbolic incentives are effective for increasing workers' efforts, but less than monetary incentives.*

This result contradicts Hypothesis 1, as efforts in the Symbolic Group Competition treatment are lower than efforts in the Monetary Group Competition treatment. A possible explanation for this contradiction is that our experiment is neither a field experiment, nor a real effort experiment, and therefore participants do not perform tasks providing intrinsic motivation. In studies where competition alone is shown to be very effective at triggering efforts without monetary incentives (e.g., Delfgaauw, 2013, or Erkal et al., 2018), participants experience intrinsic motivation. Erkal et al. (2018) show that the effectiveness of competition to trigger effort without monetary incentive, decreases with the intrinsic motivation provided by the task.

Result 1 supports Hypothesis 2, as efforts in the Symbolic Group Target treatment are significantly higher than in the Baseline treatment.

5.1.2. Workers' payoffs

Table 4 provides the descriptive statistics per treatment for workers' payoffs. Average workers' payoffs are higher in the two treatments with symbolic incentives than in the baseline treatment, but the difference is not statistically significant, according to Mann-Whitney tests ($p = 0.4233$ in both cases). They are larger than in the Monetary Group Target treatment and the difference

is highly significant ($p = 0.0039$). They are lower than in the Monetary Group Competition treatment and the difference is significant ($p = 0.0163$ for the difference with Symbolic Groupe Target and $p = 0.0065$ for the difference with Symbolic Group Competition).

The standard deviations of payoffs among workers in treatments with symbolic incentives are below the standard deviation of payoffs in the Baseline treatment and much lower than standard deviations of payoffs in the Monetary Group Target and Monetary Group Competition treatments. Hence switching from monetary to symbolic incentives drastically reduces inequalities of payoffs between workers.

Figure 2 shows the evolution over time of worker payoffs by treatment.

Figure 2: Average worker payoffs over time

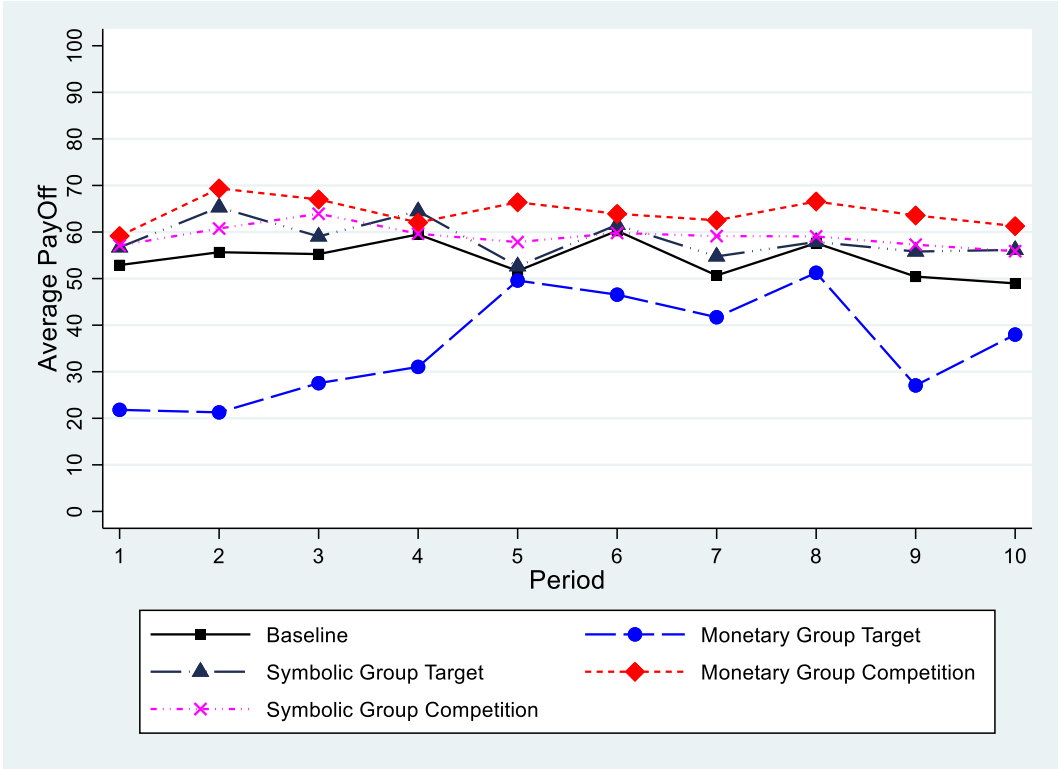


Figure 2 illustrates that Monetary Group Target generates the lowest and Monetary Group Competition the highest worker payoffs in almost every period, with Baseline, Symbolic Group Target, and Symbolic Group Competition in between.

To provide more formal evidence of our findings, we ran Random-Effects Generalized Least Squares (GLS) estimates on the determinants of payoffs. The results of these estimates are shown in Table 6.

Table 6: Determinants of Worker Payoffs

Dep. Var: Payoff level	RE GLS (1)	RE GLS (2)	RE GLS (3)	RE GLS (4)
	With clustered SE			
Baseline	Ref.	Ref.	Ref.	Ref.
Monetary Group Target	-18.72*** (4.98)	-21.02*** (5.02)	-18.72*** (4.93)	-21.02*** (5.07)
Symbolic Group Target	4.14 (4.98)	2.66 (5.03)	4.14 (4.03)	2.66 (4.33)
Monetary Group Competition	9.88** (4.31)	7.45* (4.39)	9.88*** (3.32)	7.45** (3.71)
Symbolic Group Competition	4.75 (4.31)	2.50 (4.36)	4.75 (3.36)	2.50 (3.64)
Period – Trend		-0.009 (0.25)		-0.009 (0.26)
Male		-4.86* (2.75)		-4.86* (2.56)
Previous Participation		6.89** (3.12)		6.89* (3.84)
Age		0.16 (0.32)		0.16 (0.17)
Economics		1.59 (3.44)		1.59 (3.98)
Constant	54.29*** (3.52)	52.83*** (7.50)	54.29*** (3.25)	52.83*** (4.82)
Observations	1680	1680	1680	1680
R-squared overall	0.0718	0.0833	0.0718	0.0833
Wald χ^2	46.50	55.09	79.58	154.59

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

Table 6 consists of two panels. The left panel reports estimates on the determinant of effort, without controls in column (1) and controlling for trend and demographics in column (2). The right panel replicates those estimates but standard errors are clustered at the team level to control for interdependencies within teams. All four columns provide globally consistent sign, size, and significance regarding treatment effects on efforts. Workers' payoffs in the two treatments with symbolic incentives are not significantly different than in the Baseline treatment. They are larger than in the Monetary Group Target treatment and lower than in the Monetary Group Competition treatment. These conclusions confirm the results of the Mann-Whitney tests.

Our experimental findings concerning payoffs are summarized in result 2.

Result 2: a) *There is no significant difference between Baseline, Symbolic Group Target, and Symbolic Group Competition treatments for workers' average payoffs.* b) *Workers' payoffs are significantly lower under Monetary Group Target and significantly higher under Monetary Group Competition than under those three treatments.*

5.1.3. Firm Profit and Social Welfare

Table 7 reports average firms’ profit and social welfare⁶³, at firm level.

Table 7: Descriptive statistics of outcomes by treatment per firm

	Baseline	Monetary Group Target	Symbolic Group Target	Monetary Group Competition	Symbolic Group Competition
Firm Profit	474.57 (130.54)	990.88 (153.73)	642.19 (118.13)	646.78 (175.67)	602.40 (108.51)
Social Welfare	908.92 (205.06)	1275.49 (191.92)	1109.68 (161.84)	1160.18 (209.93)	1074.70 (153.50)
Number of Observations	30	30	30	60	60

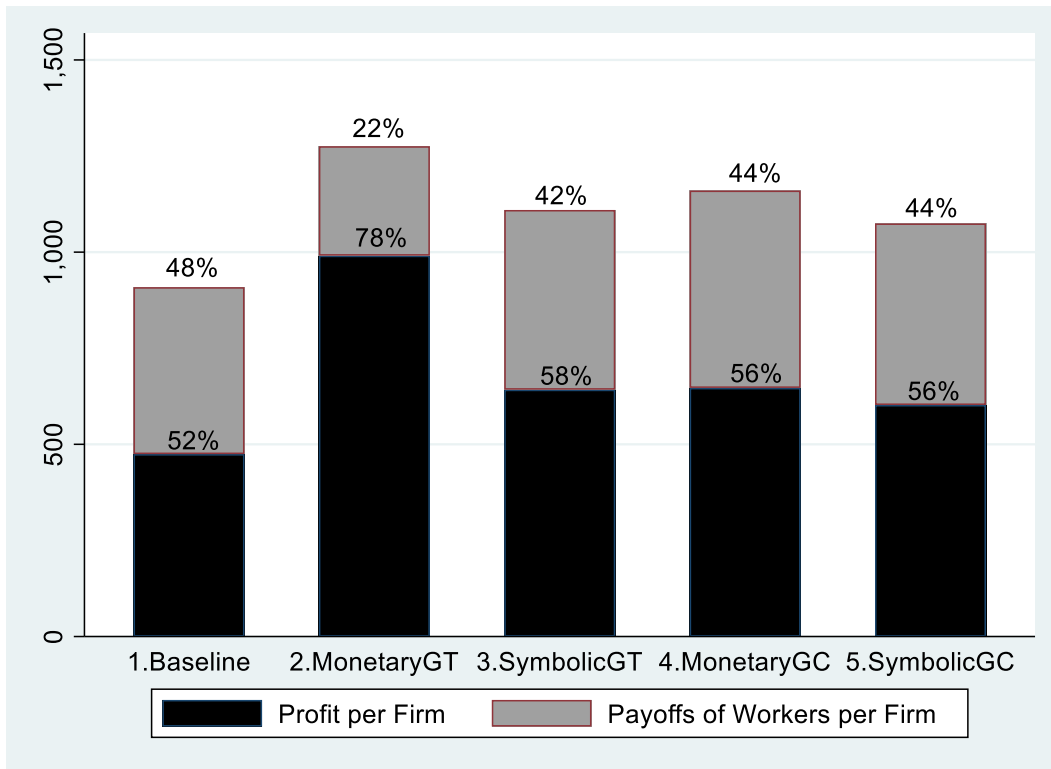
Notes: The numbers in parentheses are standard deviations.

Firms’ profits and Social Welfare are lowest in the Baseline treatment and highest in the Monetary Group Target treatment.

Table 7 allows to compare how social welfare is distributed between firms’ profits and workers’ payoffs in the different treatments. According to table 7, in the baseline treatment, social welfare equals 908.9 and firms’ profits 474.57, which represents 52% of social welfare. As 52% of social welfare go to firms’ profit, the rest, 48%, goes to workers payoffs. The same analysis can be done using the figures given in table 7. for the other treatments. We find that the distribution is of 56% for firms ‘profit and of 44% for workers’ payoffs in the Monetary and the Symbolic Group Competition treatments. It is of 58% for firms ‘profits and 42% for workers ‘payoffs in the Symbolic Group Target treatment. And it is of 78% for firms’ profits and of 22% for workers ‘payoffs in the Monetary Group Target treatment. Hence, the increase of social welfare generated by centralized incentive mechanisms tend to benefit more to firms than to workers. This observation is summarized in Figure 3, which shows how social welfare is decomposed between firms’ profits and workers payoffs in each treatment.

Figure 3: Decomposition of Social Welfare per treatment

⁶³ As formalized in equation (6) in chapter 2, the social welfare of the firm’s activities can be calculated as the sum of the firm’s profit and the worker’s payoffs.



Figures 4 and 5 below depict the evolution of average firm profit and of social welfare over time by treatment. In the Baseline Treatment, firms' profit and social welfare decline overtime. There is no clear time trend in the other treatments.

Figure 4: Average Firm Profit over time

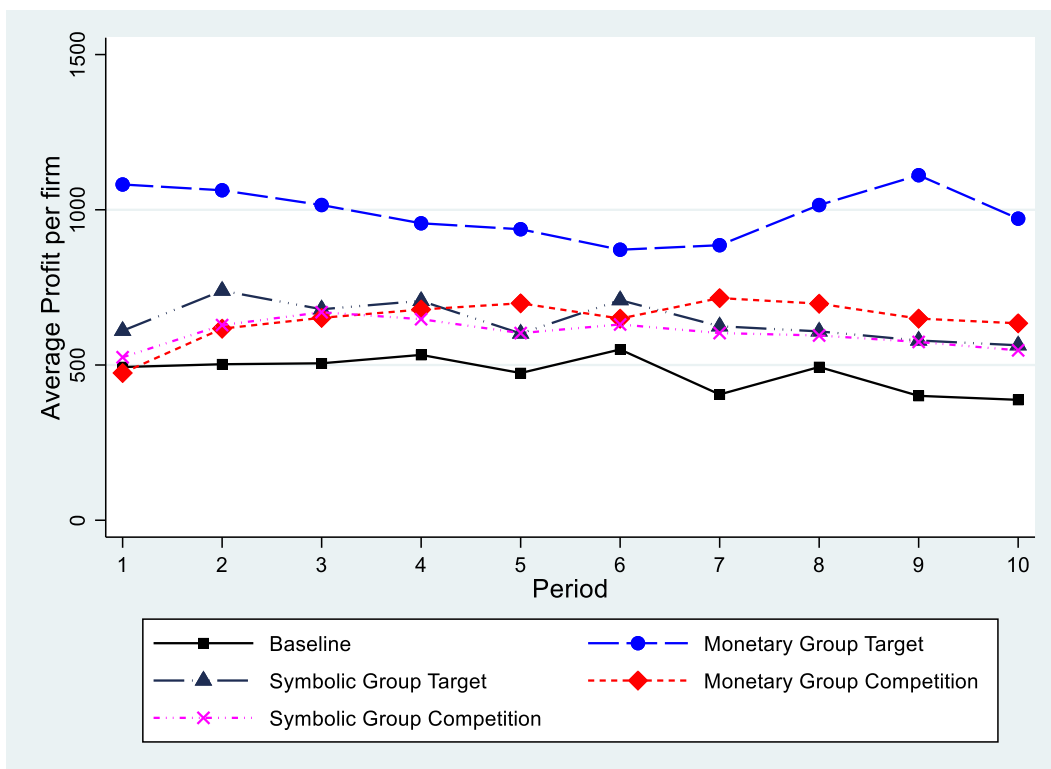
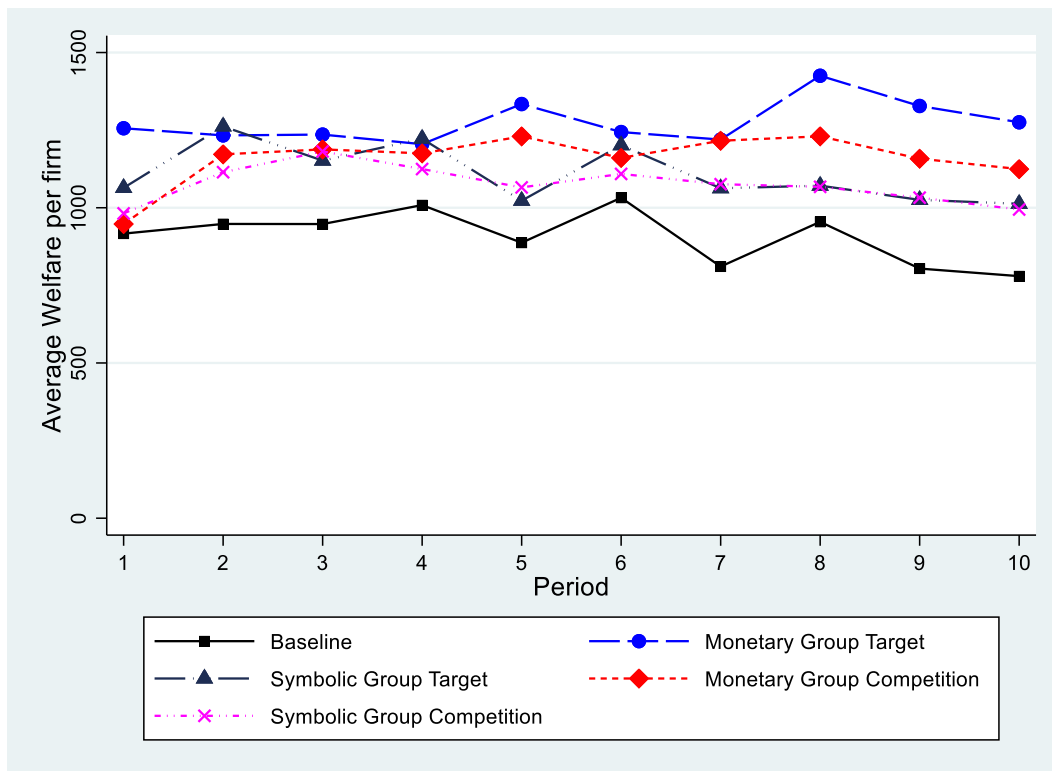


Figure 5: Average Social Welfare over time



To formalize our findings, we estimate the determinants of firms' profit and of social welfare using Random Effects GLS models, to control for the panel dimension of the data, The results are given in Table 8 below.

Table 8: Determinants of outcomes at firm level

Dep Var: RE GLS	Firm Profit (1)	Social Welfare (2)
Baseline	Ref.	Ref.
Monetary Group Target	516.31*** (72.19)	366.58*** (93.77)
Symbolic Group Target	167.62** (72.19)	200.77** (93.77)
Monetary Group Competition	172.21*** (62.52)	251.27*** (81.21)
Symbolic Group Competition	127.83** (62.52)	165.79** (81.21)
Period – Trend	-2.09 (2.95)	-2.15 (3.89)
Constant	486.04*** (53.57)	920.76*** (69.67)
Observations	210	210
R ² -Overall	0.5260	0.2440
Wald χ^2	58.50	17.44
Proba > χ^2	0.0000	0.0037

Note. Number in parenthesis are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1

The first regression confirms the significant differences of firms' profit between the baseline treatment and the four other treatments. The second regression finds, contrary to Mann-Whitney tests, significant differences of social welfare between the baseline treatment and the four other treatments. The increases in social welfare generated by the two treatments with symbolic incentives represent more than half the increases in social welfare generated by their respective counterparts using monetary incentives. Comparing the coefficients of the regressions in columns (1) and (2) shows that the increases in social welfare generated by two treatments with symbolic incentives benefit mostly, but not exclusively, to firms.

Our findings concerning firms profits and social welfare are summarized in result 3.

Result 3: *Symbolic incentives are effective for increasing social welfare, but less than monetary incentives. This increases in social welfare mostly benefit to firms.*

5.2. Effects of pure observation of individual efforts: experimental results

5.2.1. Descriptive statistics

Tables 9 presents descriptive statistics of workers' efforts and payoffs, for the four treatments considered in this section.

Table 9: Descriptive statistics of outcomes by treatment per worker

	Observation	Baseline	Symbolic Group Target	Symbolic Group Competition
Workers' Effort: Average	53.73 (25.59)	44.90 (24.17)	60.10 (24.67)	56.78 (21.03)
Workers' Payoff: Average	55.70 (24.05)	54.29 (22.35)	58.44 (21.78)	59.04 (21.74)
Number of observations	240	240	240	480

Notes: The numbers in parentheses are standard deviations.

Average effort is higher in the Observation than in the Baseline treatment, and the difference is significant according to a Mann-Whitney test ($p = 0.0782$). Differences of average effort compared to the Observation treatment is neither significant with the Symbolic Group Target treatment ($p = 0.2623$), nor with the Symbolic Group Competition treatment ($p = 0.4233$). Payoffs in the Observation treatment, are not significantly different than in the Baseline treatment ($p = 0.6310$), or in the Symbolic Group Target treatment ($p = 0.2623$), but are significantly lower than in the Symbolic Group Competition treatment ($p = 0.0782$).

Tables 9bis present descriptive statistics of firms' profits and social welfare, for the four treatments considered in this section.

Table 9bis: Descriptive statistics of outcomes by treatment per firm

	Observation	Baseline	Symbolic Group Target	Symbolic Group Competition
Firm Profit: Average	550.69 (110.60)	474.57 (130.54)	642.19 (118.13)	602.40 (108.51)
Social Welfare: Average	996.32 (154.87)	908.92 (205.06)	1109.68 (161.84)	1074.70 (153.50)
Number of Observations	30	30	30	60

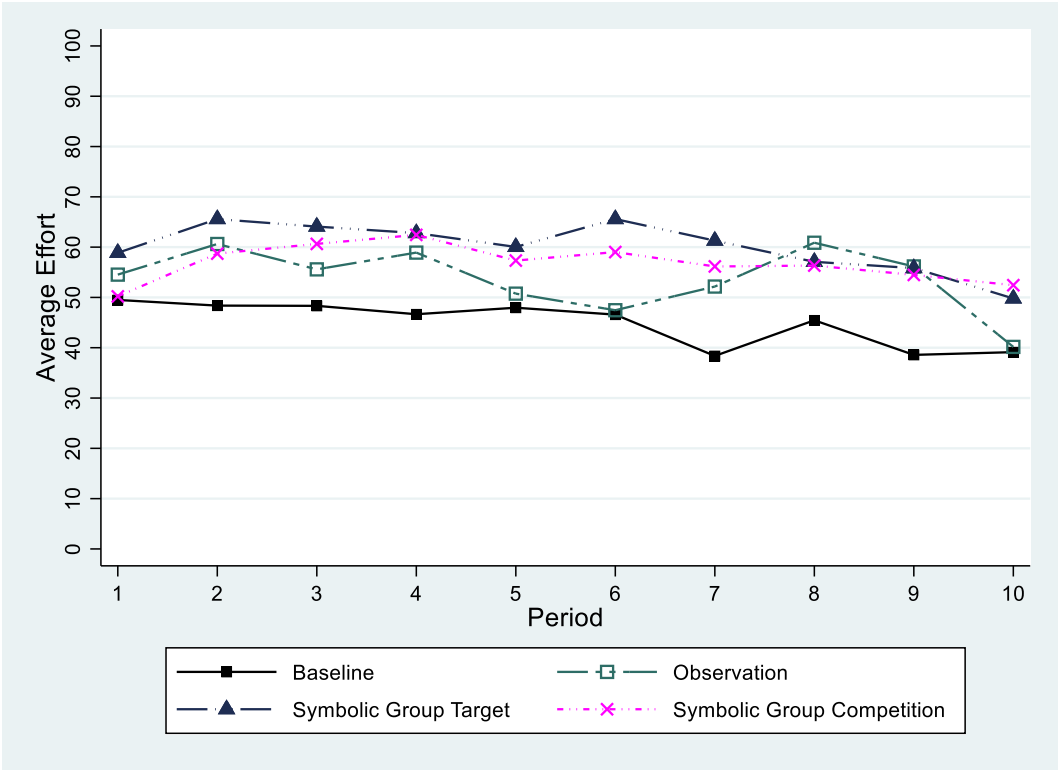
Notes: The numbers in parentheses are standard deviations.

Firms' profits and Social Welfare are lowest in the Baseline treatment and highest in the Symbolic Group Target treatment.

5.2.2. Statistical analysis of workers' efforts

Figure 6 shows the evolution over time of average effort per worker for the four treatments considered in this section.

Figure 6: Average effort over time



Effort is stable in the Observation treatment except for the last period where a significant drop is observed, in contrast with Baseline treatment where efforts steadily decrease overtime.

Interestingly, effort in the Observation treatment is above effort in the Baseline treatment in almost all periods.

To formalize our findings, we provide in Table 10 econometric estimations on the determinants of workers' efforts. We apply Random Effects GLS models to control for the panel dimension of the data.

Table 10: Determinants of effort level

Dep. Var: Effort level Treatments	RE GLS (1)	RE GLS (2)	RE GLS (3)	RE GLS (4)
	All	All except Baseline	All	All except Baseline
	With clustered SE			
Baseline	Ref.		Ref.	
Observation	8.84** (4.11)	Ref.	8.84** (4.42)	Ref.
Symbolic Group Target	16.19*** (4.14)	7.13* (4.17)	16.19*** (5.97)	7.13 (5.59)
Symbolic Group Competition	12.35*** (3.58)	3.48 (3.57)	12.35*** (3.78)	3.48 (3.29)
Period – Trend	-0.78*** (0.20)	-0.664*** (0.221)	-0.78** (0.37)	-0.664 (0.445)
Male	1.25 (2.68)	1.45 (3.00)	1.25 (2.06)	1.45 (2.43)
Previous Participation	-1.46 (3.50)	-1.39 (3.59)	-1.46 (2.20)	-1.39 (2.25)
Age	0.19 (0.21)	0.165 (0.214)	0.19 (0.17)	0.165 (0.172)
Economics	-3.92 (3.50)	-3.01 (3.66)	-3.92 (2.58)	-3.01 (2.56)
Constant	45.05*** (5.19)	53.63*** (5.93)	45.05*** (5.56)	53.63*** (6.30)
Observations	1200	960	1200	960
R-squared overall	0.0644	0.0235	0.0644	0.0235
Wald χ^2	34.90	13.51	46.31	20.68

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

Table 10 consists of two panels. The left panel reports estimates on the determinant of effort. The right panel replicates those estimates but standard errors are clustered at the team level to control for interdependencies within teams. Estimates (1) and (3) are based on the four treatments considered in this section, and control for trend and demographics. Estimates (2) and (4) replicate estimates (1) and (3) on a restricted sample without the baseline, the omitted variable being the Observation dummy. Estimates shown in the right panel of table 10 report similar findings. A notable exception is that the Symbolic Group Target coefficient, weakly significant in estimate (2) is no more significant in estimate (4). Estimate (1) and (3) indicate that efforts are significantly higher in the Observation than in the Baseline treatment. Estimates

(2) and (4) indicates that efforts in the Symbolic Group Target and Symbolic Group Competition treatments are not robustly different from efforts in the Observation treatment.

These regressions confirm the results of Mann-Whitey tests regarding efforts.

Our findings are summarized in result 4.

Result 4: *a) Efforts are higher in the Observation treatment than is the Baseline treatment. b) There is no robust statistical evidence regarding difference in efforts between Observation in the one hand, and Symbolic Group Target and Competition in the other hand.*

These results contradict Hypothesis 3. which predicted that no significant difference of effort should be observed between the Baseline and the Observation treatments.

A potential explanation for this contradiction is that the disclosure of the distribution of effort choices within teams may lead participants to anticipate that their choice, in a period, may be imitated by their team-mates in the following periods, if their team-mates are prone to reciprocate (Rabin, 1993). Such an anticipation can deter participants to choose a low level of effort, fearing to be copied, and encourage them to choose a high level of effort, hoping to be imitated. Such a mechanism is more applicable when the detailed distribution of efforts choices is disclosed, than when only average and aggregate efforts are known: in the latter case, detailed choices are blurred and the ability to reciprocate is diluted. Hence, this mechanism differentiates the effects of disclosure of the distribution of efforts from the effects of disclosure of the average and aggregate efforts. This mechanism is also consistent with the last period effect observed in the Observation treatment, because anticipation of reciprocity effects does not apply in the last period of the game.

5.2.3. Statistical analysis of workers' payoffs, firms' profits, and social welfare

Table 11 provides the results of Random Effects GLS regressions regarding workers' payoffs, firms' profits, and social welfare.

Column (1) presents estimates of determinants of workers' payoffs, controlling for trend and demographics, with standard errors clustered at team level. Column (1) indicates that workers' payoffs are not significantly different across the treatments considered in this section. Column (2) replicates column (1) on a subset of treatments, without Baseline, and using Observation as reference. Column (2) confirms the absence of significant differences in payoffs between the Observation treatment in the one hand, and the Symbolic Group Target and Competition

treatments in the other hand⁶⁴. This contradicts the Mann-Whitney test mentioned above, which found a significant difference in payoffs between Observation and Symbolic Group Competition treatments.

Columns (3) and (5) respectively present estimates of the determinants of firms' profits and of social welfare, based on all the treatments considered in this section. They show the absence of significant difference in firms' profit and in social welfare between Observation and Baseline treatments. Columns (4) and (6) replicate columns (3) and (5), on a subset of treatments, without Baseline, and using Observation as reference. The coefficients of the Symbolic Group Target variable, for firms' profit and for social welfare are positive and significant. But the coefficients of the Symbolic Group Competition variable are insignificant for firms' profit and for social welfare.

Table 11: Determinants of payoffs, profits, and social welfare

Dep. Var:	Workers 'Payoff RE GLS (1)	Workers 'Payoff RE GLS (2)	Firms' Profit RE GLS (3)	Firms' Profit RE GLS (4)	Social Welfare RE GLS (5)	Social Welfare RE GLS (6)
	Clustered SE	Clustered SE	All	Without Baseline	All	Without Baseline
Baseline	Ref.		Ref.		Ref.	
Observation	0.49 (3.91)	Ref.	76.12 (50.08)	Ref.	87.41 (80.03)	Ref.
Symbolic Group Target	3.46 (4.12)	2.85 (3.22)	167.62*** (56.08)	91.49** (44.48)	200.77** (80.03)	113.36** (56.85)
Symbolic Group Competition	3.42 (3.46)	2.71 (2.19)	127.83*** (48.57)	51.70 (38.52)	165.79** (69.31)	78.38 (49.23)
Period – Trend	-0.38 (0.25)	-0.35 (0.30)	-7.87*** (2.86)	-6.76** (3.28)	-10.88*** (4.15)	-9.58** (4.68)
Male	-4.65** (1.94)	-5.10** (2.26)				
Previous Participation	3.45 (3.01)	4.38 (3.13)				
Age	0.06 (0.10)	0.03 (0.11)				
Economics	1.87 (3.00)	1.28 (2.99)				
Constant	56.96*** (3.48)	58.18*** (2.61)	517.86*** (42.65)	587.90*** (36.27)	968.77*** (61.03)	1049*** (47.73)
Observations	1200	960	150	120	150	120
R-squared overall	0.0227	0.0227	0.2358	0.1088	0.1918	0.0976
Wald χ^2	18.02	16.32	18.21	8.51	15.01	8.46

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

⁶⁴ Regressions without clustering of standard errors at team level yield similar results.

Our findings are summarized in result 5.

Result 5: *a) Workers' payoffs are not significantly different between the Baseline, the Observation and the two treatments with symbolic incentives. b) Firms' Profit and Social Welfare are not significantly different between the Baseline, the Observation, and the Symbolic Group Competition treatments. c) Firms' Profit and Social Welfare are significantly lower in the Observation treatment than in the Symbolic Group Target treatment.*

5.3. Impact of observation on monetary incentives: experimental results

This section compares the performances of the variants of the Monetary Group Target and Monetary Group Competition treatments, where only aggregate efforts of team mates are observed, to the performances of the original versions of these two treatments, where individual efforts of team mates are observed.

First, we present descriptive statistics regarding the outcomes of the treatments. Then, we provide a statistical analysis of workers' efforts. Finally, we describe their impacts on the payoffs of workers, the profits of firms, and social welfare.

5.3.1. Descriptive statistics

Table 12 presents descriptive statistics for workers' efforts and payoffs for the five treatments considered in this section. Except for the two supplementary treatments, the other columns are also present in Table 4.

Table 12: Descriptive statistics of outcomes by treatment per worker

	Baseline	Monetary Group Target – Distribution Observation	Monetary Group Target – Aggregate Observation	Monetary Group Competition – Distribution Observation	Monetary Group Competition – Aggregate Observation
Workers Effort: Average	44.90 (24.17)	72.80 (22.97)	67.56 (28.45)	64.66 (26.20)	63.63 (24.97)
Workers Payoff: Average	54.29 (22.35)	35.58 (31.37)	33.89 (31.28)	64.18 (47.82)	64.78 (49.24)
Number of Observations	240	240	240	480	480

Notes: The numbers in parentheses are standard deviations.

Table 12 indicates that for Monetary Group Competition treatments, results with observation of the distribution of efforts and results with aggregate effort observation, are quasi-identical. This is confirmed by Mann-Whitney tests, $p = 0.8728$ for efforts and $p = 0.5218$ for payoffs. For Monetary Group Target treatments, aggregate effort observation leads to slightly lower figures than observation of the distribution of efforts. However, the difference is not significant either according to Mann-Whitney tests: $p = 0.5118$ for efforts and $p = 0.6310$ for payoffs, $p = 0.2752$ for firm profits and $p = 0.5127$ for social welfare.

Table 12bis presents descriptive statistics for firms' profits and social welfare, for the five treatments considered in this section

. Except for the two supplementary treatments, the other columns are also present in Table 7.

Table 12bis: Descriptive statistics of outcomes by treatment per firm

	Baseline	Monetary Group Target – Distribution Observation	Monetary Group Target – Aggregate Observation	Monetary Group Competition – Distribution Observation	Monetary Group Competition – Aggregate Observation
Firm Profit: Average	474.57 (130.54)	990.88 (153.73)	931.27 (172.45)	646.78 (175.67)	646.30 (151.12)
Social Welfare: Average	908.92 (205.06)	1275.49 (191.92)	1202.37 (253.53)	1160.18 (209.93)	1164.51 (185.61)
Number Observations	30	30	30	60	60

Notes: The numbers in parentheses are standard deviations.

Table 12bis indicates that for Monetary Group Competition treatments, results with observation of the distribution of efforts and results with aggregate effort observation, are quasi-identical. For Monetary Group Target treatments, aggregate effort observation leads to slightly lower figures than observation of the distribution of efforts.

5.3.2. Statistical analysis of workers' efforts

Figure 7 shows the evolution over time of average effort per workers in the treatments considered in this section.

Figure 7: Average effort over time

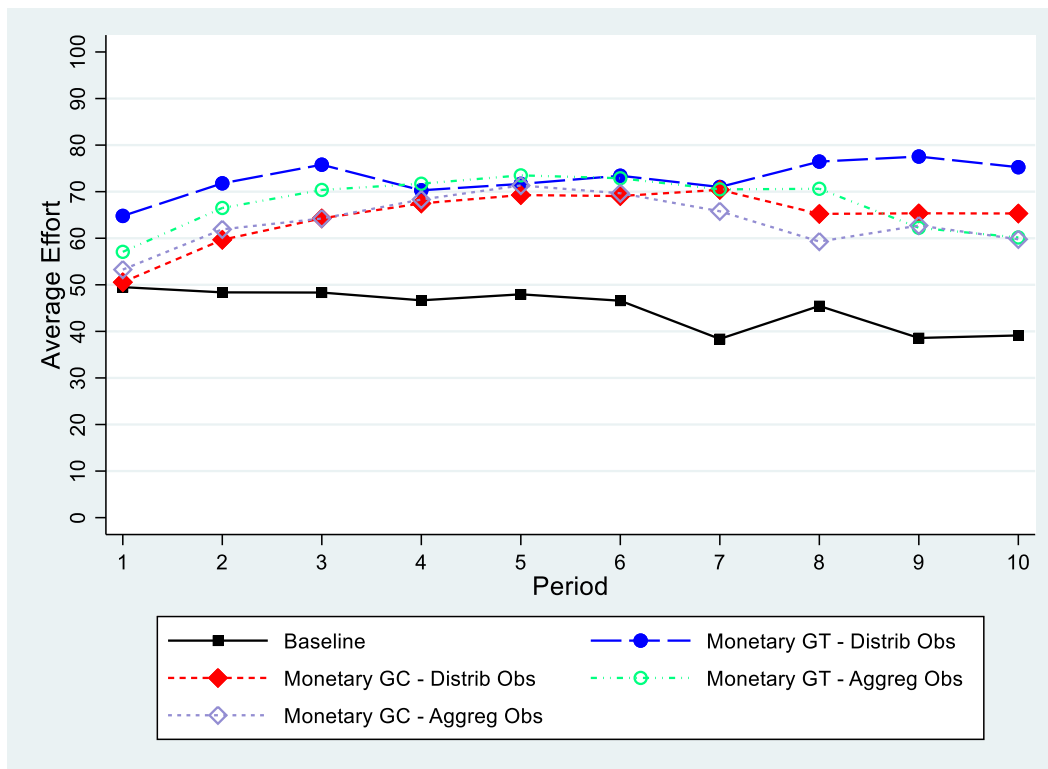


Figure 7. confirms that switching from observation of the distribution of efforts to the observation of aggregate efforts tends to impact more Monetary Group Target mechanism than Monetary Group Competition mechanism.

To formalize of our findings, we ran Random Effects GLS estimates on the determinants of effort level. The results of these estimates are shown in Table 13. Table 13 consists of two panels. The left panel reports estimates on the determinant of effort. The right panel replicates those estimates but standard errors are clustered at the team level, to control for interdependencies within teams. Estimates (1) and (4) are based on the five treatments considered in this section, and control for trend and demographics. Estimates (2) and (5) replicate estimates (1) and (4), on a restricted sample limited to the two Monetary Group Target treatments, the Monetary Group Target with observation of distribution of efforts being the reference. Similarly, estimates (3) and (6) replicate estimates (1) and (4), on a restricted sample limited to the two Monetary Group Competition treatments, the Monetary Group Competition with observation of distribution of efforts being the reference.

Estimates (1) and (4) show that the coefficient of the Monetary Group Target treatment with observation of aggregate efforts, 22.81, is highly significant but below the coefficient of the Monetary Group Target treatment with observation of the distribution of efforts, 28.05. However, the coefficient of Monetary Group Target treatment with observation of aggregate

efforts is insignificant in estimates (2) and (5), suggesting the absence of significant difference in efforts between the two Monetary Group Target treatments.

Estimates (1) and (4) also show that the coefficient of the Monetary Group Competition treatment with observation of aggregate efforts, 19.31, is highly significant and very close to the coefficient of the Monetary Group Target treatment with observation of distribution of efforts, 19.81. The coefficient of Monetary Group Competition treatment with observation of aggregate efforts is insignificant in estimates (3) and (6), confirming the absence of significant difference in efforts between the two Monetary Group Competition treatments

Table 13: Determinants of effort level

Dep. Var: Effort level	RE GLS (1)	RE GLS (2)	RE GLS (3)	RE GLS (4)	RE GLS (5)	RE GLS (6)
Treatments	All	Monetary Group Target	Monetary Group Competition	All	Monetary Group Target	Monetary Group Competition
				With clustered SE		
Baseline	Ref.			Ref.		
Monetary GT Distribution	28.05*** (4.67)	Ref.		28.05*** (4.83)	Ref.	
Monetary GT Aggregate	22.81*** (4.63)	-4.44 (5.04)		22.81*** (6.52)	-4.44 (6.56)	
Monetary GC Distribution	19.81*** (4.10)		Ref.	19.81*** (4.80)		Ref.
Monetary GC Aggregate	19.31*** (4.02)		-1.03 (3.30)	19.31*** (4.54)		-1.03 (4.56)
Period – Trend	0.32* (0.18)	0.414 (0.330)	0.66*** (0.24)	0.32 (0.37)	0.414 (0.78)	0.66 (0.48)
Male	2.09 (2.55)	-1.19 (5.29)	3.44 (3.35)	2.09 (1.91)	-1.19 (3.05)	3.44 (2.81)
Previous Participation	1.88 (3.12)	9.03 (5.98)	-1.04 (3.95)	1.88 (3.65)	9.03 (6.22)	-1.04 (4.55)
Age	0.24 (0.53)	0.006 (0.947)	0.29 (0.90)	0.24 (0.44)	0.006 (0.600)	0.29 (0.87)
Economics	-3.34 (3.24)	-1.79 (6.50)	-2.91 (4.08)	-3.34 (2.99)	-1.79 (5.91)	-2.91 (4.00)
Constant	37.47*** (11.42)	68.56*** (20.11)	54.79*** (18.80)	37.47*** (10.71)	68.56*** (11.35)	54.79*** (19.03)
Observations	1680	480	960	1680	480	960
R-squared overall	0.0971	0.0352	0.0121	0.0971	0.0352	0.0121
Wald χ^2	48.63	5.14	9.09	61.91	31.20	4.14

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

These regressions confirm the results of Mann-Whitey tests regarding efforts. Our findings are summarized in result 6.

Result 6: a) *Switching from the observation of efforts distribution to the observation of aggregate effort has no significant effects on efforts in the Monetary Group Competition*

treatments. b) The observed negative effect on efforts of switching from the observation of efforts distribution to the observation of aggregate effort stays insignificant.

These results confirm hypotheses 4 and 5 which predicted no significant difference between efforts in the two Monetary Group Target treatments, and in the two Monetary Group Competition treatments.

5.3.3. Statistical analysis of workers' payoffs, firms' profits, and social welfare

We ran Random Effects GLS estimates on the determinants of workers' payoffs, firms' profits, and social welfare per firm. The results of these estimates are shown in Table 14 for payoffs and in Table 15 for firms' profits and social welfare.

Table 14: Determinants of payoffs level

Dep. Var:	RE GLS	RE GLS	RE GLS	(3)	RE GLS	RE GLS (5)	RE GLS	(6)
Payoff level	(1)	(2)			(4)			
Treatments	All	Monetary Group Target	Monetary Group Competition		All	Monetary Group Target	Monetary Group Competition	
					With clustered SE			
Baseline	Ref.				Ref.			
Monetary GT Distribution	-19.75*** (5.60)	Ref.			-19.75*** (5.06)	Ref.		
Monetary GT Aggregate	-21.06*** (5.55)	-1.84 (3.73)			-21.06*** (6.40)	-1.84 (5.65)		
Monetary GC Distribution	8.65* (4.91)		Ref.		8.65** (3.72)		Ref.	
Monetary GC Aggregate	10.43** (4.82)		1.57 (4.69)		10.43*** (3.63)		1.57 (1.79)	
Period – Trend	0.38 (0.33)	1.84*** (0.46)	-0.14 (0.51)		0.38 (0.25)	1.84*** (0.55)	-0.14 (0.19)	
Male	0.19 (3.05)	3.46 (3.92)	-1.17 (4.75)		0.19 (2.92)	3.46 (2.47)	-1.17 (4.37)	
Previous Participation	5.43 (3.74)	3.32 (4.44)	7.13 (5.61)		5.43 (4.36)	3.32 (3.61)	7.13 (7.46)	
Age	0.25 (0.63)	0.98 (0.70)	-0.78 (1.28)		0.25 (0.33)	0.98** (0.47)	-0.78 (0.93)	
Economics	-2.23 (3.88)	-10.80** (4.82)	0.40 (5.79)		-2.23 (4.23)	-10.80*** (3.79)	0.40 (6.17)	
Constant	47.02*** (13.76)	5.41 (15.06)	78.88*** (26.75)		47.02*** (8.43)	5.41 (10.74)	78.88*** (18.08)	
Observations	1680	480	960		1680	480	960	
R-squared overall	0.0947	0.0700	0.0042		0.0947	0.0700	0.0042	
Wald χ^2	82.72	27.58	1.94		154.50	72.95	2.45	

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

Table 14 is the equivalent for workers' payoffs of Table 13 for workers' efforts. Estimates (1) and (4) show that the coefficient of the Monetary Group Target treatment with observation of aggregate efforts, -21.06, is highly significant and somewhat more negative than the coefficient of the Monetary Group Target treatment with observation of the distribution of efforts, -19.75. However, the coefficient of Monetary Group Target treatment with observation of aggregate efforts is insignificant in estimates (2) and (5), suggesting the absence of significant difference in payoffs between the two Monetary Group Target treatments.

Estimates (1) and (4) also show that the coefficient of the Monetary Group Competition treatment with observation of aggregate efforts, 10.43, is significant and somewhat more positive and more significant than coefficient of the Monetary Group Target treatment with observation of distribution of efforts, 8.65. However, the coefficient of Monetary Group Competition treatment with observation of aggregate efforts is insignificant in estimates (3) and (6), suggesting the absence of significant difference in payoffs between the two Monetary Group Competition treatments.

Table 15: Determinants of firms' profits and social welfare

Dep. Var:	Firms' profits RE GLS (1)	Firms' profits RE GLS (2)	Firms' profits RE GLS (3)	Social Welfare RE GLS (4)	Social Welfare RE GLS (5)	Social Welfare RE GLS (6)
Treatments	All	Monetary Group Target	Monetary Group Competition	All	Monetary Group Target	Monetary Group Competition
Baseline	Ref.			Ref.		
Monetary GT Distribution	516.3*** (85.5)	Ref.		366.6*** (116.6)	Ref.	
Monetary GT Aggregate	456.7*** (85.5)	-59.61 (90.66)		293.5** (116.6)	-73.12 (149.97)	
Monetary GC Distribution	172.2** (74.1)		Ref.	251.3** (101.0)		Ref.
Monetary GC Aggregate	171.7** (74.1)		-0.48 (58.05)	255.6** (101.0)		4.33 (65.68)
Period – Trend	-2.77 (3.25)	-13.37** (6.07)	4.91 (4.49)	0.28 (4.12)	1.39 (7.76)	3.82 (5.60)
Constant	489.8*** (63.07)	1064.41*** (72.27)	619.79*** (47.90)	907.4*** (85.5)	1267.87*** (114.32)	1139.16*** (55.93)
Observations	210	60	120	210	60	120
R-squared overall	0.5356	0.0886	0.0075	0.2087	0.0269	0.0032
Wald χ^2	55.23	5.29	1.20	11.36	0.27	0.47

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

Estimates (1) shows that the coefficient of the Monetary Group Target treatment with observation of aggregate efforts, 456.7, is highly significant but below the coefficient of the

Monetary Group Target treatment with observation of the distribution of efforts, 516.3. However, the coefficient of Monetary Group Target treatment with observation of aggregate efforts is insignificant in estimates (2), suggesting the absence of significant difference in firms' profits between the two Monetary Group Target treatments. Estimates (1) also shows that the coefficient of the Monetary Group Competition treatment with observation of aggregate efforts, 171.7, is highly significant and very close to the coefficient of the Monetary Group Target treatment with observation of distribution of efforts, 172.2. The coefficient of Monetary Group Competition treatment with observation of aggregate efforts is insignificant in estimates (3), confirming the absence of significant difference in firms' profits between the two Monetary Group Competition treatments. Estimates (4), (5), and (6) replicate estimates (1), (2), and (3) for Social Welfare and yield similar conclusions.

Our findings are summarized in result 7.

Result 7: *Switching from the observation of efforts distribution to the observation of aggregate effort has no significant effects on workers' payoffs, firms' profits, and social welfare, neither for Monetary Group Target, nor for Monetary Group Competition mechanisms.*

6. Conclusion

In this chapter, we investigate the impact of replacing monetary by symbolic incentives at team level in centralized target-based and competition-based mechanisms. Our motivation is to assess if centralized mechanisms using symbolic incentives may prevent free-riding as efficiently as when they use monetary incentives, without generating the negative effects of monetary incentives on the payoffs of workers observed in chapter 2. A second question addressed in this chapter is how the observation of the distribution of effort levels within teams modify workers' behaviors. We compare situations where workers observe the average and aggregate efforts of their team mates, to situations where they observe the detailed distribution of their effort choices. Our motivation is to disentangle the effects of the incentive mechanisms themselves, from the effects of switching from the observation of average efforts to the observation of the distribution of efforts.

Our approach uses an economic laboratory experiment inspired by Nalbantian and Schotter (1997) effort game. We observe that compared to the baseline treatment, symbolic incentives are effective for increasing workers' efforts and social welfare, but less than monetary incentives. This increase of social welfare mostly benefits to firms. Introducing observation of

the distribution of efforts of team mates, instead of observation their average efforts, in the baseline revenue sharing treatment, significantly increases effort. There is no robust statistical evidence of difference of efforts between revenue sharing treatment with observation of the distribution of efforts, and treatments using centralized symbolic incentives. Switching from observation of distribution of efforts, to observation of average efforts, has no significant influence on the results of treatments with competition-based monetary incentives. It may decrease efforts in treatments with target-based monetary incentives, but the difference is not significant.

Three policy implications may be suggested by this study.

The first policy implication is that team monetary incentives seem more powerful and reliable than team non-monetary incentives to increase effort and firms' profit. However, they are likely to generate tensions between firms and workers, when they result in low pay-offs for workers, or between workers, when they result in highly unequal pay-offs between workers. Hence, managers face a trade-off when using monetary team-incentives.

A second policy implication is that the observation of the distribution of efforts of team-mates, with no disclosure of the identities of who choose what, is welfare enhancing. The non-disclosure provision prevents the negative welfare impact of public recognition of behaviors underlined in Butera et al. (2022).

A third policy implication is that, in the absence of intrinsic motivation, the additional impact of centralized mechanisms using symbolic incentives, on top of the observation of effort distribution, is weak if not non-significant.

This study and these conclusions have limitations. In the one hand, as all conclusions derived from laboratory experiments, their external validity shares the limits discussed in depth in the last section of the previous chapter. In the other hand, this study also has more specific limits. A first specific limit results from the relatively small number of observations produced by the experiment, which does not allow the derivation of clear-cut conclusions from statistical analysis in all the cases of interest. A second specific limit is that all interesting combinations of incentives mechanisms have not been tested, such as centralized mechanisms with symbolic incentives and observation of aggregate effort of team mates. A third specific limit is the absence of a comprehensive theoretical behavioral model explaining our results. These limits suggest venues for further research.

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Appendix

Appendix A: Instructions (translated from French)

Instructions for the Baseline treatment, the Monetary Group Target treatment and the Monetary Group Competition treatments can be found in Appendix B of Chapter 2. The present appendix A of chapter 3, includes the instructions of the treatments which are specific to this chapter: Symbolic Group Target, Symbolic Group Competition, Observation, Monetary Group Target with Aggregate Observations and Monetary Group Competition with Aggregate Observations.

Instructions for participants in the experiment

[instructions for the Symbolic Group Target treat.]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:


1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

At the beginning of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.

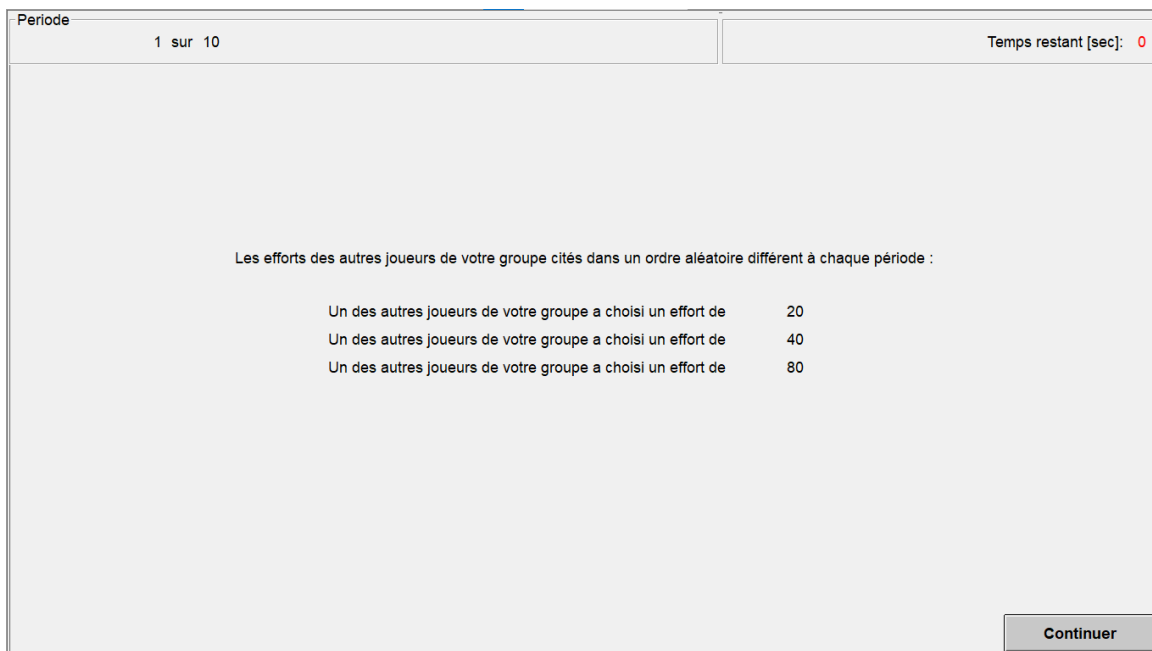


The screenshot shows a software interface for an experiment. At the top left, it says "Periode" and "1 sur 10". At the top right, it says "Temps restant [sec]: 7". The main area contains the text "Choisissez votre effort entre 0 et 100" followed by a blue input field. At the bottom right, there is a red "OK" button.

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the efforts of other players

The next screen displays the efforts chosen by the other players in your group in a random order that changes each period. The screen below shows an example where these 3 other players have chosen efforts of 20, 40 and 80:



Click "Continue" to move on.

Calculation of your payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of effort**. **We will call the resulting number the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

Each group member will receive one quarter of total group revenue. This is your **individual revenue**.

For example, if you choose an effort of 60 and the sum of the efforts of the other players in your group is 140, then the **Sum of group efforts** is $(60 + 140 = 200)$. If the random shock is (-40) , the total group production is $(200 - 40) = 160$, the total group revenue is $(1.5 \times 160) = 240$ and your individual revenue, as well as that of the 3 other players in the group is $(240 / 4 = 60)$. In other word each group member receives an equal share of total group revenue, i.e., one quarter of 240.

Your individual revenue is thus calculated as follow:

<p>Your individual revenue in each period is therefore: [1.5*(sum of group efforts + random shock between -40 and +40)/4]</p>

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

Your payoff for each period = Individual Revenue-Cost of effort+10 tokens
= $(1.5 * (\text{Sum of group efforts} + \text{Random shock between } -40 \text{ and } +40) / 4) - \text{cost of effort} + 10$

Please note that if the cost of effort exceeds your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the previous example where you choose an effort of 60 and your individual revenue is also 60, your cost of effort is 36 according to Table A, and the difference is $(60 - 36) = 24$ tokens. By adding 10 additional tokens, your payoff for the period is 34 tokens.

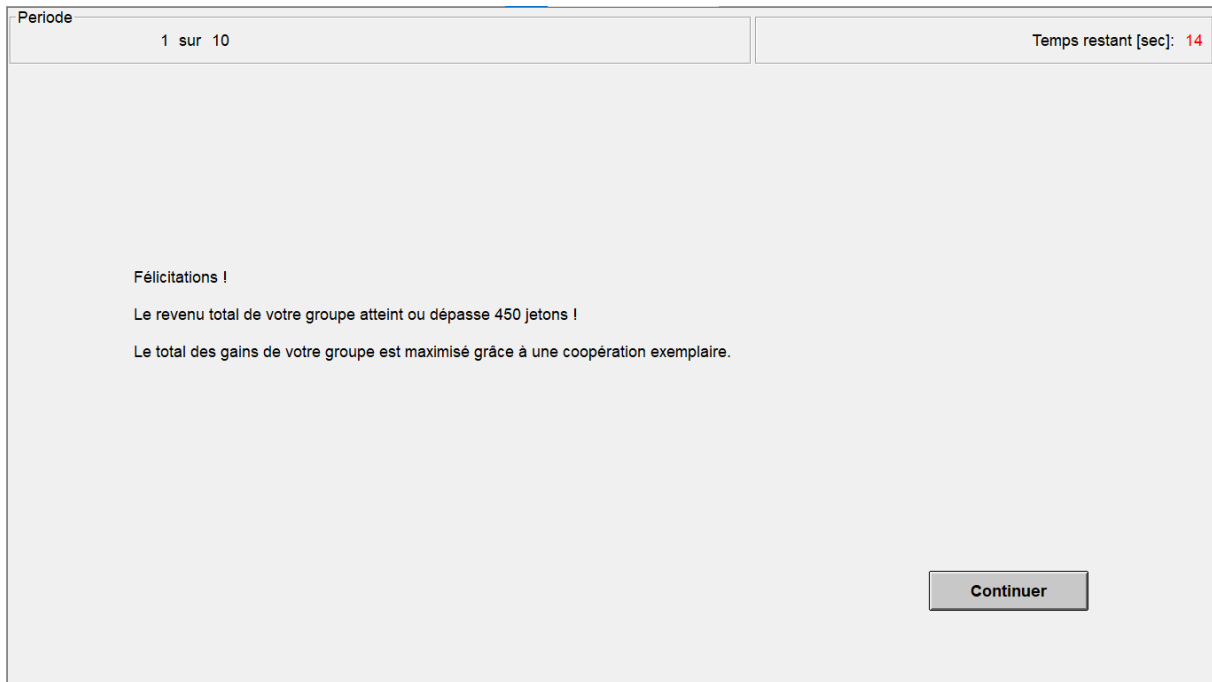
Your payoff for the period is calculated by the computer and displayed on the screen:

Periode		Temps restant [sec]: 10
1 sur 10		
Résultats pour la période		
Effort que vous avez choisi	60	
Somme des efforts du groupe	200	
Choc aléatoire (entre -40 et +40)	-40.0	
Production totale du groupe	160	
Revenu total du groupe	240.00	
Votre revenu de production	60.00	
Votre coût de production	36.00	
Votre gain de production	24.00	
Votre dotation additionnelle	10	
Votre gain pour la période	34.00	
<input type="button" value="Continuer"/>		

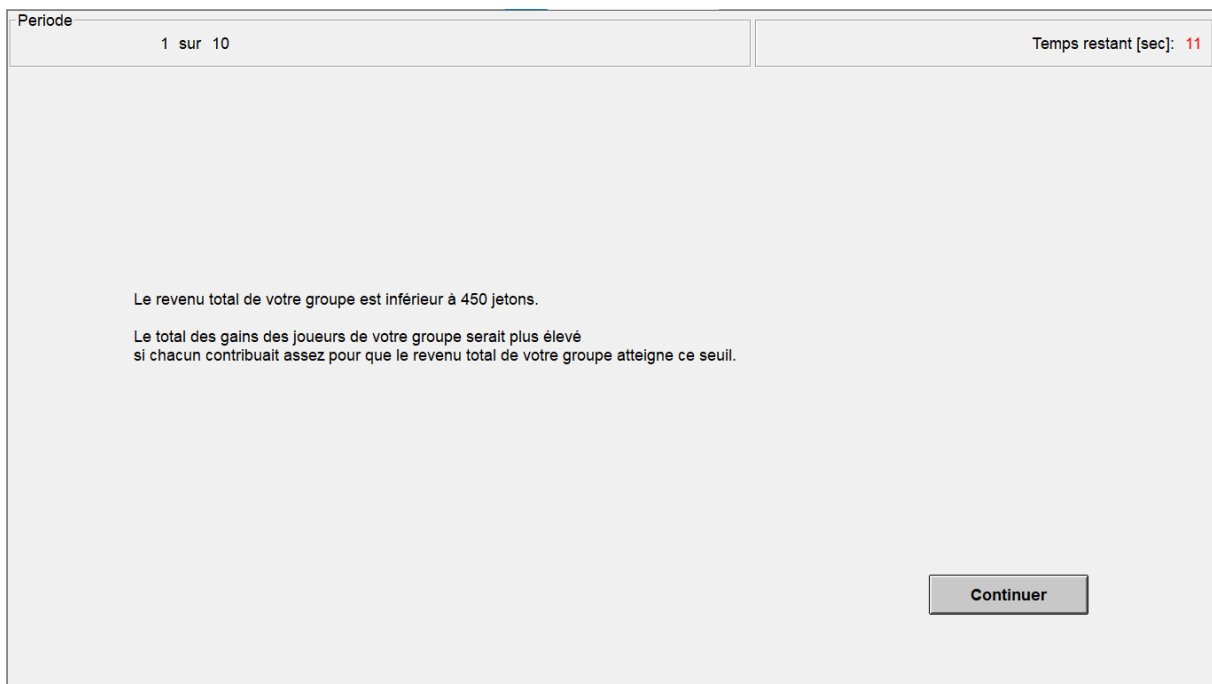
Click "Continue" to move on.

Congratulatory or alert message depending on the group's total income

If the group's total income equals or exceeds 450 tokens, congratulations are displayed on the screen:



Otherwise, an alert message appears on the screen:



Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

Instructions for participants in the experiment

[instructions for Symbolic Group Competition treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

At each period, the results of your group are compared to those of a competing group which remains the same throughout the experiment. The winning group in this comparison receives a congratulatory message and the losing group receives an alert message.

At the beginning of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.

Periode 1 sur 10

Temps restant [sec]: 7

Choisissez votre effort entre 0 et 100

OK

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the efforts of other players

The next screen displays the efforts chosen by the other players in your group in a random order that changes each period. The screen below shows an example where these 3 other players have chosen efforts of 20, 40 and 80:

Periode 1 sur 10

Temps restant [sec]: 0

Les efforts des autres joueurs de votre groupe cités dans un ordre aléatoire différent à chaque période :

Un des autres joueurs de votre groupe a choisi un effort de	20
Un des autres joueurs de votre groupe a choisi un effort de	40
Un des autres joueurs de votre groupe a choisi un effort de	80

Continuer

Click "Continue" to move on.

Calculation of your payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of effort**. We will call the resulting number **the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

Each group member will receive one quarter of total group revenue. This is your **individual revenue**.

For example, if you choose an effort of 60 and the sum of the efforts of the other players in your group is 140, then the **Sum of group efforts** is $(60 + 140 = 200)$. If the random shock is $(- 40)$, the total group production is $(200 - 40) = 160$, the total group revenue is $(1.5 \times 160) = 240$ and your individual revenue, as well as that of the 3 other players in the group is $(240 / 4 = 60)$. In other word each group member receives an equal share of total group revenue, i.e., one quarter of 240.

Your individual revenue is thus calculated as follow:

Your individual revenue in each period is therefore: $[1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40) / 4]$

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

$$\text{Your payoff for each period} = \text{Individual Revenue} - \text{Cost of effort} + 10 \text{ tokens}$$
$$= (1.5 * (\text{Sum of group efforts} + \text{Random shock between } -40 \text{ and } +40) / 4) - \text{cost of effort} + 10$$

Please note that if the cost of effort exceeds your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the previous example where you choose an effort of 60 and your individual revenue is also 60, your cost of effort is 36 according to Table A, and the difference is $(60 - 36) = 24$ tokens. By adding 10 additional tokens, your payoff for the period is 34 tokens.

Your payoff for the period is calculated by the computer and displayed on the screen:

Période		1 sur 10		Temps restant [sec]: 10	
Résultats pour la période					
Effort que vous avez choisi	60				
Somme des efforts du groupe	200				
Choc aléatoire (entre -40 et +40)	-40.0				
Production totale du groupe	160				
Revenu total du groupe	240.00				
Votre revenu de production	60.00				
Votre coût de production	36.00				
Votre gain de production	24.00				
Votre dotation additionnelle	10				
Votre gain pour la période	34.00				
<input type="button" value="Continuer"/>					

Click "Continue" to move on.

Congratulatory or alert message depending on whether the group's total income is higher or lower than that of the group competing with yours

The total income of your group is compared to that of the group that is your competitor during the entire experiment. If it is higher than that of the competitor, congratulations are displayed on the screen:

Periode 1 sur 10 Temps restant [sec]: 6

Comparaison avec votre concurrent pour la période

Revenu total du groupe	240.00
Revenu total du groupe concurrent	210.00

Gagné !

Le revenu total de votre groupe est supérieur à celui de votre concurrent.

Bravo !

Le total des gains des membres de votre groupe doit dépasser celui de votre concurrent grâce à une meilleure coopération.

Continuer

If it is lower, an alert message is displayed on the screen:

Periode 1 sur 10 Temps restant [sec]: 6

Comparaison avec votre concurrent pour la période

Revenu total du groupe	240.00
Revenu total du groupe concurrent	270.00

Perdu !

Le revenu total de votre groupe est inférieur à celui de votre concurrent.

Le total des gains des membres du groupe concurrent doit dépasser celui du vôtre. Il vous faut mieux coopérer pour augmenter vos gains.

Continuer

If it is equal, a neutral message is displayed on the screen:

Periode	1 sur 10	Temps restant [sec]: 12
Comparaison avec votre concurrent pour la période		
Revenu total du groupe		240.00
Revenu total du groupe concurrent		240.00
Egalité !		
Le revenu total de votre groupe est égal à celui de votre concurrent.		
Le total des gains des membres de votre groupe pourrait dépasser celui de votre concurrent avec une meilleure coopération.		
<input type="button" value="Continuer"/>		

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

Instructions for participants in the experiment

[instructions for Revenue Sharing with Observation treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

At the beginning of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.

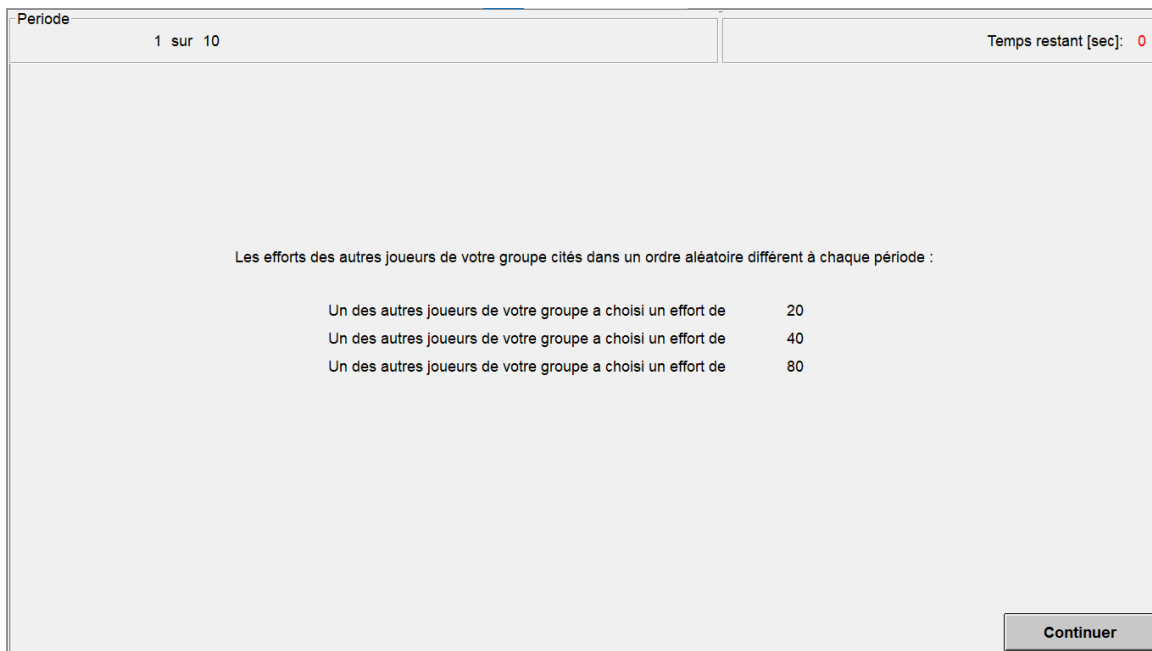


The screenshot shows a software interface for an experiment. At the top left, it says "Periode 1 sur 10". At the top right, it says "Temps restant [sec]: 7". In the center, there is a prompt "Choisissez votre effort entre 0 et 100" followed by a small blue rectangular input field. At the bottom right, there is a red button labeled "OK".

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the efforts of other players

The next screen displays the efforts chosen by the other players in your group in a random order that changes each period. The screen below shows an example where these 3 other players have chosen efforts of 20, 40 and 80:



The screenshot shows a game window with a title bar containing "Periode" and "1 sur 10" on the left, and "Temps restant [sec]: 0" on the right. The main content area displays the following text:

Les efforts des autres joueurs de votre groupe cités dans un ordre aléatoire différent à chaque période :

Un des autres joueurs de votre groupe a choisi un effort de	20
Un des autres joueurs de votre groupe a choisi un effort de	40
Un des autres joueurs de votre groupe a choisi un effort de	80

A "Continuer" button is located in the bottom right corner of the window.

Click "Continue" to move on.

Calculation of your payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of effort**. **We will call the resulting number the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

Each group member will receive one quarter of total group revenue. This is your **individual revenue**.

For example, if you choose an effort of 60 and the sum of the efforts of the other players in your group is 140, then the **Sum of group efforts** is $(60 + 140 = 200)$. If the random shock is (-40) , the total group production is $(200 - 40) = 160$, the total group revenue is $(1.5 \times 160) = 240$ and your individual revenue, as well as that of the 3 other players in the group is $(240 / 4 = 60)$. In

other word each group member receives an equal share of total group revenue, i.e., one quarter of 240.

<p>Your individual revenue in each period is therefore: [1.5*(sum of group efforts + random shock between -40 and +40)/4]</p>

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

Your payoff for each period = Individual Revenue - Cost of effort + 10 tokens

$$= (1.5 * (\text{Sum of group efforts} + \text{Random shock between } -40 \text{ and } +40) / 4) - \text{cost of effort} + 10$$

Please note that if the cost of effort exceeds your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the previous example where you choose an effort of 60 and your individual revenue is also 60, your cost of effort is 36 according to Table A, and the difference is $(60 - 36) = 24$ tokens. By adding 10 additional tokens, your payoff for the period is 34 tokens.

Your payoff for the period is calculated by the computer and displayed on the screen:

Résultats pour la période	
Effort que vous avez choisi	60
Somme des efforts du groupe	200
Choc aléatoire (entre -40 et +40)	-40.0
Production totale du groupe	160
Revenu total du groupe	240.00
Votre revenu de production	60.00
Votre coût de production	36.00
Votre gain de production	24.00
Votre dotation additionnelle	10
Votre gain pour la période	34.00

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

Instructions for participants in the experiment

[instructions for the Monetary Group Target with Aggregate Observation treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

At the beginning of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.



The screenshot shows a software interface for an experiment. At the top left, it says "Periode" and "1 sur 10". At the top right, it says "Temps restant [sec]: 7". The main area contains the text "Choisissez votre effort entre 0 et 100" followed by a blue input field. At the bottom right, there is a red "OK" button.

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the sum and average of the efforts of the other players in your group

After all members of your group have made their effort decision your screen will show you the sum of group effort and average of the efforts chosen by the other three players in your group. The screen below shows an example where the sum of the efforts chosen by the other 3 players in your group is 140, corresponding to an average effort of $140 / 3 = 46.67$ from the other 3 players in your group.



The screenshot shows a game interface with a grey background. At the top left, it says "Periode" and "1 sur 10". At the top right, it says "Temps restant [sec]: 8". In the center, there are two lines of text: "Somme des efforts choisis par les 3 autres membres de votre groupe" followed by "140", and "Moyenne des efforts choisis par les 3 autres joueurs de votre groupe" followed by "46.67". At the bottom right, there is a button labeled "Continuer".

Click "Continue" to move on.

Calculation of your payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of group effort**. **We will call the resulting number the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

The total group revenue is compared to a certain threshold. Precisely, if your total group revenue is greater than or equal to a threshold set at 450 tokens, then each group member of your group will receive one quarter of total group revenue. This is your **individual revenue**.

Otherwise, if **your total group revenue is lower than the threshold set at 450 tokens** your individual revenue equals a fixed minimum amount of 7.5 tokens.

For example, if you choose an effort of 60 and the other players in your group 20, 40 and 80, the **Sum of group efforts** is $(60 + 20 + 40 + 80 = 200)$. If the random shock is $(- 40)$, the **total group production** is $(200 - 40) = 160$ and the **total group revenue** is $(1.5 \times 160) = 240$. The total group revenue being lower than the threshold of 450, your **individual revenue**, as well as that of the other 3 players in the group, is 7.5 tokens.

If you still choose an effort of 60 but the other players in your group, choose 40, 80 and 100, respectively, the **Sum of group efforts** is $(60 + 40 + 80 + 100 = 280)$. If the random shock this time is $(+ 40)$, the total group production is $(280 + 40) = 320$ and the total group revenue is $(1.5 \times 320) = 480$. The total group revenue being greater than the threshold of 450, your individual revenue, as well as that of the 3 other players in the group, is $(480/4) = 120$ tokens.

Your individual revenue is thus calculated as follow:

Your individual revenue in each period is therefore:

$[1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40) / 4]$ If the group's total revenue is greater than or equal to 450

7.5 otherwise

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

Payoff for the period

= **Individual Revenue – Cost of Effort + 10**

=

If the group's total income is greater than or equal to 450, then

$[(1.5 * (\text{Sum of group efforts} + \text{Random shock between } -40 \text{ and } +40) / 4) - \text{Cost of Effort}] + 10$

If the total group income is less than 450, then

$[7.5 - \text{Cost of Effort}] + 10$

Please note that if the cost of effort exceeds your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the first example above where you choose an effort of 60 and your group's total income is 240, below the threshold of 450 your individual revenue is set to 7.5. Your cost of effort, equal to 36 according to Table A, exceeds your individual revenue of 7.5. As a result, the computer sets the difference to 0. By adding 10 additional tokens, your payoff for the period is 10 tokens.

In the second example above where you still choose an effort of 60 but the total income of your group is equal to 480, above the threshold of 450, your individual revenue is worth a quarter of the income of the group or 120. Your cost of effort is equal to 36 according to Table A. Therefore, the difference is $120 - 36 = 84$. By adding 10 additional tokens, your payoff for the period is 94 tokens.

Your payoff for the period is calculated by the computer and displayed on the screen:

Periode		1 sur 10	Temps restant [sec]: 6
Résultats pour la période			
Effort que vous avez choisi		60	
Somme des efforts du groupe		200	
Choc aléatoire (entre -40 et +40)		-40.0	
Production totale du groupe		160	
Revenu total du groupe		240.00	
Votre revenu de production		60.00	
Votre coût de production		36.00	
Votre gain de production		24.00	
Votre dotation additionnelle		10	
Votre gain pour la période		34.00	
Continuer			

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

Instructions for participants in the experiment

[instructions for the Monetary Group Competition with Aggregate Observation treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

At each period, the results of your group are compared to those of a competing group that remains the same throughout the experiment. The winning group of this comparison receives 180 tokens from the defeated group.

At the beginning of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.

Periode 1 sur 10

Temps restant [sec]: 7

Choisissez votre effort entre 0 et 100

OK

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the sum and average of the efforts of the other players in your group

After all members of your group have made their effort decision your screen will show you the sum of group effort and average of the efforts chosen by the other three players in your group. The screen below shows an example where the sum of the efforts chosen by the other 3 players in your group is 140, corresponding to an average effort of $140 / 3 = 46.67$ from the other 3 players in your group.

Periode 1 sur 10

Temps restant [sec]: 8

Somme des efforts choisis par les 3 autres membres de votre groupe	140
Moyenne des efforts choisis par les 3 autres joueurs de votre groupe	46.67

Continuer

Click "Continue" to move on.

Calculation of your payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of group effort**. We will call the resulting number the **sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

The total group revenue of each group is compared to that of another group within the session. If your total group revenue is greater than that of the other group, then 180 tokens are added to your Total group revenue. In the opposite if your total group revenue is lower than that of the other group, then your total group revenue is reduced by 180 tokens that are given to the winning group.

In case of a tie, no transfer takes place.

Each group member will receive one quarter of total group revenue (after transfer). This is your **individual revenue**.

For example, if you choose an effort of 60 and the other players in your group 20, 40 and 80, the **Sum of group efforts** is $(60 + 20 + 40 + 80 = 200)$. If the random shock is $(- 40)$, the **total group production** is $(200 - 40) = 160$ and the **total group revenue** is $(1.5 \times 160) = 240$.

If, in this example, the other group has a total group revenue greater than 240, therefore greater than yours, your group transfers 180 tokens to the other group, which are deducted from your total group revenue: there are therefore only $240 - 180 = 60$ tokens left to distribute among the 4 players in your group. Hence each group member receives his individual revenue of $(60/4) = 15$ tokens.

In the opposite case, if, in this example, the other group has a total income lower than 240, therefore lower than yours, it transfers to your group 180 tokens which are added to the total group revenue of your group: there are therefore $240 + 180 = 420$ tokens to be divided between the 4 players in your group. Hence each group member receives his individual revenue of $(420/4) = 105$ tokens.

Your individual revenue is thus calculated as follow:

Your individual revenue in each period is therefore:

$[1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40 + 180) / 4]$ If your total group revenue is higher than that of the other group

$[1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40 - 180) / 4]$ If your total group revenue is lower than that of the other group

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e. at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

Payoff for the period

= **Individual Revenue – Cost of Effort + 10**

= $[(1.5 * (\text{sum of group efforts} + \text{random production shock between } -40 \text{ and } +40) + 180) / 4]$
- **Cost of Effort** + 10 *if your group's total income is higher than that of the competing group*

= $[(1.5 * (\text{sum of group efforts} + \text{random production shock between } -40 \text{ and } +40) - 180) / 4]$
- **Cost of Effort** + 10 *if your group's total income is less than that of the competing group*

Please note that if the cost of effort exceeds your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the first example above, where you choose an effort of 60 and your group's total income by 240 is less than that of the competing group, your individual revenue is reduced to $(240 - 180) / 4 = 60 / 4 = 15$ tokens due to the transfer of 180 tokens to the competing group. Your cost resulting from your effort of 60 is worth 36 according to Table A. Since your individual revenue of 15 is less than your production cost of 36, the difference is set to 0. With 10 additional tokens, your payoff for the period is 10 tokens.

In the second example above, where you choose an effort of 60 and your group's total income by 240 is greater than that of the competing group, your individual revenue is increased to $(240 + 180) / 4 = 420 / 4 = 105$ tokens thanks to the transfer of 180 tokens from the competing group. Your cost resulting from your effort of 60 is worth 36 according to Table A: the difference between your individual revenue of 105 and your cost of effort of 36, i.e., 69. With 10 additional tokens, your payoff for the period is 79 tokens.

Your payoff for the period is calculated by the computer and displayed on the screen:

Periode		1 sur 10	Temps restant [sec]: 6
Résultats pour la période			
Effort que vous avez choisi		60	
Somme des efforts du groupe		200	
Choc aléatoire (entre -40 et +40)		-40.0	
Production totale du groupe		160	
Revenu total du groupe		240.00	
Votre revenu de production		60.00	
Votre coût de production		36.00	
Votre gain de production		24.00	
Votre dotation additionnelle		10	
Votre gain pour la période		34.00	
<input type="button" value="Continuer"/>			

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

Appendix B: Supplementary material

Table B1. Results of tests on socio-demographics differences between treatments (Main Experiment)

	Gender*	Participation*	Economics*	Age [‡]
Baseline vs Monetary Group Target	0.770	0.048	0.416	0.8892
Baseline vs Symbolic Group Target	0.564	0.048	0.137	0.8449
Baseline vs Monetary Group Competition	0.803	0.007	0.196	0.8978
Baseline vs Symbolic Group Competition	0.623	0.026	0.479	0.3318
Monetary Group Target vs Symbolic Group Target	0.248	1.000	0.740	0.7305
Monetary Group Target vs Monetary Group Competition	0.803	0.794	1.000	0.9416
Monetary Group Target vs Symbolic Group Competition	1.000	1.000	0.749	0.2800
Symbolic Group Target vs Monetary Group Competition	0.216	0.794	0.576	0.6753
Symbolic Group Target vs Symbolic Group Competition	0.143	1.000	0.234	0.4143
Monetary Group Target vs Symbolic Group Competition	1.000	0.657	0.609	0.1385

Note. *: Fisher exact test; chi-squared tests provide similar qualitative findings. [‡]:t-test

Table B2. Results of tests on socio-demographics differences between treatments (Complement 1)

	Gender*	Participation*	Economics*	Age [‡]
Baseline vs Observation	1.000	0.609	0.416	0.1314
Symbolic Group Target vs Observation	0.387	0.286	0.740	0.1616
Symbolic Group Competition vs Observation	1.000	0.232	0.749	0.3303

Note. *: Fisher exact test; chi-squared tests provide similar qualitative findings. [‡]:t-test

Table B3. Results of tests on socio-demographics differences between treatments (Complement 2)

	Gender*	Participation*	Economics*	Age [‡]
Baseline vs Monetary Group Target Aggregate	1.000	0.188	0.416	0.8585
Monetary Group Target Distribution vs Monetary Group Target Aggregate	1.000	0.740	1.000	0.7229
Monetary Group Competition Distribution vs Monetary Group Target Aggregate	1.000	0.410	1.000	0.6758
Baseline vs Monetary Group Competition Aggregate	0.803	0.255	0.121	0.3904
Monetary Group Target Distribution vs Monetary Group Competition Aggregate	0.803	0.206	0.776	0.4464
Monetary Group Competition Distribution vs Monetary Group Competition Aggregate	1.000	0.054	1.000	0.2539
Monetary Group Target Aggregate vs Monetary Group Competition Aggregate	1.000	0.518	0.776	0.2215

Note. *: Fisher exact test; chi-squared tests provide similar qualitative findings. [‡]:t-test

Chapter 4

Effects of team leaders on teamwork:

Experimental Evidence

1. Introduction

Many firms across countries and industries have adopted team-based organizations to enhance collaboration, creativity, and innovation. This observation is detailed in chapter 1. However, teams-based organizations have downsides, such as the well known free riding problem, as shown in the previous chapters, or the difficulty for team members to coordinate. Decision making within teams may face information sharing and coordination problems (e.g. Driskell and Salas, 1991; Gruenfeld et al., 1996; Alper et al. 1998). Decisions are delayed and teams lack reactivity. This is even more likely that teams often consist of individuals with diverse skills, backgrounds, and expertise (Masclat and Rebières, 1997).

In this chapter we investigate to what extent the introduction of a leader allows solving this coordination problem. Precisely we investigate whether the introduction of a leader may improve the efficiency of peer pressure mechanisms by reducing the excessive social cost associated with such mechanisms. In addition, we investigate the effects of leading by example induced by the introduction of a team leader. The introduction of a designed team leader or team manager is a common practice in firms (Zaccaro et al., 2001). Leaders may endorse multiple roles depending on context and where they operate in the hierarchy of firms (Thompson, 2008; Zaccaro and Klimoski, 2002).

Indeed, there may exist different types of leadership. A first form of leadership is when the leader manages teams from the outside, as a principal, without contributing to the team production. A second form of leadership is when the leader is a member of the team, contributing to the team production, and leading the team from the inside. An in-depth theoretical discussion of whether leaders should or should not contribute to the production is provided in Macho-Stadler and Pérez-Castrillo (1992). However, management of teams based on the delegation of authority to a team leader chosen among team members is common in real life. The positive impact of internal leadership on the efficiency of team production has notably been shown in Englmaier et al. (2023), where an experiment based on an escape game is used to model how work teams face non-routine tasks. This study notably finds that exogenously increasing teams' demand for leadership results in performance improvements.

In this chapter, we will focus our attention on the second type of leadership, namely the case where team leaders are also members of the team, as an intermediate option between centralized and decentralized mechanisms analyzed in chapter 2. We will investigate two specific functions of such team leader: coordinating peer pressure decisions and leading by example.

Precisely, the first research question addressed in this chapter is whether delegating punishing power to a team leader chosen among team members can improve its effectiveness and reduce its costs. Chapter 2 has shown that decentralized peer pressure increases workers' efforts, although less than centralized mechanisms. However, chapter 2 has also shown that peer pressure mechanisms are socially costly due to the cost of punishment both for the target and the punisher (see also Fehr and Gächter, 2000; Masclet et al., 2003; Denant-Boemont, 2007). This is at least the case in the earlier periods when punishments need to be implemented. In the long run, the threat of peer pressure may become sufficient to improve cooperation (see Gächter et al., 2008). To what extent introducing a leader who can coordinate punishment decisions may help reducing such social cost? Our conjecture is that delegating the power of punishing to a team leader may make it possible to coordinate its application and thus may increase its effectiveness and prevent its excesses. Assigning to a leader the monopoly of punishing should also prevent reprisals, as those who are punished cannot punish themselves, and second-order free-riding, as the leader cannot expect her team-mates to punish in her place. This is a general benefit of centralized exercise of punishment power (Markussen et al., 2014; Nicklisch et al., 2016).

This research question is experimentally addressed by investigating the impact on workers efforts and payoffs, of delegating peer pressure to a leader chosen among team members. Several options to improve the efficiency of peer pressure, by reducing its costs or improving its effectiveness, have been analyzed in the literature. Punishment costs may notably be reduced by using non-monetary punishments (Masclet et al., 2003), threats of punishments instead of actual punishments (Masclet et al. 2013), or by venting negative emotions that may lead to excessive punishments (Dickinson and Masclet, 2015). To improve the efficiency of peer pressure, literature has also evaluated, in the context of Public Good Games, the impact of individual transfers of punishment power among team-mates (Gross et al., 2016), or of delegation to an elected team leader of the power to allocate individual endowments to public or private goods (Markussen and Tyran, 2017).

But less is known on the delegation of punishment power to a team leader chosen among team members. Our study contributes to fill the gap. Another originality of our study is to compare the efficiency of delegating peer pressure to a team leader depending on how the team leader is chosen. Team members may have no influence on the choice of a leader among them, situation that we model by a random selection of the leader. Or the team leader may be chosen by team members, situation that we model by an election of the team leader by team members. The

relative performances of elected and of randomly chosen leaders in the allocation of endowments to a public good have been compared in Markussen and Tyran (2017). But, to the best of our knowledge, no previous study has attempted to compare these two types of leadership when the role of the leader is to impose punishment points to team-mates. Thus, our study contributes to the literature comparing the performances of organizations, depending on whether their functioning is exogenously imposed or endogenously chosen (Hilbe et al. 2013; Markussen et al., 2014; Rockenbach and Wolff, 2016; Kamei, 2019; Markussen and Tyran, 2023).

The second research question addressed in this chapter is to investigate the role of leading by example. Indeed, team leaders observed in actual organizations are not only expected to put pressure on their peers, but they are also expected to lead by example (Varian 1994, Hermalin, 1998). Hence, to explain the existence of team leaders, it seems necessary to study whether the efficiency of a team leader is reinforced if this leader can also lead by example. Precisely, we compare the respective efficiencies of assigning to the team leader the unique role of leading by example, the unique role of punishing, or the dual role of leading by example and of punishing.

The experimental economic literature on leaderships in teams, has studied the effects of leading by example, either theoretically (Varian, 1994; Hermalin, 1998) or experimentally in the context of sequential public good game (Güth, et al., 2007; Haigner and Wakolbinger, 2010; Gächter et al., 2010; Rivas and Sutter, 2011; Arbak and Villeval, 2011; Gächter et al., 2012; Figueres et al. 2012; Drouvelis and Nosenzo 2013; Gächter and Renner, 2018). In particular, in the context of a voluntary contribution experiment, Güth et al. (2007) find that a leader who leads by example and is also granted exclusion power on co-workers, has a positive impact on cooperation. However, the impact of a team leader who can both lead by example and impose punishment points to co-workers had not yet, to our knowledge, been studied experimentally.

These issues mentioned above are investigated by running a laboratory experiment. Precisely, the evaluation of the effectiveness and efficiency of delegating punishing power to a team leader is based on the comparison of the Peer Pressure treatment, presented in the previous chapters, to a new treatment, called “Random Leader Pressure”, where punishment decisions are centralized in the hands of a team leader, randomly chosen among team members at each period. In another treatment, called “Elected Leader Pressure”, the leader is not chosen randomly but elected by co-workers. To evaluate the impact of leading by example, we introduce the “Random Leader Example” treatment where a leader, who is chosen randomly at each period,

can lead by example by choosing her effort first. After observing the leader's effort choice, the other team members choose simultaneously their efforts. Finally, we ran a last treatment, called "Random Leader Example and Pressure", where the leader can both lead by example and coordinate punishments on co-workers.

To anticipate our results, our data regarding our first research question indicates that when pressure is delegated to a randomly selected leader, punishment is not targeted towards free-riders and is inefficient. We find that average effort in the Random Leader Pressure treatment is significantly lower than in the Peer Pressure treatment and not significantly different than in the Baseline treatment. When the leader is elected, on average, workers vote for co-workers having chosen efforts slightly but significantly larger than their own choices of effort. Effort is higher in the Elected Leader Pressure treatment than in the Random Leader Pressure treatment, and does not significantly differ between Elected Leader Pressure and Peer Pressure treatments. The average level of punishments does not significantly differ between Peer Pressure, Random Leader Pressure and Elected Leader Pressure. Finally, our data suggest that payoffs tend to be lower in the two treatments with leader pressure than in the baseline treatment. Altogether our findings indicate that, in the limits of our experimental design, the Elected Leader Pressure treatment does not perform better, and the Random Leader Pressure treatment perform worse, than the standard Peer Pressure treatment.

Hence, delegating punishing power to team leaders does not improve team work performances compared to decentralized peer pressure. Does this conclusion change, when leader's role is also to lead by example? Our results, regarding this second question, indicate that when a randomly chosen leader has a single function, either leading by example, or punishing peers, effort is not higher than in the baseline revenue sharing treatment. However, when the two functions of leading by example and of punishing peers are delegated to a randomly chosen leader, efforts are significantly higher than in the baseline treatment, and efficiency increases overtime.

The remainder of this chapter is organized as follows. Section 2 reviews the literature. Section 3 presents the experimental design and the corresponding theoretical predictions related to the two research questions addressed in this chapter (delegation of peer pressure to a team leader and impact of leading by example). Section 4 describes the associated experimental procedures. Section 5 provides our experimental results and Section 6 concludes.

2. Literature review

This literature review is focused on the two research questions addressed in this chapter. First, we review the literature dedicated to improving the efficiency of peer pressure, either by reducing the cost of punishment or by increasing its effectiveness. Second, we review the literature dedicated to leading by example in team work.

2.1. Literature on enhancing peer pressure efficiency

The existing literature has shown that peer pressure mechanisms are effective in deterring free riding. However, they are socially costly at least in the short run (Fehr and Gächter, 2000; Gächter et al., 2008). Costs of peer pressure include not only the direct costs of punishments, but also risks of reprisals, antisocial punishments and of second order free-riding (Denant-Boemont et al., 2007).

Other studies have investigated solutions to reduce its costs. One way to reduce the costs of peer pressure is to allow team members to informally express disapproval against free-riders, with no monetary consequences on the earnings of the disapprover and of the disapproved⁶⁵. Masclet et al. (2003) compare the efficiency of such a mechanism to traditional peer pressure in a Public Good Game. The study finds that non-monetary sanctions are as effective as monetary sanctions to enhance cooperation in the short run but not in the long run. However, non-monetary disapprovals are as efficient as monetary punishments in enhancing payoffs in the long run, the absence of monetary costs compensating the lower level of cooperation. Another option to try and reduce the actual costs of peer pressure, is allowing the possibility to replace actual peer punishments by threats of punishment. This option is studied in Masclet et al. (2013) in a Public Good Game. The study shows that the possibility of threatening to punish increase cooperation in the long run, but if differences between threats and actual punishments may themselves be punished, then all the efficiency gains are lost. Peer pressure costs can also be reduced by preventing excessive punishments which may results from the negative emotions generated by the observation of free-riding behaviors. This approach is investigated in Dickinson and Masclet (2015) in a Public Good Game, where the possibility of venting emotions is shown to reduce excessive punishments, and under certain conditions, to enhance welfare compared to traditional punishments. Altogether, this literature shows that mechanisms

⁶⁵ This literature investigating if peer pressure costs may be reduced by replacing monetary by non-monetary instruments is also relevant in chapter 3, where the efficiency of monetary and of symbolic incentives are compared.

exist which can effectively reduce the costs of peer pressure, however leading to reduced punishments and reduced cooperation but, under certain conditions, to enhanced welfare.

The efficiency of peer pressure in a Public Good Game may also be improved by introducing the possibility of individual transfer of punishment points among team mates, as analyzed in Gross et al. (2016). This possibility allows non-punishing cooperators to transfer their punishing power to cooperators who are ready to punish in the interest of the team. This mechanism is found to sustain cooperation, if team members manage to concentrate punishing power in the right hands, which happens in most teams (17 out of 27). However, no positive impact on cooperation is found if punishing powers transfers are exogenously imposed rather endogenously chosen by team members. Kamei (2018) also studies a situation where punishment powers are centralized, this times in the hands of a third party rather than a team leader, and in a Prisoner's Dilemma rather than a public good or a collective effort game. It shows that punishments are insufficient to impose cooperation, unless the third party's actions themselves are observed by another third party. Our study also has common features with Markussen and Tyran (2017), where the performances of randomly chosen and of elected leaders on team performances are compared. However, in this study, the power delegated to the leader is not to punish free-riders, but to choose how individual endowments of team members are allocated between public and private goods. The authors find that although a minority of public-spirited leaders allocate endowment pro-socially, the election process is inefficient because self-interested candidates can fool voters by pretending being pro-social in their pre-election behavior, in order to maximize their chances of being elected. These studies belong to a stream of literature attempting to explain the endogenous emergence of mechanisms sustaining cooperation within human organizations, despite the incentives to free-ride and the insufficient efficiency of peer pressure, notably due to second order free-riding (Hilbe et al., 2013; Markussen et al., 2014; Nicklisch et al., 2016; Rockenbach and Wolff, 2016; Kamei, 2019). An important question addressed in this literature is whether incentive mechanisms are more efficient if they are endogenously chosen rather than exogenously imposed, or "Is There a Dividend of Democracy?" as worded by Markussen and Tyran (2023). In this survey, the authors review many studies supporting such dividend of democracy, but also report on studies that find no dividend. They discuss three channels by which endogenous choice may favor efficiency, selection, signaling, and motivation and conclude that the existence of such a dividend may depends on cultural factors.

2.2. Literature on leading by example

Our second research question analyzes the influence of leading by example on teamwork. The economic literature has studied how a leader can lead by example and influence her team mates in sequential public good games, where the leader chooses her contribution before the other members of the team.

Varian (1994), theoretically analyzing a sequential public good game, shows that under symmetric information, leading by example results in lower levels of cooperation than in the absence of a leader. However, if the other members of the team think that the leader has private information, Hermalin (1998) proves that in theory, leading by example promotes cooperation, when the leader induces in her teammates beliefs that encourage them to cooperate for her benefit.

The experimental literature on sequential public good games shows that leading by example may favor cooperation but only if complementary conditions are met, such as the existence of group identity (Drouvelis and Nosenzo 2013), the power of leaders to exclude free-riders (Güth et al. 2007), or the observation of the history of each participant's behavior during past periods of the game (Figueres et al. 2012). Potters et al. (2007) also observe that leading by example enhances cooperation when the leader has private information about the returns from contributing, experimentally confirming Hermalin (1998) theory. Moxnes and Van der Heijden (2003), in a public bad experiment, observe that sequential choice of public bad leads to lower investment in public bad than simultaneous choice. Teams with prosocial and optimistic leaders (Gächter et al. 2012) or volunteer (Haigner and Wakolbinger 2010; Rivas and Sutter, 2011) cooperate more. However, according to Arbak and Villeval (2011), motivations of volunteer leaders may be strategic, altruistic or depend on social image concerns, and they do not necessarily influence their co-workers more than randomly chosen leaders. Furthermore, sequential public good game is also found to have a negative influence on cooperation, as followers punish free-riding leaders, but do not reward cooperative leaders (Gächter et al. 2010). Finally, Gächter and Renner (2018) observe, in a sequential public good game experiment, that the initial influence of leaders on followers' beliefs and contributions, is gradually dominated by the observation of other followers' past behavior.

3. Experimental design and theoretical predictions

Our design is inspired by the article of Nalbantian and Schotter (1997). We consider teams of four workers each. Each worker chooses her work effort which contributes to the production of her team, determining team remuneration. Team remuneration is equally shared among all team members. Each treatment consists of 10 identical periods under “Partner” matching.⁶⁶

In the following sections, we describe our six treatments, Baseline revenue sharing, Peer Pressure, Random Leader Pressure, Elected Leader Pressure, Random Leader Example and Random Leader Example and Pressure. Then, we present the corresponding theoretical predictions under standard hypothesis. A final section gives our behavioral hypotheses.

3.1. Treatments descriptions

3.1.1. Baseline treatment: revenue sharing

Our Baseline treatment is the same than in chapters 2 and 3. It consists of a revenue-sharing scheme for which free-riding is a dominant strategy. In each period, within each worker team, the team members $i = 1, 2, 3, 4$ simultaneously choose their effort levels $e_i \in [0, 100]$. Each team member is subsequently informed of the sum and the average of the effort levels chosen by the other members of her team. The output Y of each team is then given by:

$$Y = \sum_1^4 e_i + \varepsilon \quad (1)$$

where ε is a uniform random variable defined over the closed interval $[-40, 40]$. The team's output is then multiplied by a production price 1.5 to generate the team's revenue:

$$R=1.5Y \quad (2)$$

This revenue is shared equally among team members. Each worker in addition receives an additional lump-sum of Ω . In practice, $\Omega= 10$ in the experiment.

Effort is costly for workers, with an increasing convex cost function of $c(e_i) = e_i^2/100$.

The total payoff π generated by teamwork is:

$$\pi = 1.5(\sum_1^4 e_i + \varepsilon) - (\sum_1^4 e_i^2/100) + 4\Omega \quad (3)$$

⁶⁶ Within each team, worker identifiers change randomly from one period to another, to prevent individual reputation-building. Each participant participates in only one experiment.

Each team member i 's individual payoff function π_i is⁶⁷:

$$\begin{aligned}\pi_i &= R/4 - c(e_i) + \Omega \\ \pi_i &= 1.5(\sum_1^4 e_i + \varepsilon)/4 - (e_i^2/100) + 10\end{aligned}\quad (4)$$

3.1.2. Peer Pressure treatment

The Peer Pressure treatment is identical to the Peer Pressure treatment presented in chapter 2. It is like the Baseline treatment, except that a second stage is added in each period after the effort choice. After having chosen her own effort level, each team member observes the individual effort of the other workers in her team and can use her additional lump-sum Ω to assign costly punishment points to the other team members. If worker i applies punishment p_{iz} to worker z , this punishment reduces the payoff of worker i by p_{iz} and that of worker z by $3p_{iz}$. Worker i cannot use more than her additional lump-sum of Ω to punish the three others workers in her team. Therefore:

$$\sum_{z \neq i} p_{iz} \leq \Omega$$

In addition, in the experiment the payoff cannot be strictly negative. The final payoff of each worker is given by:

$$\pi_i = \max(1.5(\sum_1^4 e_i + \varepsilon)/4 - e_i^2/100 + 10 - \sum_{i \neq z} p_{iz} - 3 \sum_{z \neq i} p_{zi}, 0) \quad (5)$$

3.1.3. Random Leader Pressure treatment

The Random Leader Pressure treatment is like the peer pressure treatment except that peer pressure is now centralized in the hands of a team leader who is randomly chosen among team members. In this treatment, workers first simultaneously choose their effort level: e_i for each worker i . They observe the effort level e_z of other workers $z \neq i$ of their team and receive their additional lump-sum of Ω . Then, one team leader is randomly chosen among the four team members. The three co-workers who have not been chosen to be the leader transfer their additional lump-sums Ω to the leader. Therefore, the leader receives 3Ω transferred from the

⁶⁷ If the individual share of total team revenue is below the individual cost of effort, the difference is truncated at zero, before the addition of the additional endowment of z . The truncation at this stage of the individual profit calculation takes place in all our treatments, and is not set out formally in the remainder of the text. However, any treatment-specific truncation at other calculation steps is explicitly noted in the text.

three other workers of the team, in addition to her initial additional lump-sum of Ω . Hence, the leader gets a total of 4Ω which she can use to punish the other workers.

If the leader i imposes a punishment p_{iz} to worker z , this punishment decreases the payoff of leader i by p_{iz} and the payoff of worker z who is punished by $3p_{iz}$.

The leader i cannot use more than her total additional lump-sum of 4Ω to punish the three other workers of her team. Therefore:

$$\sum_{z \neq i} p_{iz} \leq 4\Omega$$

The final payoffs of workers z who have not been selected as leader are given by the equation⁶⁸:

$$\pi_z = 1.5 (\sum_{k=1}^4 e_k + \varepsilon)/4 - e_z^2/100 - 3p_{iz} \quad (6)$$

The final payoff of the worker who has been selected as leader is given by the equation:

$$\pi_i = 1.5 (\sum_{k=1}^4 e_k + \varepsilon)/4 - e_i^2/100 + 4\Omega - \sum_{z \neq i} p_{iz} \quad (7)$$

3.1.4. Elected Leader Pressure treatment

The Elected Leader Pressure treatment is like the Random Leader Pressure treatment except that the leader is elected by her team mates instead of being randomly chosen. After having chosen their effort level, observed those of the other workers of their team, and received their additional lump-sum of Ω , they vote for a leader among them. They cannot vote for themselves and they cannot abstain from voting. The worker who has received the largest number of votes is chosen as the leader, with a toss in case of tie. Once the leader has been elected, the process is the same than in the Random Leader Pressure treatment.

3.1.5. Random Leader Example treatment

In the Random Leader Example treatment, each period includes two stages. In a first stage of each period, a leader i is randomly chosen among the 4 workers of each team and chooses her level of effort e_i .

⁶⁸ In addition, in the experiment, the payoff cannot be negative and is therefore truncated at zero.

In the second stage of each period, the three other workers $z \neq i$ of the team observe the leader's effort level e_i and choose their own effort levels e_z . Then all workers of each team observe the individual levels of effort of all other members of their team.

3.1.6. Random Leader Example & Pressure treatment

The Random Leader Example & Pressure treatment merges the Random Leader Pressure and the Random Leader Example treatments.

This treatment is made of three stages: the two first stages are identical to the two stages of the Random Example treatment, and the third stage is identical to the second stage of the Random Leader Pressure treatment, including the transfer of the additional lump-sums Ω from workers who have not been chosen as leader to the leader, and the possibility of the leader to punish her team mates.

3.2. Theoretical predictions under standard hypotheses

Using backward induction, there should be not punishment in the punishment stage of the three Peer Pressure, Random Leader Pressure, and Elected Leader Pressure treatments, because punishing is costly for the punisher. In the absence of punishment, the expressions of workers' payoffs in the first stage of the game in these three schemes are identical to the expression of the payoff in the Baseline scheme. Hence, the theoretical predictions for these three treatments, under standard hypotheses, are identical to the theoretical predictions for the Baseline treatment.

As detailed in chapter 2 and its appendix, the Nash equilibrium of the Baseline treatment corresponds to $e_{ij}^* = 18.75$, far below the Pareto-optimum, maximizing workers payoffs, effort level of 75.

Regarding the Random Leader Example treatment, the theoretical analysis of this game is also straightforward. Using backward induction, in the second stage, workers who have not been chosen as leader choose the same suboptimal level of effort than in the baseline treatment: $e_z^* = 18.75$. In stage one, the leader also exerts the same suboptimal level of effort than in the baseline treatment: $e_i^* = 18.75$, because the expression of the First Order Condition for each worker is independent of the effort choice of co-workers.

Finally, in the Random Leader Example and Pressure treatment, there should be not punishment in the third stage, because punishing is costly for the punisher. Hence, the expression of the payoff for the whole game is identical to the expression of the payoff in the Random Leader Example treatment. Therefore, the resolution of the game leads to the same suboptimal level of effort $e_i^* = 18.75$.

3.3. Behavioral predictions

Gross et al. (2016) and Markussen and Tyran (2017), which are presented in detail in the literature review of this chapter, are the two relevant references to derive behavioral hypotheses regarding the Random Leader Pressure and the Elected Leader Pressure treatments.

In Gross et al. (2016), when transfers of punishment powers are imposed exogenously, it does not lead to increase of efficiency compared to standard peer pressure. In Markussen and Tyran (2017) transferring the power to allocate endowments to randomly chosen leaders do not enhance welfare compared to the baseline treatment. From these two observations, we can derive our first behavioral hypothesis:

Hypothesis 1: Efforts and payoffs should not be higher in the Random Leader Pressure treatment than in the Peer Pressure treatment.

In Gross et al. (2016), endogenously chosen transfers of punishment powers lead to higher levels of cooperation and of welfare compared to peer pressure. This suggests that in our experiment, efforts and payoffs should be higher in the Elected Leader Pressure treatment than in the Random Leader Pressure treatment. However, in Markussen and Tyran (2017), the election of a leader does not lead to higher levels of cooperation and of welfare, because selfish candidates mimic the level of cooperation of public-spirited candidates, to maximize their chances of being elected. However, such a mechanism should have an upward effect on the average choice of efforts. Hence, both references support our second behavioral hypothesis:

Hypothesis 2: Efforts and payoffs should be higher in the Elected Leader Pressure treatment than in the Random Leader Pressure treatment.

The existing literature on the effects of sequentiality of choices on cooperation is based on Public Good Games and leads to mixed conclusions. Güth et al. (2007) and Drouvelis and Nosenzo (2013) tend to find a positive effect of sequentiality on cooperation. By contrast, Varian (1994) predicts and Gächter et al. (2010) observe a negative effect of sequentiality on

cooperation. Finally, Figueres et al. (2012) find no effect of sequentiality alone on cooperation. These references do not allow express a clear hypothesis regarding the efficiency of the Random Leader Example treatment.

However, Güth et al. (2007) show that the efficiency of leading by example is enhanced if the leader is empowered to punish free-riders, in this case by excluding them. By analogy, in our experiment, empowering workers who lead by example with the capacity to punish team-mates should make leading by example more efficient. Which leads to our hypothesis 3.

Hypothesis 3: Efforts should be higher in the Random Leader Example and Pressure treatment than in the Random Leader Example treatment.

4. Procedures and parameters

The experiments took place from October 20th 2021 to April 27th 2022 at the LABEX-EM laboratory at the University of Rennes, with 144 participants, mostly Bachelors or Masters students at the University. 24% of participants were majors in Economics, and the others in various subjects such as Law, Management, Medicine, and Physics. Their average age was 20.50. 55% of participants were women and 45% men. 81% of participants had never taken part in an economics laboratory experiment before.

All treatments involved 24 participants each. The experiment was programed in Z-tree (Fischbacher, 2007). The detailed instructions for the participants were in French, and their English translations are available in the appendix of chapter 2 for Baseline and Peer Pressure, and in the appendix of this chapter for Random Leader Pressure, Elected Leader Pressure, Random Leader Example, and Random Leader Example and Pressure.

Each treatment consists of 10 identical periods under “Partner” matching⁶⁹.

Table 1 lists the descriptive socio-demographics of the participants to the 4 treatments used in section 5.1, which compares Peer Pressure and Leader Pressure to the Baseline treatment.

We performed tests of difference in means (t-test) and frequencies (Fisher exact probability test) to assess the covariate balance between the four treatments. The results of these tests are in Table B1 in the appendix. Table B1 shows that for almost all variables no significant differences

⁶⁹ Each participant participates in only one experiment. In addition, worker identifiers within each team change randomly from one period to another, to prevent individual reputation-building.

are observed across treatments, suggesting that our groups of participants are on average very similar on observable characteristics. Two notable exceptions are the frequency of students in economics between Baseline and Random Leader Pressure ($p = 0.072$), and the difference in Age between Peer Pressure and Random Leader Pressure ($p = 0.044$).

Table 1: Socio-demographics descriptive statistics of treatments used in section 5.1

	Baseline	Peer Pressure	Random Leader Pressure	Elected Leader Pressure
% Women	54%	71%	58%	50%
% Major in Economics	8%	17%	33%	25%
% No participation	96%	92%	79%	79%
Age	20.5	21.0	19.7	20.3
Number Participants	24	24	24	24

Table 2 lists the descriptive demographics of the participants to the 4 treatments used in section 5.2, which analyzes the interplay between leading by example and leader's pressure.

Table 2: Socio-demographics descriptive statistics of treatments used in section 5.2

	Baseline	Random Leader Pressure	Random Leader Example	Random Leader Example and Pressure
% Women	54%	58%	67%	33%
% Major in Economics	8%	33%	33%	29%
% No participation	96%	79%	67%	75%
Average age	20.5	19.71	20.75	20.83
Number Participants	24	24	24	24

We performed tests of difference in means (t-test) and frequencies (Fisher exact probability test) to assess the covariate balance between these four treatments. The results of these tests are in Table B2 in the appendix. Table B2 shows that most tests indicate no significant differences between variables across treatments. However, there are significant differences in the frequency of women between Random Leader Example and Random Leader Example & Pressure ($p = 0.042$), in the frequency of first participants between Baseline and Random Leader Example ($p = 0.023$), and Baseline and Random Leader Example & Pressure ($p = 0.097$), and in the frequency of students in Economics between Baseline and Random Leader Pressure ($p = 0.072$), and Baseline and Random Leader Example ($p = 0.072$).

5. Results

5.1. Peer pressure vs. Leader Pressure: Experimental Results

This section first presents the outcome of our experiments regarding efforts of workers. Secondly, we study the efforts chosen by Leaders and Non-Leaders in the Random and the Elected Leader Pressure treatments, and how workers vote to elect their leaders in the Elected Leader Pressure treatment. Third, we analyze punishment behavior in the three treatments where punishment takes place. Fourth, we observe the consequences of efforts and punishments on payoffs of workers. Descriptive statistics per team and per treatment are given in the Appendix C of this chapter.

5.1.1. Workers 'efforts

Table 3 presents average workers 'efforts by treatment.

Table 3: Descriptive statistics on efforts and payoffs of workers by treatment

	Baseline	Peer Pressure	Random Leader Pressure	Elected Leader Pressure
Average Workers' Effort	44.90 (24.17)	55.70 (23.98)	45.03 (21.84)	54.47 (25.91)
Number of Observations	240	240	240	240

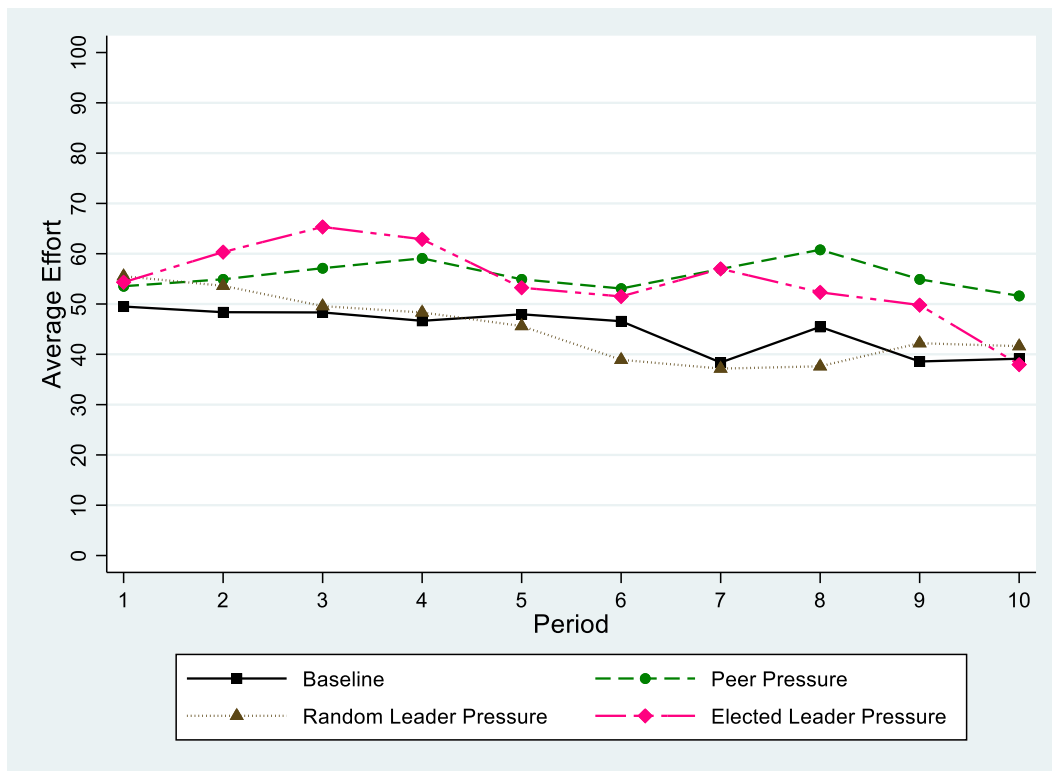
Number in parenthesis are standard deviations.

Table 3 shows that in all treatments, average effort is above the Nash equilibrium level of 18.75. Table 3 also indicates that average effort is relatively lower in the Baseline and Random Leader Pressure treatments compared to for the peer pressure and elected leader pressure treatments. According to Mann-Whitney tests, differences in average effort are insignificant respectively among low average effort treatments ($p=0.8728$) and among high average effort treatments ($p=0.8099$). Differences in average efforts between low and high average effort are not significant (from $p = 0.1093$ for Baseline vs. Peer Pressure to $p = 0.2623$ for Peer Pressure vs. Random Leader Pressure).

Figure 1 shows the evolution of average effort in each treatment over time.

In the Baseline Treatment, average effort falls slowly from period 1 to period 10, but stays well above the theoretical prediction of 18.75 corresponding to Nash equilibrium. Its stays at a stable and relatively higher level in the Peer Pressure treatment, however well below Pareto optimum of 75. Under Random Leader Pressure, average effort is close to average effort in the Baseline treatment. Under the Elected Leader Pressure treatment, average effort is close to average effort under Peer Pressure, except in the last period.

Figure 1: Average effort over time



To provide more formal evidence of our findings, we ran random-effects Generalized Least Squares (GLS) estimates on the determinants of effort level. Random Effects are used to account for the panel dimension of the data. The results of these estimates are shown in Table 4.

Table 4 consists of two panels. The left panel reports estimates on the determinant of effort. The right panel replicates those estimates but standard errors are clustered at the team level, in order to control for interdependencies within teams. Column (1) indicates that Peer Pressure and Elected Leader Pressure treatment variables capture a positive and significant coefficient, suggesting that those two incentive mechanisms have a positive effect on effort level compared to the baseline treatment. By contrast, Random Leader Pressure have no significant effect on effort level compared to the baseline. Column (2) replicates estimate (1) with the addition of a trend variable and demographics. The treatment effects are robust to the introduction of these covariates. The trend variable captures a negative coefficient, indicating that average effort decrease overtime⁷⁰. All demographics are insignificant. Column (3) replicates column (2) but on the restricted sample without the baseline. The omitted variable is the Peer Pressure dummy. The Random Leader Pressure variable captures a negative and significant coefficient indicating

⁷⁰ This negative trend hides differences across treatments. Indeed, separate estimates per treatment (available upon request) reveal a negative trend for the Baseline, the Random Leader and the Elected Leader treatments, but not for the Peer Pressure treatment.

that this treatment is less efficient than Peer Pressure in enhancing effort level. In Column (3) the coefficient of the Elected Leader Pressure variable is insignificant, suggesting the absence of significant difference between this treatment and Peer Pressure regarding effort levels. The estimates shown in the right panel of table 4 report similar findings, with however lower significance, indicating that our result should be confirmed by independent experiments.

Table 4: Determinants of effort level

Dep. Var: Effort level	All	All	All except the baseline	All	All	All except the baseline
	RE GLS (1)	RE GLS (2)	RE GLS (3)	With clustered SE		
	RE GLS (4)	RE GLS (5)	RE GLS (6)	RE GLS (4)	RE GLS (5)	RE GLS (6)
Baseline	Ref.	Ref.		Ref.	Ref.	
Peer Pressure	10.80** (4.57)	10.74** (4.74)	Ref.	10.80* (6.27)	10.74* (6.31)	Ref.
Random Leader Pressure	0.13 (4.57)	0.06 (4.87)	-11.60** (5.05)	0.13 (5.51)	0.06 (5.68)	-11.60 (7.44)
Elected Leader Pressure	9.58** (4.57)	9.53** (4.78)	-1.74 (4.98)	9.58 (5.94)	9.53 (5.87)	-1.74 (7.44)
Period – Trend		-1.24*** (0.21)	-1.25*** (0.24)		-1.24*** (0.38)	-1.25*** (0.49)
Male		0.53 (3.44)	0.27 (4.20)		0.53 (2.97)	0.27 (4.21)
Previous Participation		-1.44 (5.00)	-0.07 (5.48)		-1.44 (5.00)	-0.07 (5.35)
Age		0.14 (0.64)	-0.30 (0.89)		0.14 (0.73)	-0.30 (1.18)
Economics		1.76 (4.32)	3.17 (4.76)		1.76 (3.57)	3.17 (3.77)
Constant	44.90*** (3.20)	48.52*** (13.92)	68.21*** (19.42)	44.90*** (3.62)	48.52*** (16.34)	68.21*** (27.96)
Observations	960	960	720	960	960	720
R-squared overall	0.0430	0.0655	0.0647	0.0430	0.0655	0.0647
Wald χ^2	9.88	43.98	33.99	5.25	23.24	11.66

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

Our findings are summarized in result 1.

Result 1: a) *On average over all periods, effort under team leader pressure is equivalent to effort under peer pressure when the leader is elected by her peers.* b) *When pressure is exercised by a randomly chosen leader, effort tends to be lower than in the peer pressure treatment, and equivalent to effort in the baseline treatment without incentive.*

Result 1 is consistent with Hypotheses 1 and 2.

5.1.2. Effort choices of leaders and voting behavior

This section is dedicated to the two Leader Pressure treatments. We first compare the effort level of leaders, randomly chosen or elected, with the effort level of non-leaders, and with the effort level of workers in general. Secondly, we study how workers vote for a leader in the Elected Leader Pressure treatment.

Table 5 shows the average effort of the leader and other workers in the Random Leader Pressure treatment.

Table 5: Descriptive statistics of efforts of leaders, of non-leaders and of all workers in the Random Leader Pressure Treatment

Effort	Average (SD)	Observations
Leaders	44.20 (23.35)	60
Non-Leaders	45.30 (21.37)	180
All workers	45.03 (21.84)	240

Numbers in parenthesis are Standard Deviations

We cannot directly use a Mann-Whitney test to check whether the difference in efforts between Leaders and Non-Leaders is significant or not, because the choices of effort of leaders and of non-leaders over time in the same teams are dependent. But we can calculate the difference between efforts of non-leaders and efforts of corresponding leaders (in the same team and for the same period), averaged for the 6 independent teams involved in the treatment. This gives us a distribution of 6 independent average differences of effort, which can be compared using a Mann Whitney test, to a zero vector of 6 zeros. The exact probability of the corresponding Mann Whitney test equals $p = 1.0000$, which means that the difference between efforts of leaders and of non-leaders are not significantly different of zero. This is not surprising, as in the Random Leader treatment, the random choice of a leader is done after workers have chosen their efforts and independently of the effort they choose.

Table 6 report similar statistics as the previous tables for the Elected Leader Pressure treatment.

Table 6: Descriptive statistics of efforts of elected, not elected and all workers in the Elected Leader Pressure Treatment

Effort	Average (SD)	Observations
Elected workers	56.73 (25.47)	60
Not elected workers	53.72 (26.08)	180
All workers	54.47 (25.91)	240

Numbers in parenthesis are Standard Deviations

As for the Random Leader Pressure treatment, we cannot directly use a Mann-Whitney test between average efforts of Leaders and of Non-Leaders, because choices of effort of leaders and of non-leaders in the same teams are dependent. But, here too, we can calculate the difference between efforts of non-leaders and efforts of corresponding leaders (in the same team and for the same period), averaged for the 6 independent teams involved in the treatment. This distribution of 6 independent average differences of effort, is compared to a zero vector of 6 zeros, using a Mann Whitney test. The exact probability of the corresponding Mann Whitney test equals $p = 0.0476$, which means that there exists a small, but positive and significant difference of efforts between elected leaders and non-leaders⁷¹.

The origin of this significant difference between elected and not-elected workers can be analyzed by studying the difference between the effort chosen by a worker receiving a vote and the effort chosen by the worker who votes. There are 240 observations of such differences, with a mean of 0.59 and a standard deviation of 30.48. We can average these differences for the 6 independent teams involved in the treatment, and compare this distribution of 6 independent average effort differences, to a zero vector of 6 zeros, using a Mann Whitney test. We find an exact probability $p = 0.0476$, which means that there exists a small, but positive and significant difference of effort between the worker who votes and the worker who receives the vote.

Result.2: *There is a small but significant positive difference between efforts chosen by elected workers and effort chosen by non-elected workers.*

A second question is whether the probability of being elected depends on the positive or the negative deviation of the effort choice of a worker from the average effort of her peers. To study this question, we regress the indicator that a worker is being elected, using a probit model with random effects, on the positive and on the absolute value of the negative deviation of her effort choice compared to the average effort of her peers, controlling for the average effort of peers. We perform two versions of this estimation, the second with standard errors clustered at team level. The results of this regression are given in Table 7.

Our data support no significative influence, neither of the positive, nor of the negative deviation from peers ‘average effort, on the probability of being elected.

⁷¹ Teams are heterogenous in this respect. Heterogeneity between teams is described in more detail in the Appendix C.

Table 7: Regressing indicator of being elected on deviation of effort from peers' average

Dep. Var: Indicator of being elected	Probit RE	Probit RE With clustered SE
Peers 'average	-0.0006 (0.0055)	-0.0006 (0.0006)
Abs negative deviation from peers 'average	-0.0072 (0.0067)	-0.0072 (0.0061)
Positive deviation from peers 'average	-0.0012 (0.0072)	-0.0012 (0.0079)
Constant	-0.57 (0.35)	-0.57*** (0.10)
Observations	240	240
Log Likelihood	-134.02	-134.02
Wald χ^2	1.32	5.85
P > χ^2	0.72	0.1191

Note: The figures in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1

Alternatively, we checked whether the vote of worker i for worker j depends on the existence of positive difference of effort between j and i and on the existence of negative difference of effort between j and i . To study this question, we regress the indicator of the vote of i for j , noted I_{Vote} , on the positive differences of effort between j and i , and the absolute value of the negative differences of effort between j and i , using a probit model with random effects. We perform three versions of this regression: one without control, one controlling for the effort of i and one controlling in addition for the socio-demographics of worker i . The results of these two regressions are shown in Table 8, which consists of two panels: the right panel replicates the left panel but with standard errors clustered at the team level.

Table 8: Determinants of vote of worker i for worker j

Dep. Var: $I_{Vote} = \text{Vote}$ i for j	Probit RE (1)	Probit RE (2)	Probit RE (3)	Probit RE (1) Clustered SE	Probit RE (2) Clustered SE	Probit RE (3) Clustered SE
Positive Delta Effort $j - i$	-0.0025 (0.0028)	-0.0026 (0.0033)	-0.0026 (0.0033)	-0.0025** (0.0012)	-0.0026 (0.0017)	-0.0026 (0.0017)
Absolute Negative Delta Effort $j - i$	-0.0036 (0.0028)	-0.0036 (0.0029)	-0.0038 (0.0030)	-0.0036 (0.0022)	-0.0036 (0.0023)	-0.0038 (0.0024)
Effort of i		-0.0001 (0.0024)	0.0001 (0.0025)		-0.0001 (0.0001)	0.0001 (0.0001)
Sex: Male			-0.017 (0.11)			-0.017 (0.11)
Discipline: Economics			-0.011 (0.12)			-0.011** (0.005)
Previous Participation			-0.030 (0.15)			-0.030* (0.018)
Age			0.0047			0.0047***

			(0.021)			(0.0017)
Constant	-0.36*** (0.073)	-0.35** (0.16)	-0.44 (0.46)	-0.36*** (0.034)	-0.35*** (0.071)	-0.44*** (0.085)
Observations	720	720	720	720	720	720
Log Likelihood	-457.36	-457.36	-457.31	-457.36	-457.36	-457.31
Wald χ^2	1.84	1.85	1.95	4.86	6.26	.
P > χ^2	0.3977	0.6051	0.9628	0.088	0.0997	.

Number in parenthesis are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1

Altogether, the results presented in Table 8 do not support any robust conclusion regarding the impact of positive or negative difference of efforts between j and i on whether i votes for j or not.

This global conclusion could hide heterogeneous behaviors: for instance, free-riders may vote for free-riders and cooperators for cooperators. To check this hypothesis, we perform the same sets of regressions but on two sub-sets of observations: a sub-set of observations concerning free-riders (defined here as workers choosing a level of effort lower than the average of their peers) and a sub-set of observations concerning cooperators (defined here as workers choosing a level of effort equal or higher than the average of their peers). The results of these two complementary sets of regressions are shown in table 9.

Table 9: Determinants of vote of worker i for worker j for free-riders and cooperators

Dep. Var: $I_{Vote} = \text{Vote } i \text{ for } j$	Probit RE (2)	Probit RE (2) Clustered SE	Probit RE (2)	Probit RE (2) Clustered SE
Sub-set of observations	Free-Riders		Cooperators	
Positive Delta Effort $j - i$	-0.0025 (0.0040)	-0.0025 (0.0023)	-0.0048 (0.012)	-0.0048 (0.010)
Absolute Negative Delta Effort $j - i$	-0.0002 (0.012)	-0.0002 (0.0084)	-0.0048 (0.0034)	-0.0048** (0.0024)
Effort of i	-0.0013 (0.0040)	-0.0013 (0.0009)	0.0012 (0.0037)	0.0012 (0.0011)
Sex: Male	0.0064 (0.16)	0.0064 (0.0095)	-0.033 (0.15)	-0.033 (0.024)
Discipline: Economics	-0.0035 (0.17)	-0.0035 (0.0070)	-0.013 (0.17)	-0.013 (0.012)
Previous Participation	0.0021 (0.20)	0.0021 (0.019)	-0.025 (0.25)	-0.025 (0.025)
Age	0.0006 (0.029)	0.0006 (0.0035)	0.0036* (0.032)	0.0036* (0.0019)
Constant	-0.34	-0.34***	-0.45	-0.45***

	(0.65)	(0.075)	(0.68)	(0.12)
Observations	336	336	384	384
Log Likelihood	-213.66	-213.66	-243.44	-243.44
Wald χ^2	0.42	.	1.94	.
P > χ^2	0.9997	.	0.9633	.

Number in parenthesis are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1

Table 9 does not robustly support the hypothesis that cooperators would vote for cooperators and free-riders for free-riders. The coefficient of the absolute negative deviation appears as negative and significant in rightest column of Table 9, but no χ^2 test could be calculated for this estimation.

5.1.3. Punishment behavior per treatment

In this section we investigate the determinants of punishment behavior in the three treatments Peer-Pressure, Random Leader Pressure and Elected Leader Pressure.

Table 10 presents average number of received points per worker for these three treatments.

Table 10: Descriptive statistics on received points per worker by treatment

	Peer Pressure	Random Leader Pressure	Elected Leader Pressure
Average received points per workers:	1.82 (2.20)	1.74 (3.78)	2.01 (4.52)
Number Observations	240	240	240

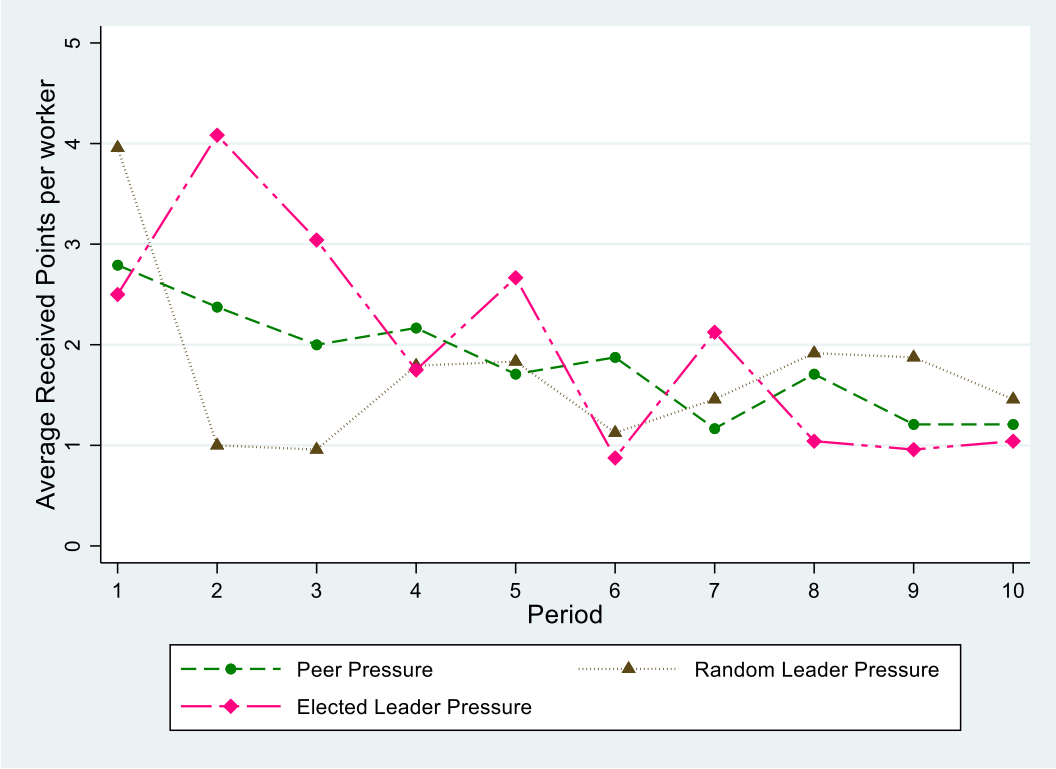
Number in parenthesis are standard deviations.

Table 10 shows that the average number of received points per worker are similar between the three treatments. According to Mann-Whitney tests applied to average number of received points per worker per team, differences in number of received points per worker between the three treatments are insignificant: $p = 0.7294$ for Peer Pressure vs. Random Leader Pressure, $p = 0.9372$ for Peer Pressure vs. Elected Leader Pressure, and $p = 0.8182$ Random Leader Pressure vs. Elected Leader Pressure.

Figure 2 shows the evolution of the average number of points received per worker overtime for each of the three treatments. Figure 2 indicates that punishment declines overtime in the Peer Pressure treatment. This finding is consistent with results found in the literature on PGG with punishment (e.g. Gächter et al.; 2008). A downward trend, albeit more erratic, seems also at

work in the Elected Leader Pressure treatment. In contrast, no clear downward trend appears in the Random Leader Pressure treatment.

Figure 2: Average number of points received over time



To identify more formally the factors explaining the punishment points received by each worker, we ran RE Tobit⁷² estimates on the determinants on the determinants of received punishment points. the explanatory variables include the average effort of others, absolute value of negative deviation from the average effort of others, positive deviation from the average effort of others, and a trend variable. We perform three sets of regressions: in the first set, punishment points are regressed using treatments as dummies, in the second set, interaction variables between treatments and negative and positive deviations from the average effort of peers are added, and in the third set, punishment points are regressed separately for each treatment.

Table 11 shows RE Tobit estimates on the determinants of received punishment on pooled data. We regress received punishment points on each treatment by including dummy variables for each treatment, peer pressure being the reference variable. The other independent variables

⁷² We use a Tobit model because the distribution of received points is left censored at zero.

include a trend variable, the average effort of team mates, absolute value of negative deviation from average effort of team mates and positive deviation from average effort of team mates.

Table 11: Determinants of received punishment points on treatments

Dep. Var: Received punishment Points	RE Tobit
Peer Pressure	Ref.
Random Leader	-1.57 (1.06)
Elected Leader	-1.40 (1.03)
Period – Trend	-0.28*** (0.094)
Average effort of team mates	0.071*** (0.022)
Abs Negative Deviation from average effort of team mates (a)	0.060*** (0.021)
Positive Deviation from average effort of team mates (b)	0.0094 (0.023)
Constant	-3.52** (1.68)
Observations	720
Log Likelihood	-1231.51
Wald χ^2	45.24
P > χ^2	0.0000

Note: The figures in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1. (a) The “Absolute negative the deviation from others’ effort” variable is constructed as follow: it takes the absolute value of negative deviation of the worker’s effort from the average effort of others within her teams if the worker exerts less effort than the others and zero otherwise. (b) “Positive the deviation from others’ effort” variable is constructed as follow: it takes the value of positive deviation of the worker’s effort from the average effort of others within her teams if the worker exerts higher effort than the others and zero otherwise.

In Table 11, the coefficient of the Random and Elected Leader Pressure treatments are negative, but insignificant, indicating no difference in punishment intensity between the three treatments. The trend coefficient is significant and negative, confirming that punishments generally decrease overtime. The coefficient of the average effort of team-mates is positive and significant, showing that workers who contribute more also tend to punish more. The coefficient of the negative deviation from average effort of team mates is also positive and significant, indicating that punishments tend to be targeted towards free-riders, on average on the three considered treatments. The coefficient of the positive deviation from average effort of team mates is not significant, suggesting that workers with prosocial behavior are neither significantly spared from punishments nor significantly targeted by punishers.

Table 12 reports an additional estimate that control for interaction variables between treatments and positive and negative deviations from team mates' average effort, in order to check whether there exist differences across treatments.

Table 12: Determinants of received punishment points on treatments with interaction variables

Dep. Var: Received punishment Points	RE Tobit
Peer Pressure	Ref.
Random Leader	-0.93 (1.33)
Elected Leader	-1.91 (1.31)
Period – Trend	-0.28*** (0.094)
Average effort of team mates	0.071*** (0.022)
Abs Negative Deviation from average effort of team mates	0.064* (0.037)
Positive Deviation from average effort of team mates	0.0034 (0.037)
Random Leader * Abs Negative Deviation	-0.056 (0.059)
Elected Leader * Abs Negative Deviation	0.019 (0.048)
Random Leader * Positive Deviation	0.016 (0.055)
Elected Leader * Positive Deviation	0.032 (0.053)
Constant	-3.51** (1.74)
Observations	720
Log Likelihood	-1230.50
Wald χ^2	47.60
P > χ^2	0.0000

Note: The figures in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1

Table 12 indicates that interaction terms between treatments and deviations from team mates 'average are not significant. This outcome does not allow to derive robust specific conclusions for each treatment.

To reach treatment specific conclusions, we need to make separate estimates on the determinants of received punishment points for each treatment, the results of which are given in table 13.

Table 13 indicates that the negative trend variable is negative and highly significant for the Peer Pressure treatment, negative and weakly significant for the Elected Leader Pressure treatment,

and insignificant for the Random Leader Pressure treatment. The average effort of team-mates variable captures a positive and significant coefficient for Peer Pressure and Elected Leader Pressure, and insignificant for Random Leader Pressure. The coefficient of the absolute value of the negative deviation from team mates' average is significant for Peer Pressure and Elected Leader Pressure, and insignificant for Random Leader Pressure, indicating that punishments do not target free-riders in this treatment. For all three treatments, the coefficient of the positive deviation from average effort of team mates is insignificant, confirming that workers with prosocial behavior are neither spared nor targeted by punishers.

Table 13: Determinants of received punishment points per treatment

Dep. Var: Received punishment Points	RE Tobit Peer Pressure	RE Tobit Random Leader Pressure	RE Tobit Elected Leader Pressure
Period – Trend	-0.24*** (0.059)	-0.054 (0.27)	-0.47* (0.24)
Average effort of team mates	0.041** (0.018)	0.095 (0.071)	0.12*** (0.045)
Abs Negative Deviation from average effort of team mates	0.061*** (0.016)	0.011 (0.068)	0.10** (0.042)
Positive Deviation from average effort of team mates	0.008 (0.017)	-0.024 (0.062)	0.049 (0.057)
Constant	-0.76 (1.21)	-8.76* (4.52)	-9.18*** (3.50)
Observations	240	240	240
Log Likelihood	-416.46	-340.32	-384.28
Wald χ^2	43.55	4.05	22.83
P > χ^2	0.0000	0.40	0.0001

Note: The figures in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1

Our main findings, supported by Table 11, 12 and 13, are summarized as follow:

Result 4: a) *This is no significant difference in punishment intensity between the three treatments* b) *In Peer Pressure and Elected Leader Pressure treatments, received punishments decrease overtime and increase with average effort of peers and with free-riding.* c) *In the Random Leader Pressure treatment, received punishments follow no trend and are influenced neither by average effort of peers nor by free-riding.* d) *In all treatments, positive deviation from peers' average effort does not influence received punishments.*

5.1.4. Workers 'payoffs

Table 14 provides the descriptive statistics of workers 'payoffs per treatment.

Table 14: Descriptive statistics on payoffs of workers by treatment

	Baseline	Peer Pressure	Random Leader Pressure	Elected Leader Pressure
Average Workers' Payoffs	54.29 (22.35)	50.11 (21.41)	46.28 (27.01)	47.98 (28.47)
Number Observations	240	240	240	240

Number in parenthesis are standard deviations.

In treatments with peer or leader pressure, costs of punishment reduce payoffs of workers below those of treatments without punishment. However, according to Mann-Whitney tests on average payoffs per team, no difference in payoffs between treatments is statistically significant at a 10% threshold. Figure 3 shows the evolution over time of worker payoffs by treatment.

Figure 3: Average workers 'payoffs over time

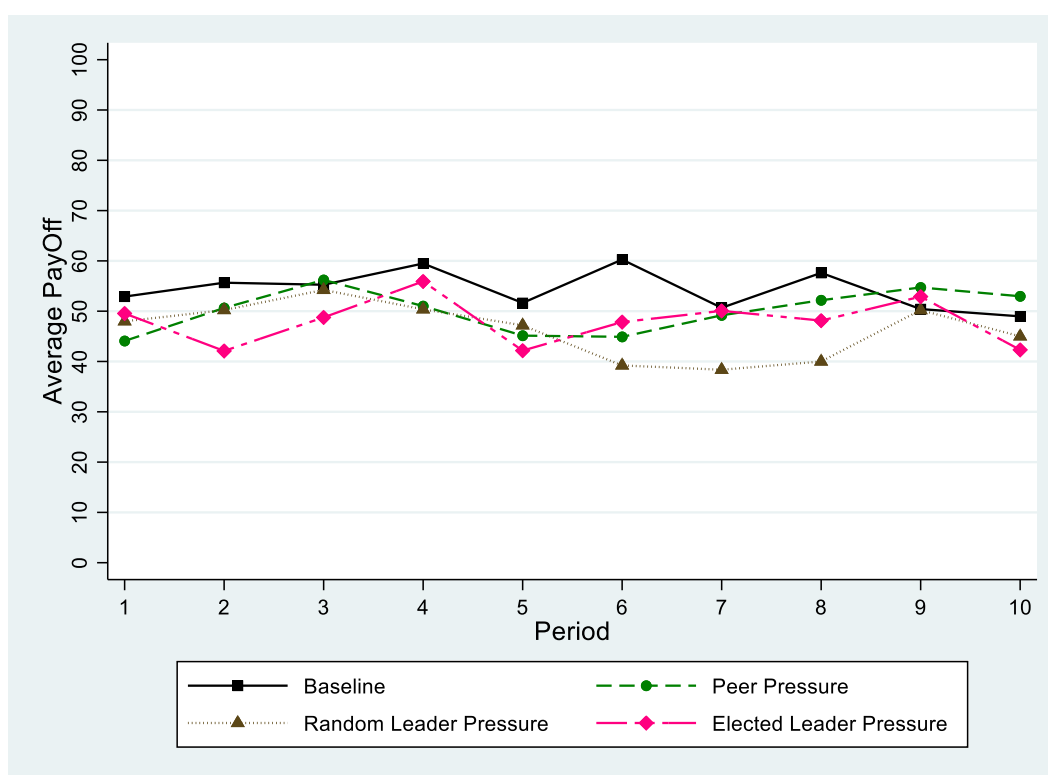


Figure 3 confirms that differences in payoffs per worker between treatments are smaller than differences in efforts per worker shown in Figure 1.

To provide more formal evidence of our findings, we ran random-effects Generalized Least Squares (GLS) estimates on the determinants of payoffs. Random. The results of these estimates are shown in Table 15.

Table 15 consists of two panels. The left panel reports estimates on the determinant of payoffs. The right panel replicates those estimates but standard errors are clustered at the team level in

order to control for interdependencies within teams. Column (1) indicates that Random and Elected Leader Pressure treatment variables capture a negative and significant coefficient, suggesting that those two incentive mechanisms have a negative effect on payoffs compared to the baseline treatment. The Peer Pressure variable also has a negative coefficient, but it is not significant. Column (2) replicates estimate (1) with the addition of a trend variable and demographics. The treatment effects are robust to the introduction of these covariates. The trend variable and all demographics have insignificant coefficients. Column (3) replicates column (2) but on the restricted sample without the Baseline. The omitted variable is the Peer Pressure dummy. The Random Leader Pressure and the Elected Leader Pressure variables have negative but insignificant coefficients. The estimates shown in the right panel of table 3 report similar findings.

Table 15: Determinants of payoffs level

Dep. Var: Payoff level	All	All	All except the baseline	All	All	All except the baseline
	RE GLS (1)	RE GLS (2)	RE GLS (3)	RE GLS (4)	RE GLS (5)	RE GLS (6)
Baseline	Ref.	Ref.		Ref.	Ref.	
Peer Pressure	-4.19 (3.67)	-4.65 (3.75)	Ref.	-4.19 (4.12)	-4.65 (4.22)	Ref.
Random Leader Pressure	-8.01** (3.67)	-9.46** (3.86)	-5.66 (3.80)	-8.01** (4.07)	-9.46** (4.17)	-5.66 (3.46)
Elected Leader Pressure	-6.32* (3.67)	-7.05* (3.79)	-2.91 (3.74)	-6.32 (5.10)	-7.05 (5.16)	-2.91 (4.33)
Period – Trend		-0.22 (0.26)	-0.13 (0.31)		-0.22 (0.26)	-0.13 (0.32)
Male		-1.98 (2.73)	-2.37 (3.16)		-1.98 (2.28)	-2.37 (3.13)
Previous Participation		0.74 (3.96)	2.71 (4.12)		0.74 (3.16)	2.71 (3.63)
Age		-0.42 (0.51)	-1.05 (0.67)		-0.42 (0.50)	-1.05 (0.81)
Economics		3.64 (3.42)	2.89 (3.58)		3.64 (3.56)	2.89 (3.92)
Constant	54.29*** (2.59)	64.73*** (11.08)	72.73*** (14.67)	54.29*** (3.26)	64.73*** (10.14)	72.73*** (17.47)
Observations	960	960	720	960	960	720
R-squared overall	0.0142	0.0218	0.0173	0.0142	0.0218	0.0173
Wald χ^2	5.34	8.52	5.33	4.09	9.45	5.08

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

Our findings are summarized in result 5.

Result 5: a) Workers' payoffs tend to be lower in the Random and Elected Leader Pressure treatment than in the Baseline treatment. b) Payoffs in the Peer Pressure treatment are neither

significantly different from payoffs in the Baseline treatment, nor significantly different from payoffs in the Random and Elected Leader Pressure treatments.

Hence, delegating punishing power to team leaders does not improve team work performances compared to decentralized peer pressure. That is why the next paragraph investigates the efficiency of leadership, when the role of the leader is not limited to punishing her team-mates but also to lead by example.

5.2. Introducing leading by example: experimental results

Section 5.1 has shown that centralizing peer pressure in the hands of a team leader does not improve the efficiency of team work. However, team leaders observed in actual organizations are not only expected to put pressure on their peers, but also to lead by example. This section compares the respective efficiencies of assigning to the team leader the unique role of leading by example, the unique role of punishing, or the dual role of leading by example and of punishing. To this end, we compare the outcomes of four treatments: Baseline, Random Leader Pressure, Random Leader Example and Random Leader Example and Pressure. In this section, we present the results regarding first, the efforts of workers, second punishment behaviors in the two treatments where punishment takes place, and third the payoffs of workers.

5.2.1. Workers ‘efforts

Table 16 presents descriptive statistics on workers ‘efforts by treatment.

Table 16: Descriptive statistics on efforts and payoffs of workers by treatment

	Baseline	Random Leader Pressure	Random Leader Example	Random Leader Example & Pressure
Workers Effort:	44.90	45.03	41.96	57.65
Average	(24.17)	(21.84)	(22.53)	(19.66)
Number	240	240	240	240
Observations				

Number in parenthesis are standard deviations.

Table 16 shows that when the team leader has a unique function, average effort is close to the average effort in the Baseline treatment, but when the team leader exercises both functions, average effort is above the average effort in the Baseline treatment.

However, according to Mann-Whitney tests on average efforts per team presented in Table 17, differences in efforts between the Random Leader Example & Pressure treatment and the three other treatment are either weakly significant, or insignificant.

Table 17: Results of Mann-Whitney tests between average effort per team per treatment

Mann Whitney Exact Probability	Baseline	Random Leader Pressure	Random Leader Example
Random Leader Pressure	0.9372		
Random Leader Example	1.000	1.000	
Random Leader Example & Pressure	0.0649	0.0931	0.2857

Figure 4 shows the evolution of average effort over time for each treatment.

Figure 4: Average effort over time

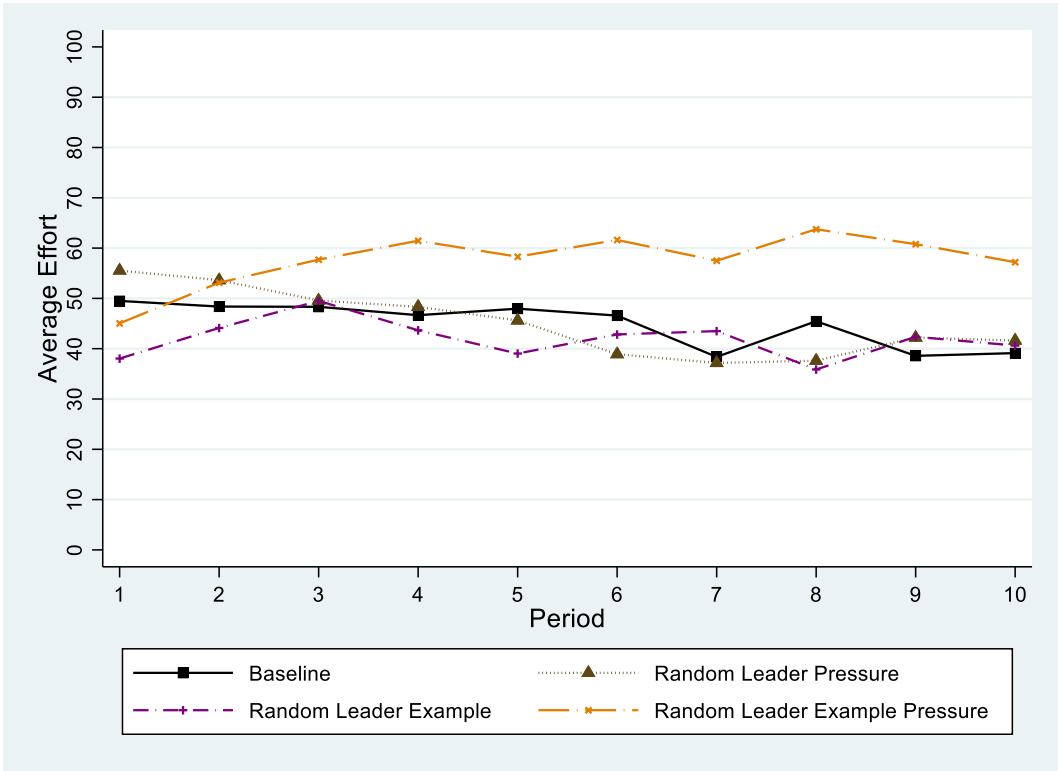


Figure 4 confirms the results of Table 16. Efforts are lower in the Baseline, Random Leader Pressure and in Random Leader Example treatments than in the Random Leader Example & Pressure treatments. Moreover, regressing effort on periods separately for each treatment indicates that in the Random Leader Example & Pressure treatment, efforts have a positive trend (1.12***), which is not the case for the other treatments.

To provide formal evidence of treatments impacts on efforts, we ran two random-effects Generalized Least Squares (GLS) estimates on the effects of treatments on effort level, the first

without controls, the second controlling for trend and demographics. The results of these estimates are shown in Table 18.

Table 18: Determinants of effort level

Dep. Var: Effort level	RE GLS (1)	RE GLS (2)	RE GLS (3)	RE GLS (4)
		With clustered SE		
Baseline	Ref.	Ref.	Ref.	Ref.
Random Leader Pressure	0.13 (4.03)	-1.35 (4.13)	0.13 (5.54)	-1.35 (5.43)
Random Leader Example	-2.94 (4.03)	-5.19 (4.21)	-2.94 (3.64)	-5.19 (3.70)
Random Leader Example and Pressure	12.75*** (4.03)	11.99*** (4.16)	12.75** (5.36)	11.99** (5.08)
Period – Trend		-0.57*** (0.20)		-0.57* (0.34)
Male		-3.61** (2.94)		-3.61** (1.83)
Previous Participation		0.79 (3.85)		0.79 (2.04)
Age		0.35 (0.54)		0.35 (0.57)
Economics		5.92 (3.60)		5.92** (2.77)
Constant	44.90*** (2.85)	41.92*** (11.56)	44.90*** (3.64)	41.92*** (12.91)
Observations	960	960	960	960
R-squared overall	0.0700	0.0929	0.0700	0.0929
Wald χ^2	18.08	30.62	17.13	58.98

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

Table 18 consists of two panels. The left panel reports estimates on the determinant of effort. The right panel replicates those estimates but standard errors are clustered at the team level in order to control for interdependencies within teams. The two regressions in column (1) and (2) yield similar results regarding the comparisons between treatments. Efforts are not significantly different in the Random Leader Example and Random Leader Pressure treatments than in the Baseline treatment. The coefficient of the Random Leader Example & Pressure treatment is positive and highly significant. The treatment effects are robust to the introduction of covariates. The estimates shown in the right panel of table 3 report similar findings, with a weaker significance of the Random Leader Example & Pressure positive coefficient.

Our findings are summarized in result 6.

Result 6: a) When a randomly chosen leader may only give the example or punish, efforts are equivalent than in the baseline treatment. b) When a randomly chosen leader may both give the

example and punish, team performance is on average higher than in the baseline treatment, and increases overtime.

Result 6 is compatible with behavioral hypothesis 3: efforts is larger when a randomly chosen leader can both lead by example and punish, than when she can only lead by example.

5.2.2. Punishment behavior

In this section we investigate the determinants of punishment behavior in the two treatments Random Leader Pressure, and Random Leader Example & Pressure. Table 19 gives the descriptive statistics on the number of received points per worker for these two treatments.

Table 19: Descriptive statistics on received points per worker by treatment

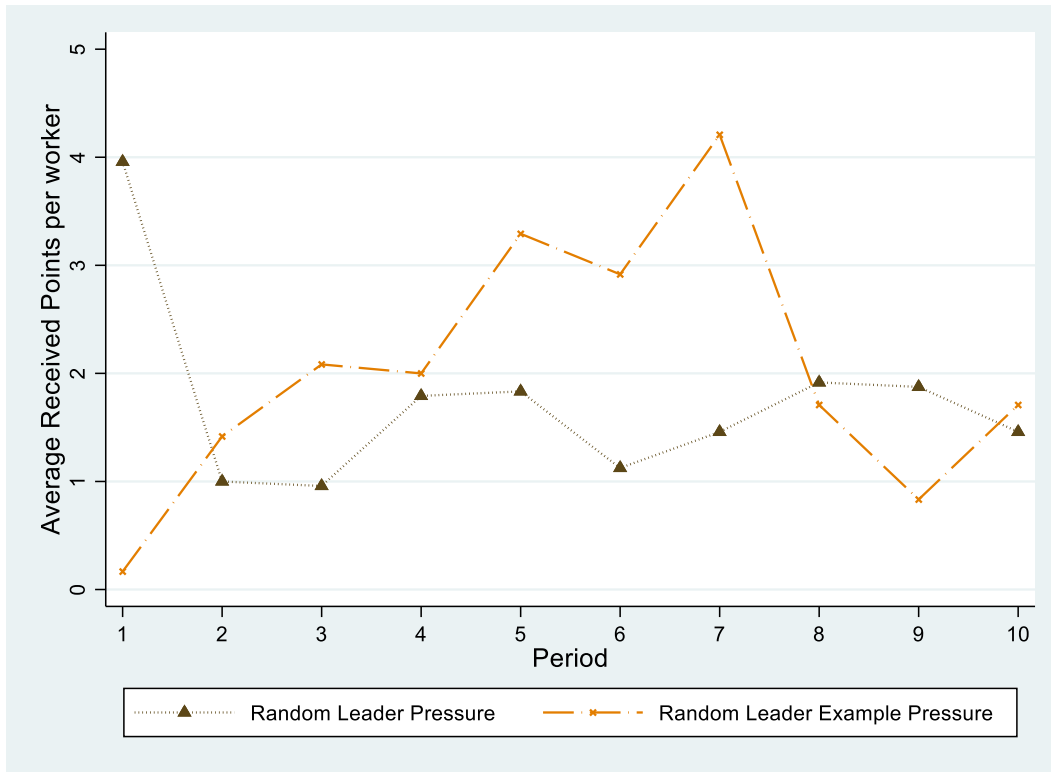
	Random Leader Pressure	Random Leader Example & Pressure
Average received points per workers	1.74 (3.78)	2.03 (4.39)
Number Observations	240	240

Number in parenthesis are standard deviations.

According to Mann-Whitney test, difference in received points between the two treatments is insignificant ($p = 0.8593$).

Figure 5 shows the evolution of the average number of points received per worker from Period 1 to Period 10 for these two treatments. Interestingly no downward trend appears in Figure 5, contrary to what is typically observed when peer pressure mechanisms are introduced. The typical downward trend of punishments is usually explained by the fact that actual punishments in the first periods makes punishment credible and less necessary afterwards. But if potential punishers randomly change at each period, as it is the case in the two treatments under consideration, punishment policies may not be consistent overtime. Hence, initial punishments do not make future punishment credible. This could explain the absence of downward trend in this case.

Figure 5: Average number of points received over time



To identify formally the factors explaining the punishment points received by each worker, we use Tobit regressions separately for the two treatments, as shown in Table 20.

Table 20: Determinants of received punishment points

Dep. Var: Received punishment Points	RE Tobit Random Leader Pressure	RE Tobit Random Leader Example Pressure
Period – Trend	-0.054 (0.269)	0.027 (0.36)
Average effort of peers	0.095 (0.071)	0.16** (0.077)
Absolute value of negative deviation from peers' effort	0.011 (0.068)	0.36*** (0.084)
Deviation from peers' effort when positive	-0.024 (0.062)	0.14 (0.11)
Constant	-8.76* (4.52)	-20.49*** (5.51)
Observations	240	240
Log Likelihood	-340.32	-302.82
LR χ^2	4.05	22.85
P > χ^2	0.3996	0.0001

Note: The figures in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1

The Random Leader Pressure column is the same in Table 20 than in Table 13. The insignificant coefficient of the absolute value of negative deviation from peers' average shows that free-

riders are not targeted by randomly chosen leaders who can only punish. Interestingly, this is not true when randomly chosen leaders not only punish, but also lead by example. In the last column, the coefficient of the absolute value of negative deviation from peers' average is highly significant. Hence, randomly chosen leaders do target free-riders, when their role is not only to punish, but also to lead by example. This finding could suggest that behaviors may be influenced not only by the intrinsic social preferences of workers, but also by the role assigned to the worker.

Our findings are summarized in result 7.

Result 7: *a) Punishments do not decrease overtime when they are given by randomly chosen leaders. b) Punishments do not target free-riders in the Random Leader Pressure treatment. c) Free-riders are strongly targeted in the Random Leader Example & Pressure treatment.*

5.2.3. Workers 'payoffs

Table 21 presents descriptive statistics on workers 'payoffs by treatment.

Table 21: Descriptive statistics on payoffs of workers by treatment

	Baseline	Random Leader Pressure	Random Leader Example	Random Leader Example & Pressure
Workers Payoffs:	54.29	46.28	51.29	53.28
Average	(22.35)	(27.01)	(19.17)	(23.60)
Number Observations	240	240	240	240

Number in parenthesis are standard deviations.

In the Random Leader Pressure treatment, costs of punishments further reduce payoffs of workers below those of treatments without punishment. By contrast, in the Random Leader Example & Pressure treatment, the high level of effort compensates for the cost of punishments and payoffs are close to those in the Baseline treatment.

Table 22: Results of Mann-Whitney tests between average payoffs per team per treatment

Mann Whitney Exact Probability	Baseline	Random Leader Pressure	Random Leader Example
Random Leader Pressure	0.1797		
Random Leader Example	0.6171	0.5714	
Random Leader Example & Pressure	0.6991	0.1320	0.8571

According to Mann-Whitney tests on average payoffs per team presented in Table 22, no difference in payoffs between treatments, is statistically significant at a 10% threshold.

Figure 6 shows the evolution over time of worker payoffs by treatment.

Figure 6: Average workers’ payoffs over time

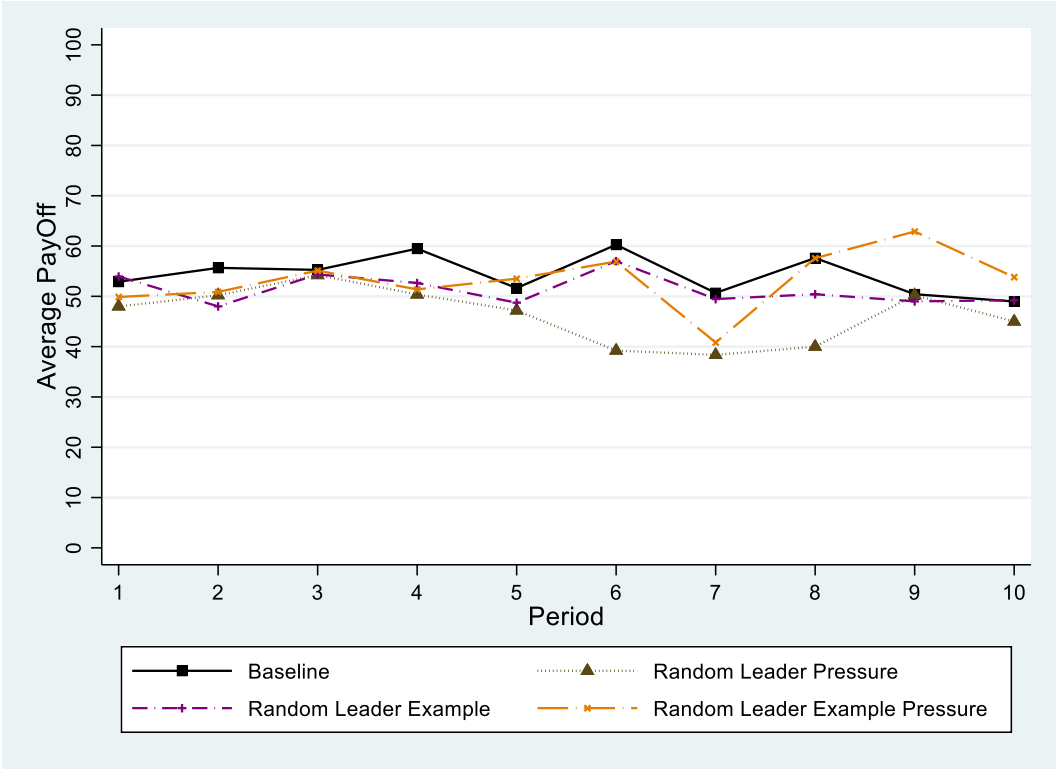


Figure 6 does not reveal any clear trend concerning the evolutions of average payoffs overtime.

To provide formal evidence of treatments impacts on payoffs, we ran two random-effects Generalized Least Squares (GLS) estimates on the effects of treatments on payoffs, the first without controls, the second controlling for trend and demographics. The results of these estimates are shown in Table 23.

Table 23 consists of two panels. The left panel reports estimates on the determinant of payoffs. The right panel replicates those estimates but standard errors are clustered at the team level. The two regressions in column (1) and (2) yield similar results regarding the comparisons between treatments: Random Leader Pressure is the only treatment for which payoffs are significantly below payoffs in the Baseline treatment. The estimates in the right panel lead to the same conclusions. These findings are summarized in result 8.

Table 23: Determinants of payoffs

Dep. Var: Payoffs	RE GLS (1)	RE GLS (2)	RE GLS (3)	RE GLS (4)
	With clustered SE			
Baseline	Ref.	Ref.	Ref.	Ref.
Random Leader Pressure	-8.01** (3.16)	-6.96** (3.20)	-8.01* (4.09)	-6.96* (3.61)
Random Leader Example	-3.01 (3.16)	-1.28 (3.27)	-3.01 (3.28)	-1.28 (3.13)
Random Leader Example and Pressure	-1.01 (3.16)	0.83 (3.22)	-1.01 (4.14)	0.83 (3.93)
Period – Trend		-0.26 (0.24)		-0.26 (0.27)
Male		-2.06 (2.28)		-2.06 (1.60)
Previous Participation		-6.88** (2.99)		-6.88*** (2.23)
Age		0.013 (0.42)		0.013 (0.36)
Economics		0.07 (2.80)		0.07 (2.69)
Constant	54.29*** (2.24)	59.69*** (9.02)	54.29*** (3.28)	59.69*** (7.44)
Observations	960	960	960	960
R-squared overall	0.0174	0.0339	0.0174	0.0339
Wald χ^2	7.62	15.99	5.65	24.27

Note: The numbers in parentheses are standard errors. ***P < 0.01, **P < 0.05, *P < 0.1.

Result 8: a) Workers' payoffs are lowest for the Random Leader Pressure treatment. b) Workers' payoffs differences between the three other treatments are insignificant.

6. Conclusion

In this chapter, we have investigated to which extend delegating peer pressure to a team leader may be an effective and efficient alternative to decentralized peer pressure, in the context of teamwork. Such mode of management is common in the workplace. The team leader remains a member of the team, participates to the team production and thereby shares insider information available within the team. Team members may remain residual claimants of team production. The leader designation may result from external circumstances, a designation process which we model as randomly choosing the leader. The leader may alternatively be chosen by the team members based on the observation of individual behaviors, a designation process which we model as electing the leader.

Using a set of controlled experiments, we compare the outcomes of pressure delegated to randomly chosen and to elected team leaders, to the outcomes of decentralized peer pressure and to the outcome of a baseline revenue sharing mechanism without specific incentive. Our main findings are the following:

First, our results indicate that when pressure is delegated to a randomly selected leader, effort is lower than under peer pressure and not significantly different than in the baseline treatment.

Second, when peer pressure is delegated to an elected leader, effort is higher than when the leader is chosen at random, but does not significantly differ from effort under peer pressure.

Third, when the leader is elected, workers vote for workers whose average choice of effort is slightly but significantly higher than theirs.

Fourth, the intensity of punishments does not significantly differ between peer pressure, random leader pressure or elected leader pressure, but randomly chosen leaders do not target free-riders, contrary to elected leaders.

Fifth, the payoffs of workers tend to be lower in the two treatments where pressure is delegated to a leader, than in the baseline treatment.

Hence, delegating peer pressure in the hands of a team leader does not improve the efficiency of team work, and therefore cannot justify the existence of team leaders. However, leaders in actual organizations are not only expected to put pressure on their peers, but also to lead by example. To explain the existence of team leaders, it therefore seems necessary to evaluate how the set of functions exercised by the leader affects the efficiency of teamwork. Precisely, using controlled experiments, we compare workers' efforts and payoffs, between treatments where the role of randomly chosen leaders is to lead by example, to punish, or to do both. The results of these three treatments are also compared to those of the baseline treatment.

First, our results indicate that when a randomly chosen leader has a unique function, either leading by example or punishing peers, effort is equivalent than in the baseline treatment.

Second, when the randomly chosen leader can both lead by example and punish peers, teamwork becomes more effective than in the baseline treatment, and its effectiveness increases overtime.

Deriving practical implications of the results presented above must be done with caution, considering the limits of the external validity of laboratory experiments, discussed in depth in the last section of chapter 2. However, within those limits, the outcome of our experiment

provides insights regarding how team leaders impact teamwork efficiency. First, concentrating punishing power in the hands of a team leader could negatively impact teamwork efficiency, if the choice of leader is perceived as arbitrary or random by team members. Second, when a team leader in charge of punishing is elected, team members choose a leader whose choice of effort is close to theirs, albeit slightly higher, and team work is more efficient than with a randomly chosen leader. Third, bundling the ability to lead by example, and the ability to punish, in the hands of the team leader, has positive effects on the efficiency of team work.

Further research could study the efficiency of leadership on teamwork, depending on the combinations of leader designation procedures and of the functions delegated to the leader. Leader designation procedures could include not only random choice or election, but also designation of workers providing the highest effort⁷³, round robin, volunteering, or designation by a principal. Functions delegated to the leader could include not only the ability to lead by example and to punish, but also for instance communication, evaluation of team members, or influence on team composition. The experimental design comparing peer pressure to leader pressure could also be extended to include possibilities of reprisals between team members. These comparisons would provide a more comprehensive assessment of the impact of leadership on team performances, and help understanding the widespread occurrence of leaders with teams.

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⁷³ A preliminary theoretical analysis of a game where the worker providing the highest effort is chosen as team leaders is given in the Appendix D. It shows that for the parameters of the effort game used in this thesis, this game has no Nash equilibrium in pure strategy.

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Appendix

Appendix A: Instructions (translated from French)

Instructions for the Baseline treatment, and the Peer Pressure treatments can be found in Appendix B of Chapter 2. The present appendix A of chapter 4, includes the instructions of the treatments which are specific to this chapter: Random Leader Pressure, Elected Leader Pressure, Random Leader Example and Random Leader Example & Pressure.

Instructions for participants in the experiment

[instructions for Random Leader Example treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

At the start of each period, a draw designates one of the 4 players in your group to choose first her or his level of effort. You therefore have a one in four chance of being designated each period.

If you are designated to choose your effort level first, you will see a screen where you must choose an effort level, in the form of a number between 0 and 100, representing your contribution to the production of your group. In the example screen below, an effort of 60 is chosen by the designated player.

Periode	1 sur 10	Temps restant [sec]: 1
<p>Vous êtes désigné</p> <p>Choisissez votre effort entre 0 et 100</p> <input type="text" value="60"/>		
<input type="button" value="OK"/>		

After choosing your effort level you must press the ok button.

Choice of effort of non-designated players knowing the effort chosen by the designated player

If you have not been designated to choose your effort level first, you wait for the designated player to choose their effort level. When he has done so, you see a screen appear where the level of effort chosen by the designated player is displayed, and where you are invited to choose your level of effort, always in the form of a number included between 0 and 100 representing your contribution to the production of your group.

In the example below, the non-designated player is informed that the designated player has chosen an effort of 60, then chooses an effort of 40 himself.

Periode	1 sur 10	Temps restant [sec]: 10
<p>Vous n'êtes pas désigné.</p> <p>Le joueur désigné a choisi un effort de 60</p> <p>Choisissez votre effort entre 0 et 100</p> <input type="text" value="40"/>		
<input type="button" value="OK"/>		

Validate your choice by clicking on “OK”. You move on when all the players in your group have validated their choice.

Information on the efforts of other players

The following screen is displayed, whether you have been chosen by the draw or not. It informs you of the efforts chosen by the other players in your group, in a random order which changes each period. The screen below shows an example where these 3 other players have chosen efforts of 20, 40 and 80.

The screenshot shows a game interface with a grey background. At the top left, it says "Periode" and "1 sur 10". At the top right, it says "Temps restant [sec]: 7". In the center, there is a text box that reads "Les efforts des autres joueurs de votre groupe cités dans un ordre aléatoire différent à chaque période :". Below this, there are three lines of text: "Un des autres joueurs de votre groupe a choisi un effort de 20", "Un des autres joueurs de votre groupe a choisi un effort de 80", and "Un des autres joueurs de votre groupe a choisi un effort de 40". At the bottom right, there is a button labeled "Continuer".

Click "Continue" to move on.

Calculation of your payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of effort**. **We will call the resulting number the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

Each group member will receive one quarter of total group revenue. This is your **individual revenue**.

For example, if you choose an effort of 60 and the sum of the efforts of the other players in your group is 140, then the **Sum of group efforts** is $(60 + 140 = 200)$. If the random shock is $(- 40)$, the total group production is $(200 - 40) = 160$, the total group revenue is $(1.5 \times 160) = 240$ and your individual revenue, as well as that of the 3 other players in the group is $(240 / 4 = 60)$. In

other word each group member receives an equal share of total group revenue, i.e., one quarter of 240.

<p>Your individual revenue in each period is therefore: [1.5*(sum of group efforts + random shock between -40 and +40)/4]</p>

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

$$\begin{aligned} \text{Your payoff for each period} &= \text{Individual Revenue} - \text{Cost of effort} + 10 \text{ tokens} \\ &= (1.5 * (\text{Sum of group efforts} + \text{Random shock between } -40 \text{ and } +40) / 4) - \text{cost of effort} + 10 \end{aligned}$$

Please note that if the costs of effort exceed your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the previous example where you choose an effort of 60 and your individual revenue is also 60, your cost of effort is 36 according to Table A, and the difference is $(60 - 36) = 24$ tokens. By adding 10 additional tokens, your gain for the period is 34 tokens.

Your payoff for the period is calculated by the computer and displayed on the screen:

Résultats pour la période	
Effort que vous avez choisi	60
Somme des efforts du groupe	200
Choc aléatoire (entre -40 et +40)	-40.0
Production totale du groupe	160
Revenu total du groupe	240.00
Votre revenu de production	60.00
Votre coût de production	36.00
Votre gain de production	24.00
Votre dotation additionnelle	10
Votre gain pour la période	34.00

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period

and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

Instructions for participants in the experiment

[instructions for the Random Leader Pressure treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

Each period consists of two stages. These instructions present the sequence of the first stage, then that of the second.

First stage

At the beginning of the first stage of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.

Periode 1 sur 10 Temps restant [sec]: 7

Choisissez votre effort entre 0 et 100

OK

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the efforts of other players

The next screen displays the efforts chosen by the other players in your group in a random order that changes each period. The screen below shows an example where these 3 other players have chosen efforts of 20, 40 and 80:

Periode 1 sur 10 Temps restant [sec]: 0

Les efforts des autres joueurs de votre groupe cités dans un ordre aléatoire différent à chaque période :

Un des autres joueurs de votre groupe a choisi un effort de	20
Un des autres joueurs de votre groupe a choisi un effort de	40
Un des autres joueurs de votre groupe a choisi un effort de	80

Continuer

Click "Continue" to move on.

Calculation of your first stage payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of effort**. We will call the resulting number **the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

Each group member will receive one quarter of total group revenue. This is your **individual revenue**.

For example, if you choose an effort of 60 and the sum of the efforts of the other players in your group is 140, then the **Sum of group efforts** is $(60 + 140 = 200)$. If the random shock is $(- 40)$, the total group production is $(200 - 40) = 160$, the total group revenue is $(1.5 \times 160) = 240$ and your individual revenue, as well as that of the 3 other players in the group is $(240 / 4 = 60)$. In other word each group member receives an equal share of total group revenue, i.e., one quarter of 240.

Your individual revenue at first stage each period is therefore:
[$1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40) / 4$]

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your first-stage payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

$$\begin{aligned} \text{Your first stage payoff for each period} &= \text{Individual Revenue} - \text{Cost of effort} + 10 \text{ tokens} \\ &= (1.5 * (\text{Sum of group efforts} + \text{Random shock between } -40 \text{ and } +40) / 4) - \text{cost of effort} + 10 \end{aligned}$$

Please note that if the costs of effort exceed your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the previous example where you choose an effort of 60 and your individual revenue is also 60, your cost of effort is 36 according to Table A, and the difference is $(60 - 36) = 24$ tokens. By adding 10 additional tokens, your first stage payoff for the period is 34 tokens.

Your first stage payoff for the period is calculated by the computer and displayed on the screen:

Résultats pour la période	
Effort que vous avez choisi	60
Somme des efforts du groupe	200
Choc aléatoire (entre -40 et +40)	-40.0
Production totale du groupe	160
Revenu total du groupe	240.00
Votre revenu de production	60.00
Votre coût de production	36.00
Votre gain de production	24.00
Votre dotation additionnelle	10
Votre gain pour la période	34.00

Click "Continue" to move on.

Second stage

At the start of the second stage of each period, a draw designates one of the 4 players in your group. You therefore have a one in four chance of being nominated each period.

If you are designated, the 3 other players in the group transfer their additional allocation of 10 tokens to you, for a total of 30 tokens. You are informed by the screen:

Periode	1 sur 10	Temps restant [sec]: 7
Vous êtes désigné et les trois autres joueurs de votre groupe vous transfèrent leur dotation additionnelle soit au total 30		
<input type="button" value="Continuer"/>		

Click “Continue” to move on.

These 30 additional tokens are added to your initial 10, giving you a total of 40 additional tokens.

If you are not designated, you transfer your 10 additional tokens to the designated player. You are informed by the screen:

Periode	1 sur 10	Temps restant [sec]: 14
Vous n'avez pas été désigné et vous transférez au joueur désigné votre dotation additionnelle soit 10		
<input type="button" value="Continuer"/>		

Click “Continue” to move on.

The designated player can reduce the gains of the other players in the group

If you are designated, you can use all or part of your 40 additional tokens to reduce the gains of the other three players in your group by distributing them disapproval points.

A screen appears where you need to enter the disapproval points you distribute to other players in your group, as in the example below:

The screenshot shows a game window with a yellow border. At the top left, it says "Periode 1 sur 10". At the top right, it says "Temps restant [sec]: 0". The main area contains the following text: "Le total des points que vous attribuez aux 3 autres joueurs de votre groupe doit être inférieur ou égal à 40". Below this, there are three lines of text, each followed by a blue input box: "Points que vous attribuez au joueur qui a choisi l'effort 80", "Points que vous attribuez au joueur qui a choisi l'effort 40", and "Points que vous attribuez au joueur qui a choisi l'effort 20". At the bottom right, there is a red button labeled "OK".

The order in which the efforts of other players are displayed is random and varies from period to period. It is therefore on the sole basis of the efforts chosen during the first stage of this period that you decide on the points that you distribute to them. The total number of points distributed to the other three players must be less than or equal to 40. Validate your choice by clicking on “OK”.

Payoffs at the end of the second stage

The calculation differs depending on whether you are designated or not during the second stage.

Your payoffs if you are designated

Each point you distribute to a particular player lowers his or her first stage payoff by 3 tokens. So, if you distribute 0 points to a player, you do not change his gain, if you distribute 1 point, you reduce his first stage payoff by 3 tokens, if you distribute 2 points you reduce his first stage payoff by 6 tokens and so on.

Distributing points to other players costs you in tokens the total of the points you distribute. This total cannot exceed 40 tokens. For example, awarding 5 points to each of the other 3 players costs you 15 tokens. You could not award 15 points to each of the other 3 players because that would be 45 points, above the maximum of 40.

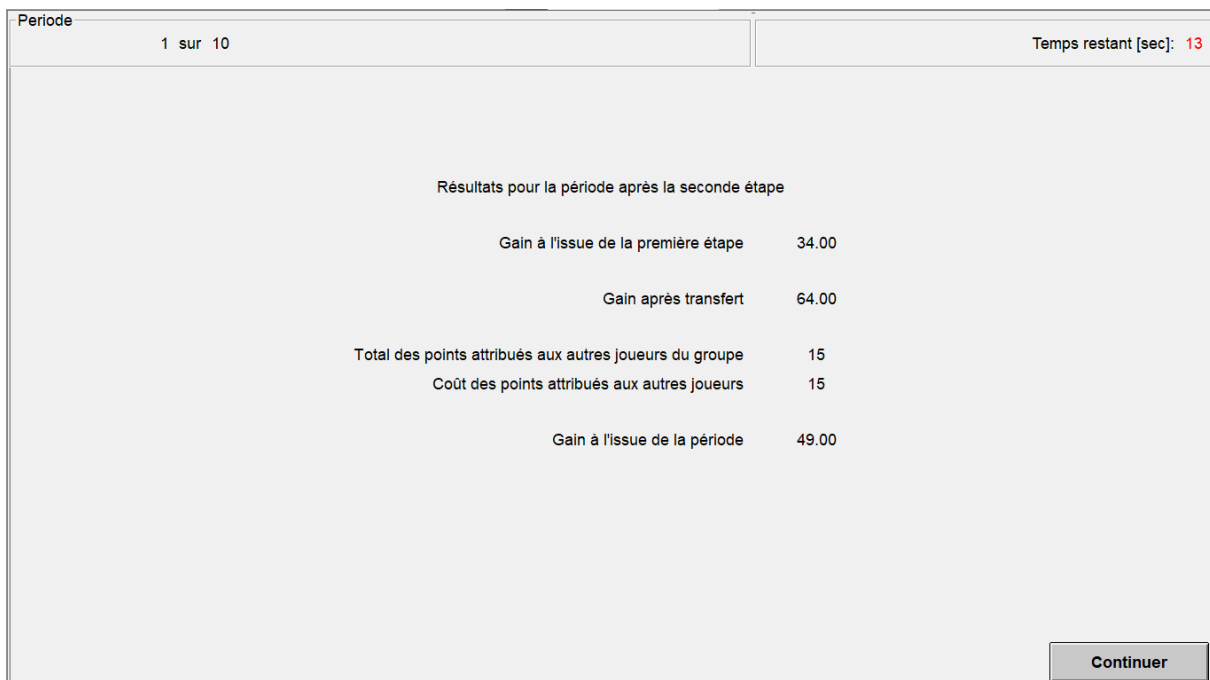
Thus, the designated player's initial payoff is first increased by the 30 tokens transferred by the non-designated players, then reduced by a number of tokens equal to the number of points she or he has distributed. For example, the payoff for the period of a designated player whose first stage payoff is 34 tokens and who distribute 5 points to each of the other 3 players is worth $(34 + 30 - (5 \times 3)) = 49$ tokens.

So, if you are designated, your final payoff for the period is calculated as follows:

Final payoff for each period =
 First stage payoff + 30 tokens transferred – Total number of points distributed

This payoff is always positive or zero, since a first-stage payoff greater than or equal to 10 is added to 30 transferred tokens and a total of points awarded less than or equal to 40 is deducted.

The calculation is done by the computer and displayed on the screen to the designated player:



Click “Continue” to move on.

Your payoffs if you are not designated

If you are not designated, your payoff is reduced by three times the total number of disapproval points that you receive from the designated player. If you receive 0 points, your payoff is unchanged, if you receive 1 point, it reduces your payoff by 3 tokens, if you receive 2 points, it reduces it by 6 tokens, etc.

For example, a non-designated player's first-stage payoff of 34 chips first drops by 10 due to the transfer of 10 tokens to the designated player, then, if she or he receives 5 points from the designated player, by $5 \times 3 = 15$ tokens, which leads to a final payoff of $(34 - 10 - 15) = 9$ tokens.

If you have not been designated, your final payoff for the period is calculated as follows:

Final payoff for each period =

$$\text{First stage payoff} - 10 \text{ tokens transferred} - 3 * \text{Total number of points received}$$

The points received by a non-designated player can cancel her or his payoff but not make it negative: if the number of points received by a player exceeds a third of his first-stage payoff minus the 10 tokens transferred to the designated player, then this player's payoff for the period will be considered zero.

The calculation is done by the computer and displayed on the screen for non-designated players:

Periode		Temps restant [sec]: 7	
1 sur 10			
Résultats pour la période après la seconde étape			
		Gain à l'issue de la première étape	34.00
		Gain après transfert	24.00
Nombre de points que vous avez reçus du joueur désigné		5	
Réduction des gains du fait des points reçus		15	
Gain théorique une fois déduite la réduction liée aux points reçus		9.00	
Gain à l'issue de la période, sachant que le gain ne peut pas être négatif		9.00	
			<input type="button" value="Continuer"/>

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

Instructions for participants in the experiment

[instructions for Random Leader Example and Pressure treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

Each period includes two stages. These instructions show the first stage, then the second stage.

First stage

At the start of the first stage of each period, a draw designates one of the 4 players in your group to choose first her or his level of effort. You therefore have a one in four chance of being designated each period.

If you are designated to choose your effort level first, you will see a screen where you must choose an effort level, in the form of a number between 0 and 100, representing your contribution to the production of your group. In the example screen below, an effort of 60 is chosen by the designated player.

Periode 1 sur 10

Temps restant [sec]: 1

Vous êtes désigné

Choisissez votre effort entre 0 et 100

OK

After choosing your effort level you must press the ok button.

Choice of effort of non-designated players knowing the effort chosen by the designated player

If you have not been designated to choose your effort level first, you wait for the designated player to choose their effort level. When he has done so, you see a screen appear where the level of effort chosen by the designated player is displayed, and where you are invited to choose your level of effort, always in the form of a number included between 0 and 100 representing your contribution to the production of your group.

In the example below, the non-designated player is informed that the designated player has chosen an effort of 60, then chooses an effort of 40 himself.

Periode 1 sur 10

Temps restant [sec]: 10

Vous n'êtes pas désigné.

Le joueur désigné a choisi un effort de 60

Choisissez votre effort entre 0 et 100

OK

Validate your choice by clicking on “OK”. You move on when all the players in your group have validated their choice.

Information on the efforts of other players

The following screen is displayed, whether you have been chosen by the draw or not. It informs you of the efforts chosen by the other players in your group, in a random order which changes each period. The screen below shows an example where these 3 other players have chosen efforts of 20, 40 and 80.

The screenshot shows a game interface with a grey background. At the top left, it says "Periode" and "1 sur 10". At the top right, it says "Temps restant [sec]: 7". In the center, there is a text box that reads "Les efforts des autres joueurs de votre groupe cités dans un ordre aléatoire différent à chaque période :". Below this, there are three lines of text: "Un des autres joueurs de votre groupe a choisi un effort de 20", "Un des autres joueurs de votre groupe a choisi un effort de 80", and "Un des autres joueurs de votre groupe a choisi un effort de 40". At the bottom right, there is a button labeled "Continuer".

Click "Continue" to move on.

Calculation of your first stage payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of effort**. **We will call the resulting number the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

Each group member will receive one quarter of total group revenue. This is your **individual revenue**.

For example, if you choose an effort of 60 and the sum of the efforts of the other players in your group is 140, then the **Sum of group efforts** is $(60 + 140 = 200)$. If the random shock is $(- 40)$, the total group production is $(200 - 40) = 160$, the total group revenue is $(1.5 \times 160) = 240$ and your individual revenue, as well as that of the 3 other players in the group is $(240 / 4 = 60)$. In

other word each group member receives an equal share of total group revenue, i.e., one quarter of 240.

<p>Your individual revenue in each period is therefore: [1.5*(sum of group efforts + random shock between -40 and +40)/4]</p>

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your first stage payoff for each period

Your first stage payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

$$\begin{aligned} \text{Your first stage payoff for each period} &= \text{Individual Revenue} - \text{Cost of effort} + 10 \text{ tokens} \\ &= (1.5 * (\text{Sum of group efforts} + \text{Random shock between } -40 \text{ and } +40) / 4) - \text{cost of effort} + 10 \end{aligned}$$

Please note that if the costs of effort exceed your individual revenue, the difference is set to zero by the computer. Therefore, your first stage payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the previous example where you choose an effort of 60 and your individual revenue is also 60, your cost of effort is 36 according to Table A, and the difference is $(60 - 36) = 24$ tokens. By adding 10 additional tokens, your first stage payoff for the period is 34 tokens.

Your first stage payoff for the period is calculated by the computer and displayed on the screen:

Periode		1 sur 10	Temps restant [sec]: 11	
Résultats de la première étape				
Effort que vous avez choisi	60			
Somme des efforts du groupe	200			
Choc aléatoire (entre -40 et +40)	-40.0			
Production totale du groupe	160			
Revenu total du groupe	240.00			
Votre revenu de production	60.00			
Votre coût de production	36.00			
Votre gain de production	24.00			
Votre dotation additionnelle	10			
Votre gain initial après la première étape	34.00			
<input type="button" value="Continuer"/>				

Click "Continue" to move on.

Second stage

If you were designated to choose your level of effort first during the first step, the 3 other players in the group transfer their additional allocation of 10 tokens to you, for a total of 30 tokens. You are informed by the screen:

Periode	1 sur 10	Temps restant [sec]: 11
Vous avez été désigné et les trois autres joueurs de votre groupe vous transfèrent leur dotation additionnelle soit au total 30		
<input type="button" value="Continuer"/>		

Click “Continue” to move on.

These 30 additional tokens are added to your initial 10, giving you a total of 40 additional tokens.

If you were not designated to choose your effort level first during the first step, you transfer your 10 additional tokens to the designated player, you transfer your 10 additional tokens to the designated player. You are informed by the screen:

Periode	1 sur 10	Temps restant [sec]: 14
Vous n'avez pas été désigné et vous transférez au joueur désigné votre dotation additionnelle soit 10		
<input type="button" value="Continuer"/>		

Click “Continue” to move on.

The designated player can reduce the gains of the other players in the group

If you were assigned to choose your effort level first in the first stage, you can use all or part of your 40 additional tokens to reduce the gains of the other three players in your group by distributing them disapproval points.

A screen appears where you need to enter the disapproval points you distribute to other players in your group, as in the example below:



The screenshot shows a game window with a yellow border. At the top left, it says "Periode 1 sur 10". At the top right, it says "Temps restant [sec]: 0". The main area contains the following text: "Le total des points que vous attribuez aux 3 autres joueurs de votre groupe doit être inférieur ou égal à 40". Below this, there are three lines of text, each followed by a blue input box: "Points que vous attribuez au joueur qui a choisi l'effort 80", "Points que vous attribuez au joueur qui a choisi l'effort 40", and "Points que vous attribuez au joueur qui a choisi l'effort 20". At the bottom right, there is a red button labeled "OK".

The order in which the efforts of other players are displayed is random and varies from period to period. It is therefore on the sole basis of the efforts chosen during the first stage of this period that you decide on the points that you distribute to them. The total number of points distributed to the other three players must be less than or equal to 40. Validate your choice by clicking on “OK”.

Payoffs at the end of the second stage

The calculation differs depending on whether you were designated during the first stage or not.

Your payoffs if you were designated

Each point you distribute to a particular player lowers his or her first stage payoff by 3 tokens. So, if you distribute 0 points to a player, you do not change his gain, if you distribute 1 point, you reduce his first stage payoff by 3 tokens, if you distribute 2 points you reduce his first stage payoff by 6 tokens and so on.

Distributing points to other players costs you in tokens the total of the points you distribute. This total cannot exceed 40 tokens. For example, awarding 5 points to each of the other 3 players costs you 15 tokens. You could not award 15 points to each of the other 3 players because that would be 45 points, above the maximum of 40.

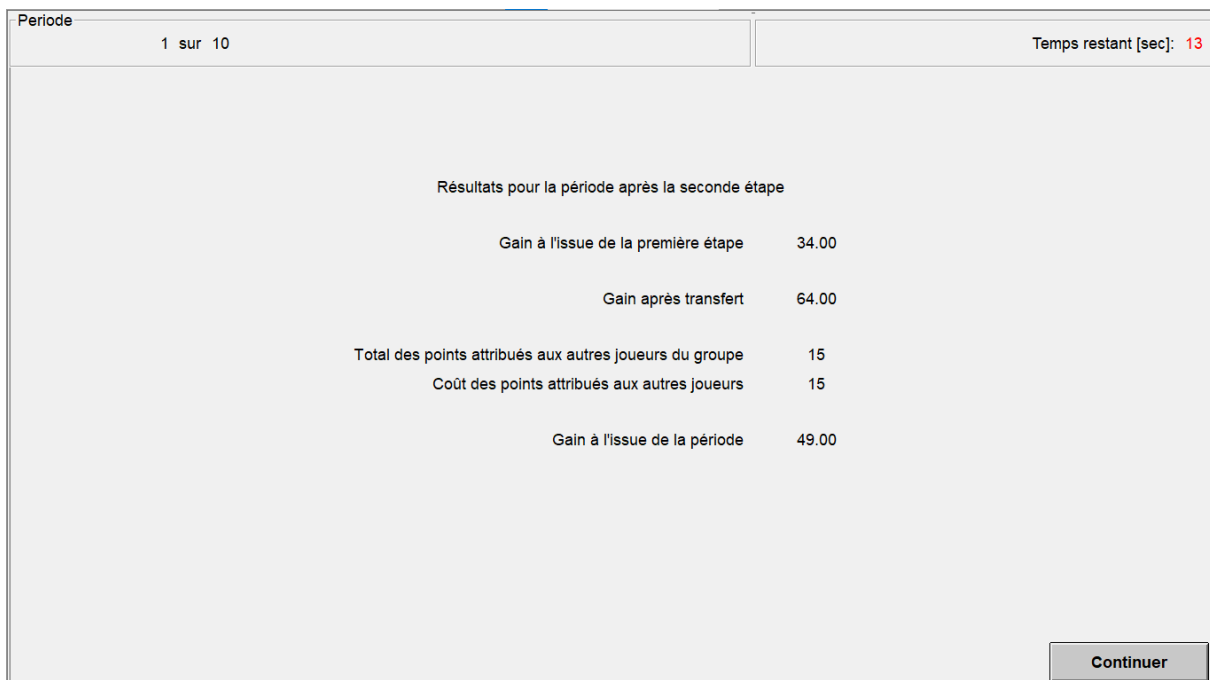
Thus, the designated player's initial payoff is first increased by the 30 tokens transferred by the non-designated players, then reduced by a number of tokens equal to the number of points she or he has distributed. For example, the payoff for the period of a designated player whose first stage payoff is 34 tokens and who distribute 5 points to each of the other 3 players is worth $(34 + 30 - (5 \times 3)) = 49$ tokens.

So, if you are designated, your final payoff for the period is calculated as follows:

Final payoff for each period =
 First stage payoff + 30 tokens transferred – Total number of points distributed

This payoff is always positive or zero, since a first-stage payoff greater than or equal to 10 is added to 30 transferred tokens and a total of points awarded less than or equal to 40 is deducted.

The calculation is done by the computer and displayed on the screen to the designated player:



Click “Continue” to move on.

Your payoffs if you were not designated

If you are not designated, your payoff is reduced by three times the total number of disapproval points that you receive from the designated player. If you receive 0 points, your payoff is unchanged, if you receive 1 point, it reduces your payoff by 3 tokens, if you receive 2 points, it reduces it by 6 tokens, etc.

For example, a non-designated player's first-stage payoff of 34 chips first drops by 10 due to the transfer of 10 tokens to the designated player, then, if she or he receives 5 points from the designated player, by $5 \times 3 = 15$ tokens, which leads to a final payoff of $(34 - 10 - 15) = 9$ tokens.

If you have not been designated, your final payoff for the period is calculated as follows:

Final payoff for each period =

$$\text{First stage payoff} - 10 \text{ tokens transferred} - 3 * \text{Total number of points received}$$

The points received by a non-designated player can cancel her or his payoff but not make it negative: if the number of points received by a player exceeds a third of his first-stage payoff minus the 10 tokens transferred to the designated player, then this player's payoff for the period will be considered zero.

The calculation is done by the computer and displayed on the screen for non-designated players:

Periode		Temps restant [sec]:
1 sur 10		7
Résultats pour la période après la seconde étape		
Gain à l'issue de la première étape		34.00
Gain après transfert		24.00
Nombre de points que vous avez reçus du joueur désigné		5
Réduction des gains du fait des points reçus		15
Gain théorique une fois déduite la réduction liée aux points reçus		9.00
Gain à l'issue de la période, sachant que le gain ne peut pas être négatif		9.00
<input type="button" value="Continuer"/>		

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

Instructions for participants in the experiment

[instructions for the Elected Leader Pressure treatment]

You are now taking part in an economic experiment financed by the Center for Research in Economics and Management of the University of Rennes 1. You will earn an amount of money which depends on your decisions and the decisions of others. It is therefore very important that you read these instructions with care.

The instructions we have distributed to you are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments

During the experiment your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euros at the following rate:

1 Euro = 45 tokens

In addition, each participant receives a lump sum payment of 4 euros. At the end of the experiment your entire earnings from the experiment will be immediately paid to you in private.

At the beginning of the experiment, the participants are randomly divided into groups of four. You will therefore be in a group with 3 other participants. This group corresponds to a production team. You are not aware of the identity of the other group members.

The experiment consists of 10 identical periods. The groups remain unchanged during the entire experiment.

Each period consists of three stages. These instructions present the sequence of the first stage, then that of the second, finally that of the third.

First stage

At the beginning of the first stage of each period, a screen appears where you must choose an effort level, in the form of a number between 0 and 100, which represents your contribution to the production of your group.

Periode 1 sur 10 Temps restant [sec]: 7

Choisissez votre effort entre 0 et 100

OK

After choosing your effort level you must press the ok button. You move on when all the players in your group have validated their choice.

Information on the efforts of other players

The next screen displays the efforts chosen by the other players in your group in a random order that changes each period. The screen below shows an example where these 3 other players have chosen efforts of 20, 40 and 80:

Periode 1 sur 10 Temps restant [sec]: 0

Les efforts des autres joueurs de votre groupe cités dans un ordre aléatoire différent à chaque période :

Un des autres joueurs de votre groupe a choisi un effort de	20
Un des autres joueurs de votre groupe a choisi un effort de	40
Un des autres joueurs de votre groupe a choisi un effort de	80

Continuer

Click "Continue" to move on.

Calculation of your first stage payoff for the period

Calculation your revenue for the period

When you and the other members of your group have entered their effort decisions, the computer will add them up to calculate the **sum of effort**. We will call the resulting number **the sum of group efforts**. Then, the computer randomly draws a number between -40 and +40, corresponding to a "**Random Shock**" which affects the production of the group. Each number between -40 and +40 has an equal chance of being drawn. The "**Sum of group efforts**" plus this random shock is called the "**Total group production**". Total group production will then be multiplied by 1.5 to get what we call the "**Total group revenue**".

Each group member will receive one quarter of total group revenue. This is your **individual revenue**.

For example, if you choose an effort of 60 and the sum of the efforts of the other players in your group is 140, then the **Sum of group efforts** is $(60 + 140 = 200)$. If the random shock is $(- 40)$, the total group production is $(200 - 40) = 160$, the total group revenue is $(1.5 \times 160) = 240$ and your individual revenue, as well as that of the 3 other players in the group is $(240 / 4 = 60)$. In other word each group member receives an equal share of total group revenue, i.e., one quarter of 240.

Your individual revenue at first stage each period is therefore:
[$1.5 * (\text{sum of group efforts} + \text{random shock between } -40 \text{ and } +40) / 4$]

Your individual revenue is calculated by the computer.

Calculation of your cost of effort

For each effort level you might choose over the range between 0 to 100, there is an associated cost of effort to be incurred. You can read your cost of effort corresponding to each effort level in table A below:

Table A: effort level and cost of effort

Effort level	Cost of effort	Effort level	Cost of effort	Effort level	Cost of effort
0	0,00	34	11,56	68	46,24
1	0,01	35	12,25	69	47,61
2	0,04	36	12,96	70	49,00
3	0,09	37	13,69	71	50,41
4	0,16	38	14,44	72	51,84
5	0,25	39	15,21	73	53,29
6	0,36	40	16,00	74	54,76
7	0,49	41	16,81	75	56,25
8	0,64	42	17,64	76	57,76
9	0,81	43	18,49	77	59,29
10	1,00	44	19,36	78	60,84
11	1,21	45	20,25	79	62,41
12	1,44	46	21,16	80	64,00
13	1,69	47	22,09	81	65,61
14	1,96	48	23,04	82	67,24
15	2,25	49	24,01	83	68,89
16	2,56	50	25,00	84	70,56
17	2,89	51	26,01	85	72,25
18	3,24	52	27,04	86	73,96
19	3,61	53	28,09	87	75,69
20	4,00	54	29,16	88	77,44
21	4,41	55	30,25	89	79,21
22	4,84	56	31,36	90	81,00
23	5,29	57	32,49	91	82,81
24	5,76	58	33,64	92	84,64
25	6,25	59	34,81	93	86,49
26	6,76	60	36,00	94	88,36
27	7,29	61	37,21	95	90,25
28	7,84	62	38,44	96	92,16
29	8,41	63	39,69	97	94,09
30	9,00	64	40,96	98	96,04
31	9,61	65	42,25	99	98,01
32	10,24	66	43,56	100	100,00
33	10,89	67	44,89		

For example, if you choose an effort level of 10, it costs you 1 token, an effort of 50 costs 25 tokens, an effort of 100 costs 100 tokens. The higher your effort level, the higher the cost you must incur. Furthermore, the cost of effort increases more than proportionally (i.e., at an increasing rate). Hence the cost of choosing an effort level of 100 effort is more than twice the cost of choosing an effort of 50.

In summary your cost of effort is calculated as follow:

Cost of effort = cost associated in Table A with the chosen effort level

For example, an effort of 60 costs 36 tokens.

Calculation of your first-stage payoff for each period

Your payoff or earning in any period will equal your individual revenue minus your cost of effort. In addition, you receive a fixed amount of 10 tokens. Precisely, using the previous formulas, we get:

$$\begin{aligned} \text{Your first stage payoff for each period} &= \text{Individual Revenue} - \text{Cost of effort} + 10 \text{ tokens} \\ &= (1.5 * (\text{Sum of group efforts} + \text{Random shock between } -40 \text{ and } +40) / 4) - \text{cost of effort} + 10 \end{aligned}$$

Please note that if the costs of effort exceed your individual revenue, the difference is set to zero by the computer. Therefore, your payoff for the period is always greater than or equal to 10, due to your additional endowment of 10 tokens.

In the previous example where you choose an effort of 60 and your individual revenue is also 60, your cost of effort is 36 according to Table A, and the difference is $(60 - 36) = 24$ tokens. By adding 10 additional tokens, your first stage payoff for the period is 34 tokens.

Your first stage payoff for the period is calculated by the computer and displayed on the screen:

Résultats pour la période	
Effort que vous avez choisi	60
Somme des efforts du groupe	200
Choc aléatoire (entre -40 et +40)	-40.0
Production totale du groupe	160
Revenu total du groupe	240.00
Votre revenu de production	60.00
Votre coût de production	36.00
Votre gain de production	24.00
Votre dotation additionnelle	10
Votre gain pour la période	34.00

Click "Continue" to move on.

Second stage

Election of a player from your group

During the second stage, one player among the 4 in your group is elected. An input screen, an example of which is shown below, allows you to vote for one and only one of the other players in your group.

 oui', 'Si vous votez pour le joueur qui a choisi l'effort 40 cochez 'oui', sinon cochez 'non' non oui', and 'Si vous votez pour le joueur qui a choisi l'effort 20 cochez 'oui', sinon cochez 'non' non oui'. An 'OK' button is in the bottom right corner."/>

Periode 1 sur 10 Temps restant [sec]: 0

Vous devez voter pour un et un seul des trois autres joueurs de votre groupe

Si vous votez pour le joueur qui a choisi l'effort 80 cochez 'oui', sinon cochez 'non' non oui

Si vous votez pour le joueur qui a choisi l'effort 40 cochez 'oui', sinon cochez 'non' non oui

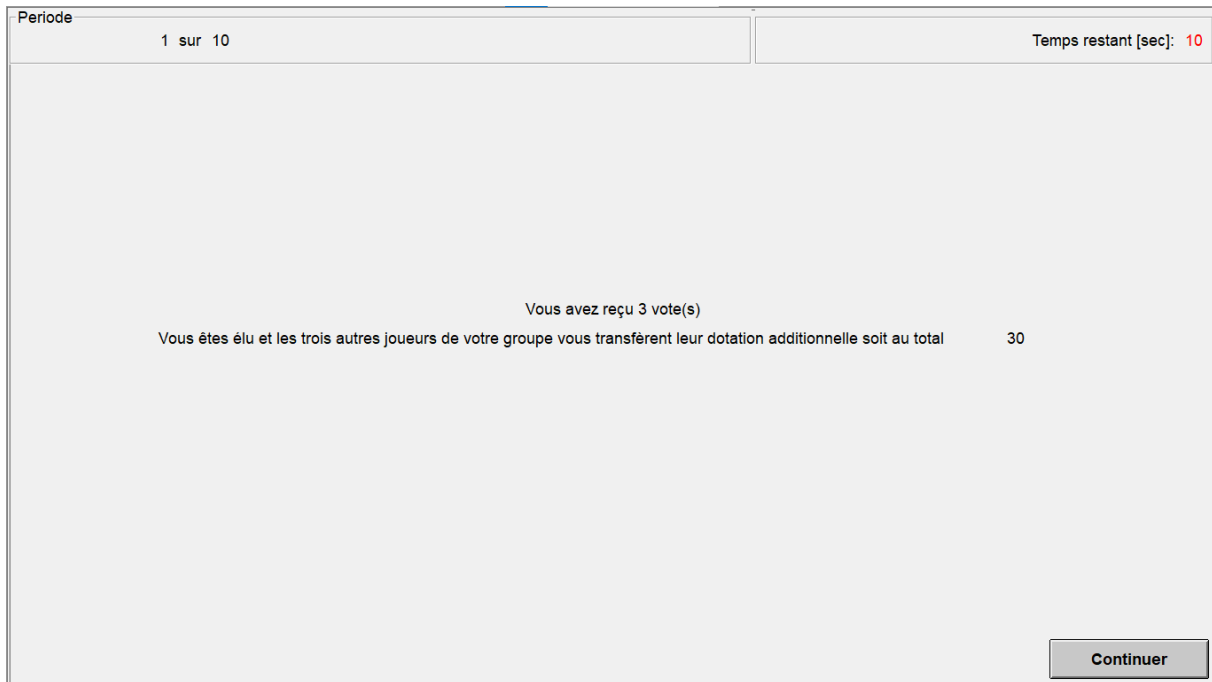
Si vous votez pour le joueur qui a choisi l'effort 20 cochez 'oui', sinon cochez 'non' non oui

OK

You vote based on players' efforts in the first stage, displayed in a random order that changes each period. You check “yes” in the box for the player you are voting for, and “no” in the other two boxes. You must check “yes” once and “no” twice. The player who receives the most votes is elected, with a toss in the event of a tie.

Validate your vote by clicking on “OK”. When all players have voted, a screen tells you the number of votes you have received, and whether you are elected or not.

If you are elected, the 3 other players in the group transfer their additional allocation of 10 tokens to you, for a total of 30 tokens. You are informed by the screen:



Click “Continue” to move on.

These 30 additional tokens are added to your initial 10, giving you a total of 40 additional tokens.

If you are not elected, you transfer your 10 additional tokens to the elected player. You are informed by the screen:



Click “Continue” to move on.

Third stage

The elected player can reduce the gains of the other players in the group

If you are elected, you can use all or part of your 40 additional tokens to reduce the gains of the other three players in your group by distributing them disapproval points.

A screen appears where you need to enter the disapproval points you distribute to other players in your group, as in the example below:

Periode 1 sur 10

Temps restant [sec]: 0

Le total des points que vous attribuez aux 3 autres joueurs de votre groupe doit être inférieur ou égal à 40

Points que vous attribuez au joueur qui a choisi l'effort 80

Points que vous attribuez au joueur qui a choisi l'effort 40

Points que vous attribuez au joueur qui a choisi l'effort 20

OK

The order in which the efforts of other players are displayed is random and varies from period to period. It is therefore on the sole basis of the efforts chosen during the first stage of this period that you decide on the points that you distribute to them. The total number of points distributed to the other three players must be less than or equal to 40. Validate your choice by clicking on “OK”.

Payoffs at the end of the third stage

The calculation differs depending on whether you are elected or not during the second stage.

Your payoffs if you are elected

Each point you distribute to a particular player lowers his or her first stage payoff by 3 tokens. So, if you distribute 0 points to a player, you do not change his gain, if you distribute 1 point, you reduce his first stage payoff by 3 tokens, if you distribute 2 points you reduce his first stage payoff by 6 tokens and so on.

Distributing points to other players costs you in tokens the total of the points you distribute. This total cannot exceed 40 tokens. For example, awarding 5 points to each of the other 3 players costs you 15 tokens. You could not award 15 points to each of the other 3 players because that would be 45 points, above the maximum of 40.

Thus, the elected player's initial payoff is first increased by the 30 tokens transferred by the non- elected players, then reduced by a number of tokens equal to the number of points she or he has distributed. For example, the payoff for the period of an elected player whose first stage payoff is 34 tokens and who distribute 5 points to each of the other 3 players is worth $(34 + 30 - (5 \times 3)) = 49$ tokens.

So, if you are elected, your final payoff for the period is calculated as follows:

Final payoff for each period =
 First stage payoff + 30 tokens transferred – Total number of points distributed

This payoff is always positive or zero, since a first-stage payoff greater than or equal to 10 is added to 30 transferred tokens and a total of points awarded less than or equal to 40 is deducted.

The calculation is done by the computer and displayed on the screen to the elected player:

Période 1 sur 10	Temps restant [sec]: 14
Résultats pour la période après la troisième étape	
Gain à l'issue de la première étape	34.00
Gain après transfert	64.00
Total des points attribués aux autres joueurs du groupe	15
Coût des points attribués aux autres joueurs	15
Gain à l'issue de la période	49.00
<input type="button" value="Continuer"/>	

Click “Continue” to move on.

Your payoffs if you are not elected

If you are not elected, your payoff is reduced by three times the total number of disapproval points that you receive from the elected player. If you receive 0 points, your payoff is unchanged, if you receive 1 point, it reduces your payoff by 3 tokens, if you receive 2 points, it reduces it by 6 tokens, etc.

For example, a non-elected player's first-stage payoff of 34 chips first drops by 10 due to the transfer of 10 tokens to the elected player, then, if she or he receives 5 points from the elected player, by $5 \times 3 = 15$ tokens, which leads to a final payoff of $(34 - 10 - 15) = 9$ tokens.

If you have not been elected, your final payoff for the period is calculated as follows:

Final payoff for each period =

$$\text{First stage payoff} - 10 \text{ tokens transferred} - 3 * \text{Total number of points received}$$

The points received by a non-elected player can cancel her or his payoff but not make it negative: if the number of points received by a player exceeds a third of his first-stage payoff minus the 10 tokens transferred to the elected player, then this player's payoff for the period will be considered zero.

The calculation is done by the computer and displayed on the screen for non- elected players:

Periode		Temps restant [sec]:
1 sur 10		1
Résultats pour la période après la troisième étape		
Gain à l'issue de la première étape		34.00
Gain après transfert		24.00
Nombre de points que vous avez reçus du joueur élu		5
Réduction des gains du fait des points reçus		15
Gain théorique une fois déduite la réduction liée aux points reçus		9.00
Gain à l'issue de la période, sachant que le gain ne peut pas être négatif		9.00
<input type="button" value="Continuer"/>		

Click "Continue" to move on.

Calculation of your final payoff for the whole experience

Your final payoff in tokens for the whole experiment equals the sum of your payoffs for each of the 10 periods of the experiment. At the end of the game, a summary screen appears showing you for the 10 periods, your payoffs for each period and the cumulative payoffs of the period and previous periods. The cumulative payoff at the end of the tenth period corresponds to your final payoff in tokens at the end of the experiment.

Appendix B: Tests on socio-demographic differences between treatments

Table B1. Results of tests on socio-demographic differences between treatments (Main Experiment)

	Gender*	Participation*	Economics*	Age [‡]
Baseline vs Peer Pressure	0.371	1.000	0.666	0.5905
Baseline vs Random Leader Pressure	1.000	0.188	0.072	0.3287
Baseline vs Elected Leader Pressure	1.000	0.188	0.245	0.8229
Peer Pressure vs Random Leader Pressure	0.547	0.416	0.318	0.0444
Peer Pressure vs Elected Leader Pressure	0.238	0.416	0.724	0.3857
Random Leader Pressure vs Elected Leader Pressure	0.772	1.000	0.752	0.4169

Table B2. Results of tests on socio-demographic differences between treatments (Complementary Experiment)

	Gender*	Participation*	Economics*	Age [‡]
Baseline vs Random Leader Pressure	1.000	0.188	0.072	0.3287
Baseline vs Random Leader Example	0.556	0.023	0.072	0.7823
Baseline vs Random Leader Example & Pressure	0.244	0.097	0.137	0.7171
Random Leader Pressure vs Random Leader Example	0.766	0.517	1.000	0.1311
Random Leader Pressure vs Random Leader Example & Pressure	0.147	1.000	1.000	0.1134
Random Leader Example vs Random Leader Example & Pressure	0.042	0.752	1.000	0.9182

Appendix C: Performances per teams per treatment

This Appendix provides descriptive statistics of the performances of the six teams of four workers involved in each treatment. Tables 4.A-1 to 4.A-4 detail these statistics for Baseline, Peer Pressure, Random Leader Pressure and Elected Leader Pressure respectively. Results are presented in separate tables to underline that teams are different between treatments, as we use a “between” design.

Table A-1: Descriptive statistics of efforts and payoffs per team in the Baseline treatment

Team	1	2	3	4	5	6	Nb Obs. per team
Average Effort of workers	48.03 (19.41)	45.45 (26.28)	36.60 (23.28)	36.28 (26.81)	41.28 (17.09)	61.75 (22.29)	40
Average payoffs of workers	63.65 (18.66)	55.95 (21.71)	45.33 (19.62)	44.64 (24.66)	52.03 (14.24)	64.16 (25.88)	40

Numbers in parenthesis are Standard Deviations

Table A-2: Descriptive statistics of efforts, of received punishments points, and of payoffs, per team, in the Peer Pressure treatment

Team	1	2	3	4	5	6	Nb Obs. per team
Average Effort of workers	48.45 (36.04)	77.73 (15.63)	55.18 (13.48)	44.50 (24.09)	64.98 (14.03)	43.35 (9.92)	40
Average number of punishment points	1.1 (1.69)	2.15 (1.61)	0.13 (0.79)	2.8 (2.08)	2.23 (1.59)	2.53 (3.38)	40
Average payoffs of workers	51.50 (30.08)	53.51 (20.80)	58.32 (17.23)	39.25 (22.16)	51.84 (18.95)	46.22 (10.06)	40

Numbers in parenthesis are Standard Deviations

Table A-3: Descriptive statistics of efforts of all workers, of leaders and non-leaders, of received punishments points, and of payoffs, per team, in the Random Leader treatment

Team	1	2	3	4	5	6	Nb Obs. per team
Average Effort of all workers	40.82 (30.30)	56.45 (12.61)	33.75 (21.12)	56.13 (12.06)	50.73 (12.31)	32.28 (22.23)	40
Average Effort of Non-Leaders	39.13 (27.82)	56.03 (13.86)	32.73 (21.13)	57.17 (10.72)	51.37 (13.80)	35.37 (22.22)	30
Average Effort of Leaders	45.9 (38.01)	57.70 (8.21)	36.80 (21.90)	53.00 (15.67)	48.80 (6.20)	23.00 (20.58)	10
Average number of punishment points	0.83 (2.32)	0.58 (1.17)	1.1 (2.10)	4.30 (4.69)	2.75 (5.54)	0.88 (3.56)	40
Average payoff of workers	45.96 (27.98)	55.92 (22.15)	37.46 (26.96)	48.91 (26.58)	47.95 (27.05)	41.49 (28.67)	40

Numbers in parenthesis are Standard Deviations

Table A-4: Descriptive statistics of efforts of all workers, of elected and not elected workers, of received punishments points, and of payoffs, per team, in the Elected Leader treatment

Team	1	2	3	4	5	6	Nb Obs. per team
Average Effort of workers	73.72 (26.29)	55.18 (20.32)	39.68 (28.40)	57.35 (15.18)	42.33 (31.23)	58.58 (14.64)	40
Average Effort of Not Elected workers	71.80 (29.09)	54.90 (18.89)	37.07 (27.29)	57.33 (16.90)	43.53 (31.19)	57.67 (15.08)	30
Average Effort of Elected workers	79.50 (14.83)	56.00 (25.25)	47.50 (31.68)	57.40 (8.82)	38.70 (32.75)	61.30 (13.57)	10
Average number of punishment points	4.60 (5.79)	0.68 (1.05)	2.18 (6.41)	0.70 (2.64)	2.50 (4.36)	1.40 (3.54)	40
Average payoffs of workers	42.65 (29.92)	52.74 (25.14)	35.15 (27.72)	59.89 (24.13)	38.69 (30.16)	58.74 (24.60)	40

Numbers in parenthesis are Standard Deviations

Tables A-1 to A-4 show that team performances are heterogenous between teams. For instance, the ratio between lowest and the highest average effort per team equals 0.59 for the Baseline treatment, 0.56 for the Peer Pressure treatment, 0.57 for the Random Leader Treatment and 0.54

for the Elected Leader Treatment. Standard deviation figures in Tables 1.A-1 to 1.A-4 indicate that performances are also heterogeneous within teams.

A specific comment can be done on Table A-4 concerning the Elected Leader Pressure Treatment. Average effort of elected workers is close to (Teams 2, 4 and 6), below (Team 5) or above (Teams 1 and 3) the average effort of not-elected workers of the team. It appears that the largest the absolute difference between the average effort of elected workers and the average effort of all not-elected workers, the largest the average number of punishment points and the lowest the average payoff for workers. Hence, punishments seem to be minimum and workers payoffs maximum when the average effort of non-elected workers of the team is close to the average effort of elected workers.

This comment does not apply to Table A-3, concerning the Random Leader Pressure treatment. The average number of punishment points seems to vary independently of the relative average efforts of Leaders and of Non-Leaders.

Appendix D: Theoretical analysis of the game where the worker choosing the highest effort is selected as leader

This appendix theoretically analyses an additional leader designation mechanism where the leadership of the team is entrusted to the participant who chooses the maximum effort.

In practice, if such a mechanism is imposed from the outside by a principal, it would be a form of tournament with competition for the place of leader, with risks of unethical and destructive behaviors such as cheating, rent-seeking, or sabotage. Putting aside these considerations, the main conclusion of the theoretical analysis of this mechanism, is that under standard neoclassical hypotheses and with the parameters of the effort game used in this thesis, no Nash equilibrium exists in pure strategy.

The game equilibrium is analyzed by backward induction.

- 1) In the second stage of the game, the leader may punish her peers. However, as punishing is costly for her, she has no interest in punishing, in a profit maximization perspective. Therefore, under standard neoclassical hypothesis, no punishment is imposed in the second stage.
- 2) Therefore, the first stage of the game is studied assuming there is no punishment in the second stage. The remaining of this appendix is dedicated to the first stage of the game.

The transfers of fixed parts of remuneration between non-leaders and leader generate discontinuities in the payoff of players as a function of their effort. For this reason, it is handier to consider efforts and payoffs as discrete variables rather than continuous variables. Effort is modelled as a positive integer between 0 and 100. Instead of studying the derivatives of the payoff of players as a function of their efforts, we study the finished differences of the payoff of players as a function of unitary variations of their effort.

The remaining of the appendix first analyses the variations of players' payoffs as a function of their efforts, and second proves that no pure strategy may be a Nash equilibrium of the game.

D.1. Study of the variations of players' payoffs as a function of their efforts

Any unilateral variation in a player's effort results on the one hand in a variation in production payoff and on the other hand in a variation in transfer payoff, the total variation in player payoff being the sum of the variation of production payoff and of the variation of transfer payoff.

The variation of production payoff $vp(e_i, e'_i)$ when the effort of a player i goes from e_i to e'_i , the efforts of the other players remaining constant, is equal to the variation of the difference between the production revenue and the production cost of the player, i.e.:

$$vp(e_i, e'_i) = \left(1.5 \times \frac{e'_i + \sum_{z \neq i} e_z}{4} - \frac{e'^2_i}{100} \right) - \left(1.5 \times \frac{e_i + \sum_{z \neq i} e_z}{4} - \frac{e_i^2}{100} \right)$$

Which can be rewritten:

$$vp(e_i, e'_i) = \left(1.5 \times \frac{e'_i + \sum_{z \neq i} e_z}{4} - 1.5 \times \frac{e_i + \sum_{z \neq i} e_z}{4} \right) - \left(\frac{e'^2_i}{100} - \frac{e_i^2}{100} \right)$$

Which is simplified to:

$$vp(e_i, e'_i) = \frac{1,5 \times (e'_i - e_i)}{4} - \left(\frac{e'^2_i - e_i^2}{100} \right)$$

If we are particularly interested in the unitary variations for which $e'_i = e_i + 1$, we can write:

$$vp(e_i, e_i + 1) = \left(1.5 \times \frac{(e_i + 1) + \sum_{z \neq i} e_z}{4} - 1.5 \times \frac{e_i + \sum_{z \neq i} e_z}{4} \right) - \left(\frac{(e_i + 1)^2}{100} - \frac{e_i^2}{100} \right)$$

Which is simplified to:

$$vp(e_i, e_i + 1) = \frac{1,5}{4} - \left(\frac{2 \times e_i}{100} \right)$$

As can be seen from this formula, $vp(e_i, e_i + 1)$ decreases linearly with e_i from 0 to 99. Numerically, we observe that $vp(e_i, e_i + 1)$ becomes negative when e_i goes from 18 to 19, which means that the player i 's production payoff, the efforts of the other players being fixed, increases when e_i increases from 0 to 19, and decreases when e_i increases beyond 19. The player i 's maximum production payoff, the efforts of the other players being fixed, is therefore reached for $e_i = 19$. We have:

$$vp(0,1) = \frac{1,5}{4} = 0,375$$

$$vp(18,19) = \frac{1,5}{4} - \frac{36}{100} = 0,015$$

$$vp(19,20) = \frac{1,5}{4} - \frac{38}{100} = -0,005$$

$$vp(99,100) = \frac{1,5}{4} - \frac{198}{100} = -1,605$$

All other values of $vp(e_i, e_i + 1)$ fall between these two extremes:

$$vp(e_i, e_i + 1) \in [-1,605; 0,375]$$

Let us observe that by definition:

$$vp(e_i, e'_i) = -vp(e'_i, e_i)$$

And in particular:

$$vp(e_i, e_i + 1) = -vp(e_i + 1, e_i)$$

Subsequently:

$$vp(e_i + 1, e_i) \in [-0,375; 1,605]$$

D.2. Proof that no pure strategy is a Nash equilibrium of the game

The proof that no pure strategy is a Nash equilibrium of the game is established by following the following steps:

- 1) A situation where only one player has the best bid and his choice of effort is at least two units greater than or equal to the choice of effort of the other player(s) cannot be a Nash equilibrium.
- 2) A situation where only one player has the best bid and his choice of effort is one unit greater than the choice of effort of the other player(s) cannot be a Nash equilibrium.
- 3) A situation where two or more players are tied for best and their effort is less than 100 cannot be a Nash equilibrium.
- 4) A situation where two or more players are tied for best and their effort is equal to 100 cannot be a Nash equilibrium.

In each of these four cases, we show that there is at least one profitable unilateral deviation for one of the players, which shows that the situation is not a Nash equilibrium. These four cases

cover all possible configurations, which shows that none of the configurations of the game (in pure strategies) can be a Nash equilibrium.

- 1) A situation where only one player has the best bid and his choice of effort is at least two units greater than or equal to the choice of effort of the other player(s) cannot be a Nash equilibrium.

A situation where only one player has the best bid and his choice of effort is at least two units greater than or equal to the choice of effort of the other player(s) cannot be a Nash equilibrium. Indeed, in this configuration, a reduction of one unit in the effort of the best player or an increase of one unit in the effort of the second will not change their respective rank, and therefore their transfer payoffs. Only variations in production payoffs must be accounted for. And in this situation:

- In all cases where the effort of the best player is greater than or equal to 20, it is in his interest to decrease by one unit, because his variation in production payoff is positive, since the optimum is at 19. The deviation is therefore profitable.
- In all cases where the effort of the second best player is less than or equal to 18, it is in his interest to increase by one unit, because his variation in production payoff is positive, since the optimum is at 19. The deviation is therefore profitable.

And when the best player has an effort less than 20, and the second best has an effort greater than 18, the gap between the two cannot be greater than or equal to two units. The deviation is therefore profitable in all cases corresponding to point 1), which demonstrates point 1).

- 2) A situation where only one player has the best bid and his choice of effort is one unit greater than the choice of effort of the other player(s) cannot be a Nash equilibrium.

A situation where only one player has the best bid and his choice of effort is one unit greater than the choice of effort of the other player(s) cannot be a Nash equilibrium. In this case, the second best player has an interest in increasing his effort by one unit to be tied with the best and share the transfer payoff. In fact, its transfer payoff then goes from -10 before the increase in effort, to $0,5 \times 30 + 0,5 \times (-10) = 10$ after the increase in effort, i.e., a transfer payoff

variation of 20. We know that a variation of one unit of effort generates a variation in production payoff which is always greater than $-1,605$ since $vp(e_i, e_i + 1) \in [-1,605, 0,375]$.

It follows that the sum of the transfer payoff variation of 20 plus the variation in production payoff is always positive in this case, whatever e_i between 0 et 99. The deviation is therefore profitable, which demonstrates point 2).

- 3) A situation where two or more players are tied for best and their effort is less than 100 cannot be a Nash equilibrium.

Consider situations where the maximum effort is less than 100 and is shared between two, three or four players. Let us first take the example of two players to simplify the presentation.

A situation with two players sharing the maximum effort cannot be a Nash equilibrium because each of the two possible leaders would have an interest in deviating unilaterally by increasing their effort by one unit in order to increase their expected transfer payoff from $0,5 \times 30 + 0,5 \times (-10) = 10$ initially to $1 \times 30 = 30$ after deviation, i.e., a transfer payoff variation of $30 - 10 = 20$ which is always greater than the variations in production payoff. The deviation is therefore always profitable.

The same reasoning is a fortiori valid with three or four players initially tied for leader below 100 because the variation in transfer payoff associated with a deviation of one unit is even higher than with two players initially tied for leader.

The deviation is therefore profitable in all cases corresponding to point 3), which demonstrates point 3).

- 4) A situation where two or more players are tied for best and their effort is equal to 100 cannot be a Nash equilibrium.

The only remaining setups to consider are those with two, three, or four players initially tied with an effort of 100. We show that these configurations are not Nash equilibria either. Indeed, a deviation by one of the leaders to lower his effort from 100 to, for example, 19 is profitable. Take the example where the initial situation is a tie between two players. In this case, if one of the players lowers his contribution from 100 to 19, he ceases to be leader and suffers a variation

in transfer payoff of -20 (from 10 to -10). But this is more than offset by the variation in production payoff, which is worth

$$vp(100,19) = \left(1.5 \times \frac{19 - 100}{4}\right) - \left(\frac{19^2}{100} - \frac{100^2}{100}\right) = 66,015$$

The positive variation in production payoff is greater than the negative variation in transfer payoff. The unilateral deviation from 100 to 19 is therefore profitable. This same reasoning applies a fortiori when the starting situation is a tie of three or four players to 100, because in these two cases, the loss of transfer payoff is less than starting from a tie of two, while the increase in production payoff remains the same.

The deviation is therefore profitable in all cases corresponding to point 4), which demonstrates point 4.

General Conclusion

Team work has become a dominant mode of organization in firms since the end of the twentieth century. Firms have introduced teamwork in their organizations because it can increase productivity, stimulate mutual aid and skill transfer between colleagues, provide flexibility to face the hazards of production and of demand, and favor more rational decision-making by employees. However, teamwork organization has its downsides. First, coordination problems may emerge in the absence of a clear decision-making process (Driskell and Salas, 1991), if team members have diverging views (Masclat and Rebières, 2017). Second, as individual compensations depend on team collective performance, free-riding problems may arise, because rewards generated by individual efforts are shared with team mates, which dilutes the individual incentive to contribute (Holmstrom, 1982; Kandel and Lazear, 1992).

Economic analysis and in particular experimental economics have studied several mechanisms designed to prevent free riding in teams, such as centralized mechanisms based on a team target or on collective tournaments (Holmstrom, 1982; Nalbantian and Schotter, 1992), decentralized mechanisms exploiting peer pressure (Kandel and Lazear, 1992; Barron and Gjerde, 1997; Fehr and Gächter, 2000), or mechanisms based on the action of a team leader (Drouvelis and Nosenzo, 2013). But the efficiency of those mechanisms has not yet been directly compared in a consistent experimental design.

The main contribution of this thesis is threefold.

First, we evaluate both the effectiveness and the efficiency of a baseline revenue sharing mechanism, a decentralized mechanism of peer pressure, and centralized mechanisms based on a team target or on collective tournaments. The effects of treatments on workers' efforts and payoffs, on firms' profits, and on social welfare are analyzed.

Second, this thesis investigates if replacing monetary rewards by symbolic incentives in centralized mechanisms (team target and collective tournaments) is efficient in preventing free-riding and avoiding the potential negative effects of monetary incentives on workers' payoffs. Furthermore, we attempt to identify the specific effects on workers' behavior of pure observation of individual efforts.

Third, this thesis assesses whether introducing a team leader could alleviate the coordination problem within teams, increase the effectiveness of peer pressure and improve its efficiency by reducing its social cost. We also investigate the effects of leading by example on team performances.

For these purposes, we use the experimental methodology, by conducting laboratory experiments that provide a strong internal validity. Our experiments are based on an effort game inspired by Nalbantian and Schotter (1997). Such game appears relevant for modelling teamwork in firms, and comparing different incentive mechanisms to fight against free-riding.

Our main findings are the following:

First, our results confirm that, in the absence of incentive mechanisms, effort is subject to free-riding, although not as severely as theoretically-predicted under standard hypotheses.

Decentralized peer pressure mechanisms increase effort compared to the baseline, but substantial free riding remains. Furthermore, peer pressure does not improve workers' payoffs because the gains from higher cooperation are offset by the cost of punishments. Peer pressure is costly both for the target and for the punisher.

Centralized mechanisms are more effective than decentralized peer pressure to enhance effort. The scheme based on a team target leads to the highest level of effort, but to the lowest level of workers' payoffs. This results from the large proportion of teams who fail to reach the target, which implies low earnings for members of those teams. In contrast, the team target scheme maximizes the profits of firms.

Competition between teams significantly enhances effort but fails to improve workers' payoffs. In addition, competition between teams generates high inequality of payoffs between workers, due to the large revenue transfers between winner and loser teams.

Social welfare is maximized under centralized incentive schemes. This increase in social welfare benefits to the firm, and not to workers.

Second, compared to the baseline treatment, centralized mechanisms using symbolic incentives effectively increase workers' efforts and social welfare, but less than with monetary incentives. Introducing, observation of individual efforts in the baseline revenue sharing treatment, instead of observation of average effort, significantly increases effort. However, such pure effect of observability is not found to be significant, in the context of centralized mechanisms using monetary incentives.

Third, introducing team leaders has a positive and lasting effect if they can both lead by example and sanction free-riders. Conversely, introducing leadership has a counterproductive effect if the leader can only either sanction or lead by example. Finally, the effectiveness of leadership increases if the leader is elected by peers rather than chosen randomly.

Practical implications from these experimental results can only be derived with caution, considering the limits of the external validity of our laboratory experiments (Berkowitz and Donnerstein, 1982; Colquitt, 2008; Levitt and List, 2007a, 2007b). Indeed, our experiments are too far from real-world situations to reliably estimate the magnitude of the effects under consideration. However, they should correctly identify the direction of those effects as discussed in Kessler and Vesterlund (2015) and Levitt and List (2007a). Furthermore, our experiments only represent a first step, calling for replications and testing in more realistic contexts.

That being said, our results suggest some practical policy implications.

First, our findings suggest that centralized mechanisms based on monetary incentives tend to outperform decentralized peer pressure mechanisms regarding workers' efforts, firms' profits, and social welfare. Hence, firms using centralized monetary incentives may improve their efficiency. However, firms should be cautious by implementing such centralized monetary incentives: these systems may have negative effects for workers as they may induce low payoffs in the case of team targets, or a strong dispersion of earnings between winners and losers in the case of team tournaments. In the long run, this could lead some team members to become resigned over time, and prompt certain employees to leave the firm.

Another perverse effect of team tournaments (whether based on absolute or relative performance) is that they could lead to unethical activities such as sabotaging the output of the opposing team, or artificially enhancing the team's performance to win the tournament. Economic literature extensively covers individual tournaments for which such effects have been observed (Charness et al., 2014, Sheremeta, 2016). Experimental literature also shows that collective tournaments can generate very high costs of conflicts between teams (Abbink et al. 2010).

Hence, the management of a firm may face a trade-off between competitiveness on the downstream market of product and service, and competitiveness on the upstream labor market, when choosing a team incentive mechanism. Appropriate balancing of monetary and symbolic team incentives, could be option deserving further investigation.

Regarding the impacts of leadership, concentrating punishing power in the hands to a team leader does not make it more effective than under decentralized peer pressure. It can even harm team's performance if the choice of leader is perceived as arbitrary, and if her prerogatives are incomplete. However, a leader who can both lead by example and punish her peers has a

positive and sustainable effect on the performance of the team, and a leader chosen by her peers perform better than a leader perceived to be chosen on arbitrary grounds.

Altogether, these findings also underline that when considering a remuneration scheme, several dimensions including effectiveness, efficiency but also how welfare is shared between workers and firms, and among workers, should be balanced.

Several directions of further research may be proposed. A first extension of this work may consist in replicating this experiment in the field to gain in term of external validity. In addition, examining whether professionals exhibit similar behavior in the laboratory, would provide more external validity to our results, before experimenting in a work context (Harrison and List, 2004). Our experiment could also be run using a stranger design instead of a partner design, to disentangle the role played by reputation-building effect from the policy effect⁷⁴.

Second, more elaborate incentive mechanisms could be tested. In the specific case of leadership, further studies could evaluate its impact on teamwork, depending on the combinations of leader designation procedures and of the functions delegated to the leader. The former could include not only random choice or election, but also designation of workers providing the highest effort, or designation by a principal. The latter could include not only the ability to lead by example and to punish, but also communication, evaluation of team members, or influence on team recruitment. The experimental design comparing peer pressure to leader pressure could also be extended to include possibilities of reprisals between team members. Hence, further research could investigate the effects of comprehensive, multi-dimensional incentives mechanisms, uncovering not only the stand alone, but also the incremental impact on each option on top of others.

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⁷⁴ This was suggested by the anonymous reviewer of the article corresponding to chapter 2.

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Titre : Efficacité et efficacité des mécanismes centralisés et décentralisés au sein des équipes de travail : approche expérimentale

Mots clés : Travail d'équipe, incitations collectives, pression par les pairs, économie expérimentale, économie du travail et des ressources humaines

Résumé : Le travail en équipe occupe une place prépondérante dans de nombreuses entreprises. Il peut accroître la productivité, stimuler l'entraide et le transfert de compétences et offrir davantage de flexibilité face aux aléas de production ou de demande. Toutefois, le travail en équipe pose des problèmes de coordination et de passager clandestin. Cette thèse étudie dans quelle mesure l'introduction de mécanismes centralisés (tournois entre équipes ou introduction d'un objectif d'équipe) ou décentralisés (pression des pairs) améliore l'efficacité et l'efficacité du travail en équipe. Il s'agit également d'étudier si l'introduction d'un leader peut faciliter la coordination au sein de l'équipe. Nous mobilisons pour cela l'approche expérimentale. L'introduction de mécanismes centralisés avec enjeux monétaires conduit à des niveaux d'effort et de profits significativement plus élevés qu'en l'absence de mécanisme incitatif. Toutefois les gains pour les travailleurs sont plus inégaux et peuvent être plus faibles qu'en l'absence de ces mécanismes. Avec des enjeux symboliques, les mécanismes centralisés restent efficaces mais cette efficacité est moindre que lorsque les enjeux sont monétaires. Les mécanismes décentralisés de pression des pairs ont également un effet positif sur l'effort mais plus faible que celui des mécanismes centralisés. La pression des pairs n'augmente ni le profit de l'entreprise ni les gains des travailleurs, en raison des coûts sociaux des sanctions. L'introduction d'un leader d'équipe a un effet positif et durable sur la coopération au sein de l'équipe s'il peut à la fois donner l'exemple et sanctionner les passagers clandestins. A l'inverse l'introduction d'un leader a un effet contre productif s'il peut seulement sanctionner ou donner l'exemple. Enfin l'efficacité du leadership s'accroît si le leader est élu par ses pairs plutôt que choisi au hasard.

Title: Effectiveness and efficiency of decentralized and centralized mechanisms in teamwork: experimental evidence

Keywords: Teamwork, team incentives, peer pressure, experimental economics, labor and personnel economics

Abstract: Teamwork plays a predominant role in many firms. It can increase productivity, promote mutual assistance and skills transfer and offers flexibility to face production or demand fluctuations. However, teamwork can also generate free riding and coordination problems.

This thesis investigates whether centralized mechanisms (teams tournaments or team objectives) or decentralized mechanisms (peer pressure) can reduce free-riding in teams. It also studies if a team leader can coordinate peer pressure mechanisms, which may be socially costly. For this purpose we resort to experimental methodology.

The introduction of centralized mechanisms with monetary stakes leads to significantly higher levels of effort and profits than in the absence of incentive mechanisms.

However, gains for workers are more unequal and may be lower than in the absence of these mechanisms. With symbolic stakes, centralized mechanisms remain effective, but this effectiveness is lower than when the stakes are monetary. Decentralized mechanisms of peer pressure also have a positive effect on effort but weaker than that of centralized mechanisms. Peer pressure does not increase firms' profits or workers' payoffs due to the social costs of sanctions. The introduction of team leaders has a positive and lasting effect if they can both lead by an example and sanction free-riders. Conversely, introducing leadership has a counterproductive effect if the leader can only either sanction or lead by example. Finally, the effectiveness of leadership increases if the leader is elected by peers rather than chosen randomly.