Competing Norms of Cooperation¤

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Abstract

A key question concerning social norms is whether norms that are bad for its members can survive. This paper argues that when identical workers have the outside option to join a competing ¯rm with a di®erent norm, good norms can exist only in the presence of bad norms. With non contractible e®ort, agents cannot credibly commit to cooperation when all outside options are equally good. This is proposed as a rationale for endogenous strati¯cation of coexisting norms and corporate cultures. The framework naturally gives rise to authority relations within ¯rms: seniors earn higher wages than entering juniors. However, authority is limited and does not eradicate the strati¯cation of norms.

Keywords. Social Norms. Matching. Authority. Trust. Inequality.

1 Introduction

Social norms play an important role in economics and social sciences.[1] Peer groups, Ma¯a gangs, fraternities, religions, ¯rms,... have all very di®erent rules of behavior to which members voluntarily adhere. A fraternity member who does not agree with the terms on how to ¯nance the services provided, is free to leave and join another association. Even members of religious groups are reported to change membership (turnover in cults is extremely high; 40% of all Protestants leave to another faith). Firms have workers coming and going. Some ¯rms are known to have a strong corporate culture with high employee cooperation, others have a weak culture. This paper is an attempt to model norms of cooperation, while individuals can choose which norm to belong to. A

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[1] Knack and Keefer (1997) show that the average of a country's norms (measured as trust or social capital) signi¯cantly increases its per capita growth rate in cross country comparisons.

member's willingness to adhere to the norm is determined by the outside option of joining other norms available in the economy. In understanding norms as a social phenomenon, attention is naturally drawn towards the difference in characteristics and behavior between norms. The theory of conventions (see for example Young (1993)) explains norms as a device for the coordination of actions in a setting where there is no interaction between members of separate societies (familiar examples include driving left or right on the road, standing up or sitting down through the entire game in a sports stadium). An equally significant issue, hitherto ignored by economists, is what the effect is of competition between norms. Social Norms are as much a societal feature with interaction between norms through mobility of its members. Can social norms that are bad for its members survive? In the presence of unlimited entry, and free mobility, will social norms tend to become uniform because citizens will choose the successful norms only?

In this paper, a social norm is referred to as a set of common characteristics, behavior, beliefs,... that apply to a subgroup of society, in our case the firm. Each individual firm has a social norm associated with it. We believe that applying our theory to the case where the subgroup is a firm, is justified for two reasons: 1. Empirical evidence suggests that norms within a firm are strongly related to productivity;[2] 2. Firms operate in an environment where there is sufficient mobility of its members. By choosing the firm as our focus of attention, we concentrate on the interplay between private incentives and group incentives within the social norm.[3] That does not imply that the individual firm's norm stands alone, independent of other firms' norms in the economy. Competing norms can only exist if it is an equilibrium in the economy as a whole. Unlike a legal norm that is enforced by law using coercive sanctions, the social norm is the result of a (voluntary) implicit contract.

Consider the basic components of the competing norms model in more detail. 1. Each firm is characterized by a social norm: one firm, one norm. 2. The norm of a firm is determined by the contribution of effort of each of its members. The stage game builds on Holmström's (1982) analysis of moral hazard in teams. Firms have a production technology where a fixed number of employees jointly provide effort. Effort is not contractible, but after production is realized, output is observed. The immediate private benefit is determined by a budget balancing sharing rule. 3. The model is dynamic. Because all workers are non-myopic and forward looking, in their actions they trade off current gains and losses with the discounted future changes in value. 4. Matching is endogenous. After realization of the output, a worker will either remain in the firm or leave the

[2] Kotter and Heskett (1992) and Cappelli and Neumark (1999) find strong evidence of heterogeneity of norms (corporate culture) between firms. In addition, both studies show a significant relation between productivity and a measure for the quality of the norm.

[3] The value of a firm's social norm can be referred to as its aggregate social capital (as introduced by Loury (1977), and Coleman (1990)). However, it will be the individual (or behavioral) social capital that determines costs and benefits of membership, and whether an individual member in the group is willing to comply with the firm's norm or not. This distinction between an individual based as opposed to a group based definition of norms, is drawn from Loury (1977) and Glaeser, Laibson, Scheinkman and Soutter (1999). We also adopt their view that a firm's norm is only as good as the aggregate of it's members' individual social capital.

¯rm after which she is randomly matched to a new ¯rm. Endogenous separation can occur for two reasons: either because she decides to leave the ¯rm or because of punishment: she is made redundant. In addition, there is an exogenous separation probability. Any separated employee randomly draws a new ¯rm. There is no friction in this model as matching is instantaneous (the Poisson arrival rate of a match is in¯nity) and employees prefer any match for one period than receiving zero utility from remaining unmatched.

In the model described above, a worker joining a ¯rm with a norm of cooperation gets a higher level of utility by cooperating than she would get in a ¯rm with a norm of non-cooperation. However, given her belief that all other employees in that ¯rm will cooperate, she can get even higher utility by free riding through less e®ort. In the static game this is a dominant strategy. In the dynamic game, whether this is a optimal strategy or not depends on her expectations about her future utility. Suppose we have an equilibrium where all ¯rms have a norm of cooperation. Free riding implies she will be made redundant at the end of the period. When separated, she is instantaneously matched to a new ¯rm, drawn from the distribution of ¯rms. Given the belief that all ¯rms have norms of cooperation, with probability one she will be matched to a ¯rm with a norm of cooperation. Her future value after separation is not lower by being rematched. This implies that free riding, which yields a higher °ow utility, is a dominant strategy. An equilibrium where all ¯rms cooperate does not exist because it is not individually incentive compatible.

When a fraction of ¯rms do and the complementary fraction do not cooperate, then the option value of defecting when matched to a cooperating ¯rm depends on the expected value of being rematched. If there are su±cient ¯rms with a norm for non-cooperation, then the expected value of rematching is proportionally lower than the option value of cooperating and remaining in the good norm ¯rm. If the immediate gain from free riding is not larger than the expected discounted future loss, it is a dominant strategy for an employee matched to a high norm ¯rm to cooperate and not separate. Consider the equilibrium where each employee adheres to this strategy when matched to a ¯rm with a norm of cooperation, and free rides with immediate separation in all other ¯rms. We want to verify for deviations by all employees. First, given this belief, a strategy of cooperation without separation when matched to a cooperative norm is incentive compatible. No employee in a cooperating ¯rm can gain from deviating. Second, when matched to a ¯rm with a norm for non-cooperation, the best response when all free ride is to free ride. Providing e®ort above the static Nash level would yield less utility (by de¯nition of the Nash equilibrium). In addition, separation is a dominant strategy as the expected value of rematching is higher than the value of remaining in a low cooperation ¯rm: there is a fraction of high cooperation norms around that yield a higher utility than the low norms. Since no employee gains from deviating, this belief is con¯rmed by the equilibrium actions.

This is the main result of the competing norms model. A norm of cooperation can exist only if there is a su±cient number of ¯rms with a norm of non-cooperation. Though cooperation implies a positive externality within the ¯rm, it also has a negative external e®ect on all other ¯rms through the improved outside option of the workers in all other ¯rms.[4] Despite the fact that all agents are identical, norms are heterogeneous and as a result there is a wage di®erential across ¯rms. The wage gap results in a higher degree of turnover in low e®ort ¯rms. Employees in the low norm ¯rm separate as quickly as possible in order to try and match a high norm ¯rm. Note also that the wage di®erential occurs for identical workers, while at the same time it is necessary to sustain incentive compatibility and hence equilibrium.

A result new to the literature follows from extending the model to allow for a market for authority. With exogenous sharing rules, new entrants in a ¯rm with a norm of cooperation receive a strictly higher option value than in a low norm ¯rm. Senior incumbents can extract some of the rents by setting the sharing rule such that the junior entrant is still willing to enter. This type of "backloading" or "performance bonds" have in the past been proposed as a solution to these dynamic incentives problems: a market for junior job openings determines the wage-tenure schedule and makes entrants indi®erent between good and bad ¯rms.[5] The contribution here is to show that such a market for authority does not necessarily result in the indi®erence between the option value of entering a good and that of a bad ¯rm. It is shown that limited authority arises because lowering the entrant's share of the cooperative output also lowers her share when she deviates. Lowering the share violates the incentive compatibility constraint of the new entrant, and no ¯rm ¯nds it optimal to do so. This is the case when exogenous separation is relatively low compared to the discount rate. The result is that even in the presence of a market of authority, junior workers are not indi®erent between the option value of good and bad ¯rms, and that strati¯cation of ¯rm norms persists.

These results are compatible with empirical ¯ndings of heterogeneity in incomes amongst observationally equivalent workers. Krueger and Summers (1988) ¯nd evidence against explanations based on unmeasured di®erences in ability across industries. This suggests that competing norms may help explain endogenous heterogeneity. In addition, their analysis shows that turnover and wages for observationally identical workers are negatively related, and that the wage structure is highly correlated with job tenure. Both these facts ¯t the competing norms model: bad norm ¯rms pay low wages and have high turnover, and wage-tenure schedules for identical workers arise naturally in good norm ¯rms.

This paper is related to a large literature in economics on social norms. The theory of conventions (Young (1993)) proposes an explanation for the existence of social norms that is based on coordination. When there are multiple Nash equilibria, a convention (e.g. driving on the left) coordinates

[4]Eeckhout and Jovanovic (1998) show that inequality necessarily arises in a dynamic framework, when an economy-wide production externality involves higher moments of the distribution of types. This is the case in our model: low norm ¯rms induce a positive externality while high norm ¯rms have a negative external e®ect. Note that this is not the case for example in standard endogenous growth models where only the mean of the distribution of types enters the externality. In such a framework, inequality has no real e®ect.

[5]Because of this indi®erence, no worker is better o® than any other (irrespective of the ¯rm in which she works), but that does not imply the bad norm ¯rms are eradicated.

beliefs and actions, just like a focal point. The extensive literature following this interpretation has a long standing tradition dating back to Arrow's (1973) application to discrimination.[6] Competing norms di®er from conventions in three substantial aspects. First, conventions derive behavior that applies to an economy as a whole rather than to a subgroup of the economy. Roughly speaking, a norm relates to a convention as culture relates to society.[7] Second, mobility between di®erent conventions is not modeled. Third, the theory of conventions is about homogeneous (because coordinated) behavior within an economy. In contrast, the competing norms model provides a rationale for observed heterogeneity and strati¯cation within the same economy.

Surprisingly, not much theoretical work has been done on competing norms. The line of research that provides most of the fundamental building blocks of our model is the work on the theory of repeated games. The main result in this literature[8] is formulated as the folk theorem: any individually rational payo® can be sustained in a subgame perfect equilibrium for high enough discount factors. Not only has this been shown to hold for a ¯xed set of players, but also for randomly matched players as long as there is some aggregate information available.[9] Most relevant to our model is the work on the folk theorem with endogenous matching and without information °ows. Ghosh and Ray (1996) and Kranton (1996) make important contributions by showing that in such an environment, cooperation can exist where the behavior is characterized by a gradually increasing degree of cooperation. Greif (1993) ¯nds evidence for this practice and for endogenous matching in early trade relations in the Magreb. Ghosh and Ray use exogenous heterogeneity to model the economy: some traders are irrational and are never willing to cooperate. Through gradually increasing degrees of cooperation, rational players can learn the type of their partner. This work shows that the strategy described above, when commonly adopted by all agents in the economy (i.e. a convention), yields cooperation. Neither of these papers on endogenous matching takes up the main concern here - whether bad norms of low cooperation can exist in the presence of norms of high cooperation.

The paper is organized as follows. In the following section, the competing norms model is presented. Given exogenous sharing rules, in section 3 the model is solved and the main result, strati¯cation of

[6] Conventions have also provided an explanation for history and belief dependent equilibria in several dynamic settings: customs in the marriage market (Cole, Mailath and Postlewaite (1992)), training and turnover di®erentials (Acemoglu and Pischke (1998)), corruption (Tirole (1996)) and corporate culture (Kreps (1990) and Carillo and Gromb (1999)).

[7] " [...] society provides the larger reference groups and culture the local reference groups with respect to which norms [...] operate. Culture is local and allows for strong bonds to a small number of persons. Society is global and allows for weaker ties to a larger number of persons.", Elster (1989), p. 250.

[8] See Fudenberg and Maskin (1986) for most of the results in the case of repeated interaction between the same players.

[9] Rosenthal (1979) shows that cooperation can be sustained through the evolution of reputation. Okuno-Fujiwara and Postlewaite (1990) derive a similar result where the information available is much less speci¯c and is transmitted as an economy wide social norm. Random matching can also result in cooperation without such information as long as the populations is small enough: Kandori (1992) and Ellison (1994) show this using contagion strategies, i.e. punishments that unravel and spread through the whole population fast enough so as to impose su±cient punishment.

norms, is derived. This is illustrated with an example and further discussed with some comparative statics results. In section 4, the market for authority is introduced. Though wage-tenure schedules arise naturally, authority is limited and does not eradicate stratification. The robustness of the model to the introduction of capital, general monitoring technologies, general sharing rules and renegotiation is discussed in section 5. In section 6, the implications for the model from extensions to include heterogeneous agents and complementary inputs in production are considered. Finally, some concluding remarks are made.

2 The Competing Norms Model

In this section, the basic model is presented. We describe the incentives employees face when joining a firm with a certain social norm, and define equilibrium.

Workers, Firms and the Stage Game. The economy is populated with an infinite number of identical workers. The set of workers W has measure 1 and each worker is interpreted as an infinitesimally small subset of W. Production occurs in firms of a fixed and finite number of $m > 2$ worker. Index workers within a firm by $i = 1, \ldots, m$. The set of all firms is given by N and has measure $\frac{1}{m}$. A generic firm is referred to as $n \in N$. For the purpose of the characterization below, consider the partition $\{C, D\}$ of N, where $c \in C$ is a firm with a norm of cooperation and $d \in D$ is a firm with a norm of non-cooperation.

We want to capture the notion of joint production. The stage game is therefore as Holmström's (1982) moral hazard in teams model. Total output y produced in a firm is a function of all individuals' effort. Let e_i be worker i's level of effort and let $e = (e_1, \ldots, e_m)$ be the vector of all effort levels in a firm n. The firm's total output produced $y = Q(e)$ is deterministic and symmetric in e_i. Workers receive a share $s_i(Q), \forall i$ of total output. The utility cost of effort to each individual is $C(e_i)$, with C convex. The utility of agent i is given by

$$u_i = s_i(Q(e)) - C(e_i) \quad (1)$$

Given the sharing rule, agents choose their level of effort e_i; they produce, and in function of the vector e, output Q is realized. Effort is not contractible, which gives rise to the moral hazard problem. Ex ante shares rules are binding because they are contracted, and ex post output is perfectly observed.

In a competitive environment, firms' profits are zero. Given a technology without physical capital, it follows that the total wage bill is equal to total production. We have chosen this simple production function to economize on notation. In section 5, the model is shown to be robust to the introduction of a production function with physical capital in addition to effort. Throughout the paper, the following assumption is maintained: the sharing rule $\{s_i(Q)\}$ satisfies Balanced Budget: $\sum_{i=1}^{m} s_i(Q) = Q$.

Holmström (1982) shows that the solution to the static game with budget balancing sharing rules is inefficient. Given the vector of effort choices by all other workers $e_{-i}; \forall -i (\neq i) \in n$, the best response correspondence of worker i satisfies $\arg\max_{e_i} \{s_i(Q(e_i; e_{-i})) - C(e_i)\}$. The Nash equilibrium effort e_i^*, with corresponding utility u^* satisfying (1), solves for the fixed point $e_i^* = \arg\max_{e_i} \left\{ s_i\left(Q(e_i; e_{-i}^*)\right) - C(e_i) \right\}, \forall i$. Pareto optimal effort e_i^o yield utility u^o, and satisfies $e_i^o = \arg\max_{e_i} \left\{ Q(e_i; e_{-i}^o) - C(e_i) \right\}$.

Theorem 1 (Holmström) There do not exist sharing rules $\{s_i(Q)\}$ which satisfy $\sum_i s_i(Q) = Q$, and which yield e_i^o as a Nash equilibrium in the non cooperative game with payoffs u_i^o.

Would all workers cooperate and provide optimal effort levels e^o, then an individual best response is to deviate and provide effort $e^d \neq e^o$ such that $e^d = \arg\max_{e_i} \left\{ s_i\left(Q(e_i; e_{-i}^o)\right) - C(e_i) \right\}$, which yield u^d.[10] As a corollary to the theorem it follows that for a given sharing rule, equilibrium effort $e^* < e^o$ is suboptimal and that $u^d > u^o > u^*$. The theorem holds for a general production function and for general sharing rules.

The inefficiency result crucially hinges on the assumption of budget balancing sharing rules. A large part of the literature has given attention to studying incentives in environments where this assumption can be relaxed, for example involving an independent principal (see Holmström (1982)). Perhaps of equal importance is the interaction between joint production and mobility across firms. Our analysis is an attempt to complement the incentives approach.[11] The objective here is to find solutions for the moral hazard problem even in environments where the budget is balanced. This is the case for example where it is not possible to involve a completely independent principal. Any dependent principal needs to be considered as one of the employees, which brings us back to the inefficiency. In the case of partners in a law firm for example, partners are both the owners and employees.

Matching and Monitoring. Consider now the repeated game, where utility that is delayed for one unit of time is discounted at the common rate $1 + r$. Time is continuous, and the firms of m workers are formed for one period. Periods of different firms overlap. At the end of the period, output Q is realized and shared according to the sharing rule $\{s_i(Q)\}$, contracted upon ex ante. At the end of the stage game, each employee decides whether to stay in the current firm or to separate. When separated, a random match with a new firm is formed immediately.[12] This captures the notion of competing norms. Any employee can opportunistically execute her outside option by going to a another firm.

[10] Formally, $u_i^d = s_i\left(Q(e_i^d; e_{-i}^o)\right) - C(e_i^d)$.

[11] A similarly complementary approach has been taken by Meyer (1994) in studying learning in task assignment of team members.

[12] There is no friction and no agents is ever unmatched. Remaining unmatched with zero utility is an option, but never individually rational.

The decision to separate is bilateral. This is the punishment device that employees in a ¯rm have over their colleagues. Underlying the punishment is the monitoring technology. After observation of Q; monitoring implies that the ¯rm has some information about each individual employee's e®ort contribution. We assume that with probability 1; the ¯rm knows which of the employees has provided e®ort below the optimal level.[13] In addition to endogenous separation - either from punishment or opportunism -, there is an exogenous probability ® with which partners separate. The parameter ® is the arrival rate of a Poisson process.

Social Norms and Equilibrium. Loosely speaking, a social norm is a totality of common characteristics, behavior patterns, beliefs,... that applies to each ¯rm individually. More precisely, the social norm consists of the strategy or the behavior rule that workers follow within the ¯rm. It is a full contingent plan of action: for a given history, in each period workers choose e®ort and, after realization of Q; they decide whether or not to terminate the partnership. Of course, we will not be looking for just any set of strategies that constitute a ¯rm's norm, but those that are an equilibrium, both within the ¯rm and in an economy as a whole. We return to equilibrium in more detail below.

The interest here is in equilibria where a norm of cooperation within some ¯rms can be maintained, despite the non-cooperative outcome in the static game. As is the case in the folk theorem, a norm is an implicit dynamic agreement between the workers in a ¯rm. Of course, because agents have the option to separate, matching is endogenous and the standard folk theorem for in¯nitely repeated games between a given set of agents (see for example Fudenberg and Maskin (1986)) does not apply. In deriving equilibrium, we will be looking for those strategies that can support social norms of cooperation in the presence of endogenous matching.

Two remarks are worth noting at this point. First, in concentrating on equilibria that are supported by strategies speci¯c to each ¯rm's norm, the focus is on pure strategy equilibria. Nothing prevents workers from playing a mixed strategy, and such equilibria may exist. We consider it part of the contribution that the results on the coexistence of di®erent (good and bad) norms do not rely on mixed strategies. Second, the main objective of this paper is to derive those competing norms that exhibit the highest degree of cooperation. As is the case with the standard folk theorem, any individually rational payo® can be sustained in a subgame perfect equilibrium.

Whenever a worker is matched to a new ¯rm, she forms a belief about the norm in that ¯rm. Given the norm, i.e. belief about the strategy of all other m ¡ 1 workers, an optimal strategy must be a best response. In addition, equilibrium requires that adhering to the norm is individually incentive compatible. An equilibrium is then described by a rule, such that given the best response of all other workers in the economy, each player chooses e®ort to maximize expected discounted

[13] The assumption of this particular monitoring technology is without loss of generality. In section 5 the more general case is solved where with probability ¯ < 1; a worker's e®ort is monitored ex post. Note that in matches with 2 workers only, ¯ is always equal to 1: after realization of Q; a worker who knows her own e®ort can deduce the other employee's e®ort with probability 1.

utility. Suppose that all other workers cooperate, cooperation is a best response only if the payoff is higher from cooperating, and remaining matched to the firm with a norm of cooperation. It is precisely the separation that will determine the equilibrium in the economy as a whole. A norm of cooperation is not merely the choice of effort, but also the decision not to separate. A worker's best response will depend on her belief whether her colleagues will cooperate and decide not to separate. The incentive compatibility constraint will ultimately tie down the economy's equilibrium. This is precisely the role of different types of norms. Since free riding in a cooperating firm has a higher immediate payoff, the distribution of firms, in particular the ones with a bad norm, will constitute a sufficiently high threat through separation so as to satisfy the incentive compatibility constraint. Equilibrium is then determined by all individuals' best replies within a firm's norm, given they are incentive compatible (i.e. given the distribution of norms in the economy). The incentive compatibility constraint ties down the equilibrium distribution of norms.

Two more remarks are worth noting. First, all matches must be individually rational. For symmetric exogenous sharing rules, this is always satisfied as matches are formed instantaneously and being matched has a higher value than being unmatched. The issue does have immediate relevance in the case of endogenous sharing rules. We will take up the issue in section 4. Second, the assumption of having more than two workers in a firm ($m > 2$) is not without consequences. In matches of two, punishment is costly: the punisher is separated as well as the punished. This gives rise to problems of renegotiation proofness.[14] In the case of $m > 2$; the issue does not arise as the firm's norm does not disappear. By assuming that only one worker at the time gets separated exogenously and by considering non-cooperative equilibrium (i.e. unilateral deviations only), the non-separated workers remain matched and keep adhering to the norm with one newly matched worker.

3 The Main Result: Stratification

The model is first solved for exogenously given symmetric sharing rules (see for example Farrell and Scotchmer (1988)). This assumption implies $s_i(Q) = s_j(Q) = s; \forall i, j \in n$. The problem individuals face at the beginning of each period is to choose effort in order to maximize the discounted value. We will now construct the incentives in the case where some firms $c \in C \subset N$ exist where workers choose to cooperate and choose not to separate unless other workers deviate. Consider a firm where all other workers cooperate and choose a level of effort e^o: In addition, you expect them not to separate if output $Q = Q(e^o)$. Then the option value of cooperation (i.e. choosing $e = e^o$) V^o

[14] The issue of renegotiation proofness is discussed in more detail in section 5.

is given by[15]

$$rV^o = u^o + \alpha[EV - V^o] \tag{2}$$

The flow utility a worker gets is u^o and after each period, she only gets separated from the firm due to exogenous break up. This happens with probability α: In the case of separation, the expected utility when rematched is EV. Below, we will derive EV explicitly. Whether or not cooperation is an equilibrium depends on the option value of defecting instead of cooperating in this high norm firm. This is given by V^d

$$rV^d = u^d + \left[EV - V^d\right] \tag{3}$$

Defecting yields a higher utility $u^d > u^o$ but implies that at the end of the period, the worker will get separated. Output is then observed to be below the optimal level $Q < Q(e^o)$; and the monitoring technology identifies the defector with probability one.

In contrast, when matched to a firm with a norm of non-cooperation, a worker's best response is to choose effort such that it maximizes the one period utility and to separate at the end of the period. The option value is then equal to the flow value of one period of non-cooperation plus the discounted expected value of a future match:

$$rV^* = u^* + [EV - V^*] \tag{4}$$

Note that it is sufficient to observe whether the other workers in the firm have been matched together before to distinguish whether the norm is in C or in D. Because exogenous separation is assumed to happen one at the time, a worker matched to all newly matched colleagues deduces that the norm is D. This works like a public randomization device in matches between two players (see for example Fudenberg and Maskin (1986)).

The crucial variable here is the expected value of a future match EV: It is the belief any worker has about the whole population of workers' behavior. A first preliminary result is that a strategy where none of the workers cooperates is an equilibrium.

Proposition 1 (No Cooperation) Non Cooperative behavior, $e = e^*$ in all firms in N is an equilibrium

Proof. If there is no cooperation in none of the firms, then the option value in all firms is V^*: Since all firms are identical, the expected value of a future match is $EV = V^*$. As a result, the worker chooses e_i to maximize $rV^* = \max_{e_i} \left\{ s_i \; Q(e_i; e^*_{-i}) - c(e_i) \right\}$, the solution of which by definition of the static Nash equilibrium is $e_i = e^*_i$. Because workers in all firms are indifferent between rematching and remain matched to the current partner ($EV = V^*$), an equilibrium may involve any separation strategy, i.e. with any probability $\in [0; 1]$. ■

[15] For a time interval $[0; t]$, the expected value V^o satisfies

$$(1 + rt)V^o = u^o t + (1 - \alpha t)V^o + \alpha t EV$$

which implies equation (2).

Now suppose a newly matched worker believes that her new firm has a norm of cooperation. Her best response depends on the incentives for deviating. This is given by the incentive compatibility constraint (IC)

$$V^o \geq V^d \tag{5}$$

This is a necessary condition for a worker to be induced to cooperate in a high norm firm, rather than free ride on the other members and rematch in the next period. From equations (2) and (3), this condition can be written as

$$u^o \geq \frac{\alpha + r}{1 + r} u^d + \frac{r(1 - \alpha)}{1 + r} EV \tag{6}$$

the flow utility from cooperating must be large enough to make cooperating incentive compatible. It is therefore a function of u^d; the utility of deviating, and of EV; the expected value of rematching. The value of rematching is determined by the distribution of norms in the economy, and it is easy to see that, in order to induce the worker to cooperate rather than free ride, the utility from cooperating must be larger the larger the expected outside option EV:

The outside option will pinn down the equilibrium distribution of firm norms in the economy. Let $F(n)$ be the cumulative density function of all norms in the economy. Since we are constructing equilibrium where the norm is either one of two types: the norm $c \in C$ with the optimal level of effort and no endogenous separation or the norm $d \in D$ the static Nash equilibrium level of effort followed by immediate separation. Let $F(c) = f$ and $F(d) = 1 - f$: Then in each period of time, the total mass of separated workers is proportional to $1 - f + \alpha f$; all the bad norm workers rematch each period and only the exogenously separated good norm workers do so. As a result, the fraction of newly matched workers that will be matched to a firm with a norm of cooperation is

$$p = \frac{\alpha f}{1 - f + \alpha f} \tag{7}$$

This now determines the expected outside option from rematching: $EV = pV^o + (1 - p)V^*$: The expected value from a match is the weighted sum of the values of each type of firm. We can now state the main result.

Theorem 2 (Stratification) There exists a pair $(\bar{r}, \bar{\alpha})$ such that for any $r \in (0, \bar{r}]$ and for any $\alpha \in (0, \bar{\alpha}]$; an equilibrium exists where a fraction f of firms $c \in C \subset N$ have a norm for cooperation, with

$$f = 1 - \left(\frac{u^d - u^o}{u^o(r + 1) - ru^d - u^*} (r + 1) \right) \frac{\alpha}{1 - \alpha} < 1 \tag{8}$$

Proof. Consider the following strategy: a worker chooses: 1. $e = e^*$ if the the other workers in her firm were matched together in the last period and remains matched if $Q \geq Q^o$; and 2.

$e = e^*$ and separation otherwise. Given this strategy, substitutin the expected value of a match $EV = pV^o + (1 - p)V^*$ in equations (2), (3), (4) implies

$$\begin{aligned} rV^o &= u^o + \alpha(1 - p)[V^* - V^o] \\ rV^d &= u^d + (1 - p)\left[V^* - V^d\right] \\ rV^* &= u^* + p[V^o - V^*] \end{aligned}$$

We can now calculate the incentive compatibility constraint (5) which implies

$$u^o \geq \gamma u^d + (1 - \gamma)u^* \qquad (9)$$

where

$$\gamma = \frac{r + p + \alpha(1 - p)}{r + 1} \qquad (10)$$

It suffices to demonstrate the existence of a non negative pair $(\bar{r}; \bar{\alpha})$ such that condition (9) is satisfied and such that no worker in a non cooperating firm wants to deviate, i.e. $e_i^* = \arg\max_{e_i} V^*$. To establish (9) we can choose an $\bar{r}$ and $\bar{\alpha}$ to satisfy (9) with equality. To see this is possible, note that $\lim_{r\to 0}(\lim_{\alpha\to 0}\gamma) = 0$ and $\lim_{r\to\infty}(\lim_{\alpha\to\infty}\gamma) = 1$; and that $\frac{d\gamma}{d\alpha} > 0$ and $\frac{d\gamma}{dr} > 0$; making use of equation (7). Since by definition, $u^o; u^*$, and u^d satisfy $u^d \geq u^o \geq u^*$, we choose $(\bar{r}; \bar{\alpha})$ so that $u^o = \gamma u^d + (1 - \gamma)u^*$. Now, for a given $(r; \alpha) < (\bar{r}; \bar{\alpha})$; the IC constraint is satisfied. Using (7) and (10) to substitute at the IC constraint (9), yields equation (8).
Equation (9) ensures that no worker in a firm with a norm for cooperation wants to deviate. We now verify deviations by workers in low effort firms. Suppose she chooses a level of effort $e \neq e^*$, then by definition of Nash equilibrium, her utility $u(e_i; e^*_{-i}) < u^*$. Given the separation strategy of her coworkers, she will be separated with probability 1; giving her the same expected continuation value. As a result, her option value from choosing $e \neq e^*$ is lower than V^*. ■

The fraction of firms with a norm of cooperation f as derived in the theorem is the upper bound. It now follows immediately that an economy where all firms have a norm for cooperation (i.e. $f = 1$) cannot be an equilibrium. The outside option after separation is no worse, which makes cooperation not credible. This is confirmed by mere observation of equation (9). When $f = 1$; then $p = \gamma = 1$. Since u^d is strictly larger than u^o; the IC constraint is always violated. The way the upper bound (8) is determined is precisely by solving for highest possible f such that the IC is binding. Note that though workers are identical, and even with mobility, wages (and for that matter option values) differ between firms. There is a gap between the utility derived from being in the high norm firm compared to the utility in the low firm. This gap is necessary to make cooperation incentive compatible.

An Example and Some Comparative Statics Results

We illustrate the result with a simple example. Let $m = 3$, $Q = \sum_i e_i$ and $C(e) = \frac{e^2}{2}$. Output is shared equally $s(Q) = \frac{1}{3}Q$. We can calculate the Nash equilibrium effort and utility $e^* = \frac{1}{3}; u^* = \frac{5}{18}$ and the optimal effort and utility $e^o = 1; u^o = \frac{1}{2}$. Deviating when both other partners supply optimal effort implies $e^d = \frac{1}{3}$, $u^d = \frac{13}{18}$. Suppose that the rate of discounting is $r = 0.1$ and that the exogenous separation rate $\alpha = 0.1$. Then Theorem 2 allows us to calculate f, and from equation (8) it follows that $f \approx 0.86$. Eighty six percent of the firms have a norm of cooperation, with the remaining fourteen percent having a norm of non cooperation.

Separation Rate. The exogenous rate of separation has two different effects. It determines the fraction of high cooperation jobs that are opened each period of time, and as a result, the expected value of a new match EV. Second, it also determines the probability with which cooperative behavior will be "unjustly" punished. Both effects go the same way:

$$\frac{\partial f}{\partial \alpha} = -\frac{\left(u^d - u^o\right)(r+1)}{(r+1)u^o - ru^d - u^*}\frac{1}{(1-\alpha)^2} < 0$$

The higher the exogenous separation rate, the more attractive free riding becomes and as a result, the higher the fraction of firms with bad norms needs to be in order for cooperation to remain incentive compatible.

Discounting. An increase in the interest rate implies that the future is discounted more which makes workers more myopic. The more myopic workers are, the less they care about future low utility matches in their trade off between current effort and future utility. It follows that a larger fraction of non cooperating firms is needed to enforce cooperation, i.e. to satisfy the IC constraint.

$$\frac{\partial f}{\partial r} = -\frac{\left(u^d - u^o\right)\left(u^d - u^*\right)}{[(r+1)u^o - ru^d - u^*]^2}\frac{\alpha}{1-\alpha} < 0$$

In the limit of complete myopia, the future is not valued at all, so that all firms are non-cooperative. As was shown in Theorem 2, there is however a upper limit $\bar{r}$ in order to assure existence.

Firm Size. The effect of larger teams implies that free riding becomes more interesting. Ceteris paribus, an increase in m results in a higher value u^d, while keeping u^o and u^* constant. This in turn brings about a larger fraction of norms of non cooperation. Free riding is more lucrative, hence punishment is required to be stronger (i.e. a larger probability of a bad match). Formally, we show this for a linear additively separable production function, for which $e^d = e^*$. Let $Q = \sum_i e_i$; then $u^d = \frac{1}{m}\left[(m-1)e^o + e^d\right] - C(e^d)$, and as a result, $\frac{\partial u^d}{\partial m} = \frac{e^o + e^d}{m^2} > 0$. Now, it immediately follows that

$$\frac{\partial f}{\partial m} = -\frac{\alpha}{1-\alpha}(r+1)\frac{\partial u^d}{\partial m}\frac{u^o - u^*}{(r+1)u^o - ru^d - u^*} < 0$$

The larger the teams, the lower the fraction of cooperating firms.

Applying competing norms to the firm environment seems to make sense, given the observed mobility of employees between different firms. The endogenous stratification may be more generally applied in other social environments. As alluded to in the introduction, religions in the US face substantial mobility of its members. Iannaccone (1992, p.272) reports that "90% of cult converts drop out within a few years, and 40% of all Protestants change denomination at least once [...and that there is] considerable "internal" mobility across di®erent branches of Judaism and among Catholic parishes with very di®erent styles of worship". She considers religions as club goods where religion is an object of choice and with the degree of participation voluntarily accepted. A similar reasoning applies to secret societies. Though often referred to by both insiders and outsiders as one society, "the lodge" for example, there are many di®erent local branches competing for members. Finally, it has been argued by biologists that "social behavior" of some animals includes mobility between groups. Wolves living in packs for example, expel members who violate the rules. Expelled wolves usually try and join another pack. Some of the wolves also leave voluntarily in an attempt to be become the alpha wolf in another pack. This is related to the presence of internal authority, an issue to which we will turn in the next section.

In a more typical economic environment, we could think of competing norms as a version of Tiebout's theory of local public goods. In fact, the social capital associated to the norm can be interpreted as a local public good. By "voting with their feet" citizens move between di®erent neighborhoods and sort themselves into homogeneous neighborhoods. Heterogeneity between neighborhoods increases. This is often applied to the case of heterogeneous citizens ¯nancing a local public good (e.g. education). What the theory of competing norms shows, is that even with identical citizens and with su±cient mobility, neighborhoods will have di®erent degrees of contribution to the public good (and di®erential degrees of turnover).

4 The Market for Authority: Wage-Tenure Schedules

The strati¯cation result derived in the previous section has one salient feature: the option value in a ¯rm with a norm of cooperation is strictly higher than the option value when the norm is non cooperation: $V^{o} > V^{¤}$: All workers strictly prefer joining a high norm ¯rm. Deriving this result when sharing rules are exogenous yield involuntary strati¯cation. Because the market for new job openings in the high norm ¯rms is missing, unmatched workers cannot outbid each other. If the argument applies, such a market would lower the wage received upon entry in a ¯rm c; up to the point where workers are indi®erent between entering a ¯rm with a high norm or a low norm: $V^{o} = V^{¤}$. This type of voluntary strati¯cation implies that the compensation packages (often referred to as performance bonds) in high norm ¯rms exhibit "backloading": wages increase with tenure which results in an authority relation between junior entrants and senior incumbents. In this section, the objective is to introduce such a market for authority. Though wage-tenure schedules arise naturally, it will be shown that authority is limited, and that involuntary strati¯cation is robust to the introduction of the market for authority.

We distinguish between junior and senior workers, indexed by the subscript j and s respectively. Junior workers are new entrants to the ¯rm. Seniors are all other incumbent workers. Being junior lasts until a senior gets separated (or until the junior gets separated herself). In every firm, there is one junior and $m - 1$ identical seniors.[16] The model is as before, where output shares for juniors are $s_j(Q)$ and $s_s(Q)$ for seniors. As a result, the flow utility to a any worker is $u_i = s_i(Q(e)) - C(e); \forall i \in \{j; s\}$. For analytical tractability of some of the results, we make the following simplifying assumption: the technology is additively separable in effort ant the sharing rule is linear:

Assumption A: $Q(e) = \sum_i e_i$ and $s_i(Q(e)) = s_i Q(e)$

For a given sharing rule $\{s_j; s_s\}$, we can now derive the equivalents to equations (2),(3),(4), taking into account that V_j^o is in general different from V_s^o. In the firms of type d, all workers are newly matched and the surplus is split equally. The main difference in the option value is at the level of the junior worker. A junior worker now has the prospect of becoming senior[17]:

$$rV_j^o = u_j^o + \alpha\left[EV + (m-1)V_s^o - mV_j^o\right] \tag{11}$$

$$rV_s^o = u_s^o + \alpha\left[EV - V_s^o\right] \tag{12}$$

The fundamental difference here is that when joining a firm of type c, as a junior there is the prospect of becoming a senior. Once a senior has been separated exogenously, the junior gets promoted to senior and a new junior is hired. Because a senior in general receives a higher share from the output than a junior, here is a gap between the option value of a senior and that of a junior. Let Δ be defined as $\Delta = V_s^o - V_j^o$; then equation (11) can be written as $rV_j^o = u_j^o + \alpha\left[EV - V_j^o + (m-1)\Delta\right]$. Substituting out EV in equations (11) and (12), it is easy to show that for any given sharing rule $\{s_j; s_s\}$, Δ is given by

$$\Delta = \frac{u_s^o - u_j^o}{r + m\alpha} \tag{13}$$

and that it is decreasing in s_j.

Lemma 1 For any given sharing rule $\{s_j; s_s\}$, Δ is decreasing in the junior's share: $\frac{\partial \Delta}{\partial s_j} < 0$.

Proof. Since $e_j^o = e_s^o = e^o$, and $u_i^o = s_i(Q^o) - c(e^o)$, the utility difference is equal to $u_s^o - u_j^o = s_s(Q^o) - s_j(Q^o)$. Under budget balancing, $s_j(Q) + (m-1)s_s(Q) = Q$ which implies $u_s^o - u_j^o =$

[16] There is no reason to assume that ex ante bargaining between all parties will treat all senior incumbents equally. What is captured here is that all $m - 1$ incumbents bargain jointly with the new entrant. This reduces the split of the surplus to a two party bargaining problem, which is better documented in the literature than multi agent bargaining problems. For a given bargaining solution, the model could be extended to the case of a complete seniority schedule.

[17] For a time interval $[0; t]$ the equation (11) is derived from

$$(1 + rt)V_j^o = u_j^o t + \alpha t EV + (1 - \alpha t)\left[(m-1)\alpha t V_s^o + (1 - (m-1)\alpha t)V_j^o\right]$$

$\frac{Q^o - m s_j(Q^o)}{m-1}$: Taking the derivative of (13) with respect to s_j:

$$\frac{\partial \Delta}{\partial s_j(Q)} = \frac{-m}{(r + m\alpha)(m-1)} < 0$$

This completes the proof. ■

It immediately follows from observation of equation (13) that for $s_j = s_s$; there is no difference in the option value of juniors and seniors: $\Delta = 0$ and that for any $s_s > s_j$; Δ is strictly positive. In order to be able to derive the incentive compatibility condition, we need the option value of a deviator:

$$rV_i^d = u_i^d + \left[EV - V_i^d \right]; \forall i \in \{j; s\} \tag{14}$$

As before, the utility of a non cooperative partnership will be determined by the static Nash equilibrium payoff u^* and the expected continuation payoff EV : $rV^* = u^* + [EV - V^*]$: Incentive compatibility requires that no agent has an incentive to deviate in a cooperating firm

$$V_i^o \geq V_i^d; \forall i \in \{j; s\} \tag{15}$$

Incentive compatibility ensures a worker will not deviate once a job has been accepted. With authority, the firm in addition has to ensure that these rules are individually rational for the junior worker. Workers may decide to reject offers which give a very low current option value. A junior worker will accept an offer of a match to a cooperating firm, as long as the option value of that match is at least as high as the option value of sampling a firm with a norm d. As a result, individual rationality IR requires

$$V_j^o \geq V^* \tag{16}$$

Note that this does not imply that the flow utility from a match with a cooperating firm should be at least as high as the utility from a match with a non-cooperating firm: $u_j^o \geq u^*$. In fact, when the IR constraint is satisfied, utility u_j^o may even be negative. The following lemma derives the lower bound on s_j:

Lemma 2 There is a lower bound $\underline{s}_j$ on the sharing rule, satisfying

$$\underline{s}_j \left(Q^d - c(e_j^d) \right) = u^* \tag{17}$$

Proof. In appendix ■

At $s_j = \underline{s}_j$, $V_j^o = V^*$ and any worker is indifferent between joining firm with a norm of type c or a firm with a norm of type d: Given this sharing rule, there is no longer any involuntary stratification, in the sense that workers are indifferent and hence equally well off in both types of firms. That does however not rule out the existence of the two types of different norms. Proposition 2 establishes the existence of equilibrium and derives the distribution of firms in the presence of authority. This Proposition is the equivalent of Theorem 2, where $s_j = s_s$.

Proposition 2 Under assumption A; there exists a pair $(\bar{r}, \bar{\alpha})$ such that for any $r \in (0, \bar{r}]$ and for any $\alpha \in (0, \bar{\alpha}]$; and for a sharing rule $\{s_j; s_s\}_c; \forall c \in C$, where $s_j \in [\underline{s}_j; s_s]$, an equilibrium exists where a fraction f of firms $c \in C \subset N$ have a norm of cooperation, with

$$f = 1 - \frac{\left(u_j^d - u_j^o\right)(r+1) + \alpha(m-1)\cdot}{u_j^o(r+1) - ru_j^d - u_j^* + \alpha(m-1)(1+r)\cdot}\frac{\alpha}{1-\alpha} \tag{18}$$

Proof. In appendix ■

The proposition states that equilibrium exhibiting authority relations within firms with a norm of cooperation, exists. In fact, any type of authority is an equilibrium (i.e. the proposition holds for any feasible s_j) where all firms in C adhere the same sharing rule. We have derived equilibrium when authority is assumed. We now turn to endogenous authority, i.e. firms choose the sharing rule.

4.1 Limited Authority

Consider a firm with a norm of cooperation. Juniors are better off in the high norm firm than in a low norm firm as long as the IR constraint (16) holds without equality. If a senior has the power to negotiate the contract prior to the production stage, then Lemma 3 shows that whatever the equilibrium in the economy, she increases her option value by decreasing s_j:

Lemma 3 The option value of a senior worker is increasing with decreasing s_j

$$\frac{\partial V_s^o}{\partial s_j} < 0$$

Proof. From equation (12) it follows that

$$V_s^o = \frac{1}{r+\alpha}\{u_s^o + \alpha EV\}$$

Derivation with respect to s_j,

$$\frac{\partial V_s^o}{\partial s_j} = \frac{1}{r+\alpha}\frac{\partial u_s^o}{\partial s_s}\frac{\partial s_s}{\partial s_j}$$

which is negatives since budget balance implies that $\frac{\partial s_s}{\partial s_j} < 0$. ■

Consider this is a two player bargaining problem between all identical seniors (or one representative) and one junior. Given individual rationality and the fact that matching is frictionless (rematching happens instantaneously in case the bargain breaks down), the junior is willing to accept any sharing rule s_j such that $V_j^o \geq V^*$. A junior will not reject an offer with a lower s_j (even if that yields a current flow value $u_j^o = s_j(Q^o) - c(e^o)$ that is smaller than u^* or even negative) since the option value in the high norm is above the option value in the low norm. An equilibrium with endogenous sharing rules is now as before, with the additional requirement that the budget balancing sharing rule $\{s_j; s_s\}_c; \forall c \in C$ for each firm is optimally chosen to maximize V_s^o, given the choice of an optimal sharing rules by all other firms $\{s_j; s_s\}_{-c}; \forall -c (\neq c) \in C$. At first sight, it looks like seniors will want to choose s_j as low as possible ($s_j = \underline{s}_j$), from Lemma 3. However, Proposition 3 establishes that there is a limit to the authority senior incumbents can exercise. It establishes conditions under which incumbents do not want to lower the share s_j: The reason is that when lowering s_j the IC_j constraint is violated, so the firm finds it optimal to set $s_j = \{s_j\}_{-c}$.

Proposition 3 (Limited Authority) Under assumption A; there exists a pair $(r^*; \alpha^*)$ and an $\hat{r}$ such that for any $r \in [r^*; \hat{r}]$ and for any $\alpha \in (0; \alpha^*)$; an equilibrium exists where seniors in a firm $c \in C$ with a norm of cooperation, choose $\{s_j; s_s\}_c = \{s_j; s_s\}_{-c}$, satisfying $s_j \in [\underline{s}_j; s_s]$ and where the fraction f of firms in C is

$$f = 1 - \frac{\left(u_j^d - u_j^o\right)(r+1) + \alpha(m-1)\cdot}{u_j^o(r+1) - r u_j^d - u_j^* + \alpha(m-1)(1+r)\cdot}\frac{\alpha}{1-\alpha} \tag{19}$$

Proof. We proceed to prove the proposition in two steps. First, in Lemma 4 we show that, for a given sharing rule of all other firms $\{s_j; s_s\}_{-c}$, firm c's best response is $\{s_j; s_s\}_c = \{s_j; s_s\}_{-c}$. Then we apply Proposition 2 to show existence and derive f as in equation (19).

Lemma 4 (Best Response) Under assumption A; and provided IC_j is binding, there exists a pair $(r^*; \alpha^*)$; such that for any $r \in (r^*; \infty]$ and for any $\alpha \in (0; \alpha^*)$; a firm i's best response $\{s_j; s_s\}_c; \forall c \in C$ satisfies $\{s_j; s_s\}_c = \{s_j; s_s\}_{-c}$.

Proof. The constraint IC_j binding implies, from equation (15) that $V_j^o = V_j^d$. From equations (11) and (14) it follows that

$$\begin{aligned} V_j^o &= \frac{1}{r+\alpha}\left\{u_j^o + \alpha\left[EV + (m-1)\cdot\right]\right\} \\ V_j^d &= \frac{1}{r+1}\left(u_j^d + EV\right) \end{aligned}$$

The problem of the senior is to choose s_j (and as a result s_s, from budget balancing) in order to maximize V_s^o subject to IC_j

$$\begin{gathered} \max_{s_j} V_s^o \\ \text{s.t. } V_j^o \geq V_j^d \end{gathered}$$

Since V_s^o is always increasing for decreasing s_j (from Lemma 3) it suffices to verify whether for a lower s_j the IC_j constraint is still binding, i.e. whether

$$\frac{\partial V_j^o}{\partial s_j} \leq \frac{\partial V_j^d}{\partial s_j} \tag{20}$$

From assumption A this implies

$$\frac{Q^o}{r+\alpha}\left(1 - \frac{m\alpha}{(r+m\alpha)}\right) \leq \frac{Q^d}{1+r} \tag{21}$$

We now show that there exists a pair (r^*, α^*) for which equation (20) holds with equality. To see this, we consider two extreme points. At $r = 0$, equation (20) holds with strict inequality for any $\alpha > 0$, since

$$\lim_{r \to 0} \frac{Q^o}{r+\alpha}\left(1 - \frac{m\alpha}{(r+m\alpha)}\right) = 0$$

$$\lim_{r \to 0} \frac{Q^d}{1+r} = Q^d > 0$$

At $r = 1$, the inequality is violated if

$$Q^o \frac{1}{(1+\alpha)(1+m\alpha)} > \frac{Q^d}{2} \tag{22}$$

which is the case for all $\alpha \in (0, \alpha^*)$, where α^* solves equation (22) with equality (note that the left hand side is monotonically decreasing in α and goes to zero as α goes to infinity). It now follows that, provided $\alpha < \alpha^*$ there exists an r^* such that equation (21) holds with equality, since $\forall r \in (0, 1)$, $\frac{d}{dr}\frac{\partial V_j^o}{\partial s_j} = Q^o \frac{1-r}{(1+\alpha)(1+m\alpha)} > 0$ and $\frac{d}{dr}\frac{\partial V_j^d}{\partial s_j} < 0$.

For any pair (r, α) such that $r \in (r^*, 1]$ and $\alpha \in (0, \alpha^*)$, the IC_j constraint satisfies

$$\frac{\partial V_j^o}{\partial s_j} > \frac{\partial V_j^d}{\partial s_j} \tag{23}$$

A decrease in s_j implies a higher marginal effect on V_j^o than on V_j^d. Given that IC_j is binding for the strategy $\{s_j, s_s\}_{-c}$ by all other norms $-c \in C$, it follows that $V_j^o = V_j^d$, for $\{s_j, s_s\}_c = \{s_j, s_s\}_{-c}$. Equation (23) implies that $V_j^o < V_j^d$ for $\{s_j\}_c < \{s_j\}_{-c}$ implying that the best response is $\{s_j, s_s\}_c = \{s_j, s_s\}_{-c}$. This completes the proof of the Lemma. ■

The proof of Proposition 3 is now nearly complete. We only need to show that there is an $r^* < \hat{r}$, so that Proposition 2 applies. For any $\hat{r}$, there exists an α low enough such that this is satisfied. To see this, consider equation (21). It follows that r^* is decreasing in decreasing α

$$\frac{dr^*}{d\alpha} = \frac{Q^o r^*}{Q^o(1 - r^*) + Q^d \frac{(r^*+\alpha)(r^*+m\alpha)}{(1+r^*)^2}} > 0$$

and with α going to zero, r^* becomes negative since $Q^o > Q^d$

$$\lim_{\alpha \to 0} r^* = \frac{-Q^o}{Q^o - Q^d} < 0$$

As a result, there is always an $r^* < \hat{r}$. This completes the proof of Proposition 3. ■

The intuition is that even though the seniors' value is increasing for a decreasing s_j; the incentive compatibility constraint of the juniors is affected by the change in s_j: What the proposition shows is the conditions under which a decrease in s_j violates the IC_j constraint. For sufficiently high r and sufficiently low α; a decrease in s_j decreases V_j^o marginally more than a decrease in V_j^d; which violates the IC constraint. Consider $V_j^o = V_j^d$ binding, then a decrease in s_j decreases both V_j^o and V_j^d: Since V_j^o depends on both r and α; and V_j^d only on r; both values have a different marginal effect for different pairs $(r; \alpha)$.

This clearly limits a firm to extract authority rents from newly entering juniors. The best one individual firm can do is extract as much as the other firms. Of course, there is a continuum of equilibria in this economy: if all other firms extract more from the juniors (i.e. have a low s_j) then an individual firm can extract that much as well. The equilibrium level of s_j does affect the equilibrium distribution, and hence efficiency. In general, the effect of s_j on f is ambiguous.

4.2 An Example With Authority

Consider the same example as above, where each time, two senior incumbents hire one junior. Note that assumption A is satisfied. The sharing rule satisfies budget balancing: $s_j + 2s_s = 1$; and utility is given by $u_i = s_i Q - \frac{e_i^2}{2}; \forall i \in \{j; s\}$. Optimal effort is unchanged $e^o = 1$ and adjusting for the shares, optimal utility $u_i^o = s_i 3 - \frac{1}{2}$: Effort for deviating is determined by the first order condition, where $C'(e) = e$ implies $s_i = e_i$. It follows that

$$u_i^d = s_i(2 + s_i) - \frac{s_i^2}{2} = 2s_i + \frac{s_i^2}{2}; \forall i \in \{j; s\}$$

Making use of budget balancing $s_j + 2s_s = 1$; it follows that

$$\begin{aligned} u_j^d &= 2s_j + \frac{s_j^2}{2} \\ u_s^d &= 1 - s_j + \frac{(1 - s_j)^2}{8} \end{aligned}$$

As before, in firms with a norm of non-cooperation, output is shared equally: $e^* = \frac{1}{3}$ and $u^* = \frac{5}{18}$: From equation (13) it follows that $\Delta = \frac{3}{2}\frac{1-3s_j}{r+3\alpha}$: Note that for $s_j = s_s = \frac{1}{3}$; we have the case of symmetric exogenous sharing rules, and $\Delta = 0$: From the individual rationality condition (16), $u_j^d = u^*$ it follows that $2s_j + \frac{s_j^2}{2} = \frac{5}{18}$; which is satisfied for $\underline{s}_j = 0{:}13$: Note that $u^o = s_j 3 - \frac{1}{2}$ is negative for any $s_j < \frac{1}{6} \approx 0{:}17$ (at $s_j = \underline{s}_j$; $u_j^o = -0{:}097$).

We first verify the conditions of Proposition 2:

1. The junior's IC is binding

$$\Delta \geq \frac{u_s^d - u_j^d}{r + 1}$$

implies

$$\frac{3}{2}\frac{1-3s_j}{r+3\alpha} \geq \frac{1}{8}\frac{9-26s_j-3s_j^2}{r+1}$$

which is satisfied for all the examples we give below. Hence f is derived from (18)

$$f = 1 - \left[\frac{\left(2s_j + \frac{s_j^2}{2} - 3s_j + \frac{1}{2}\right)(1+r) + \alpha\frac{3(1-3s_j)}{r+3\alpha}}{\left(3s_j - \frac{1}{2}\right)(1+r) - r\left(2s_j + \frac{s_j^2}{2}\right) - \frac{5}{18} + \alpha\frac{3(1-3s_j)}{r+3\alpha}(1+r)}\right]^{\frac{\alpha}{1-\alpha}} \tag{24}$$

2. Limited authority (L.A.), from equation (23)

$$3\left(\frac{r}{(r+\alpha)(r+3\alpha)}\right) > \frac{2+s_j}{1+r}$$

It is easy to verify that this condition holds for $r = \alpha = 0.1$. And though it does not hold for $r = \alpha = 0.2$ over the whole range of s_j (in particular near $s_j = \frac{1}{3}$); it does hold over the whole range for $r = 0.3$ and $\alpha = 0.1$. This implies that when it holds, authority is limited to what the market offers. Firms cannot offer an s_j that is lower than the rest of the firms. If they would, that would violate the juniors' IC constraint. When this condition is not satisfied, firms can exercise unlimited authority by offering the lowest share possible.

We now plot the distribution f in function of s_j from equation (24) for different combinations of r and α: The junior's share is bounded from above by $\frac{1}{3}$ and from below by $\underline{s}_j = 0.13$. The solid line gives equation (24).

The share f in function of s_j $(r = \alpha = 0.1)$

Below an illustration of the different types of equilibrium distributions. In the first panel, f is bounded from below for any feasible s_j. The minimum level of inequality is at $s_j = \underline{s}_j$; where f = 0:42: For r and ® even lower (equal to 0:01), the minimum level of inequality increases f = 0:89. As ® and r go to zero, all ¯rms in the limit have a norm of cooperation. On the other hand, as r and ® increase, the equilibrium with heterogeneity in norms eventually does not exist, as in the example for r = ® = 0:4; and all ¯rms have a norm of non-cooperation.

In the ¯rst and the second panel, (as is the case in ¯gure 1), authority is limited (L.A.). If all ¯rms choose pay a share s_j; then the best response for a ¯rm that employs a new entrant is to o®er a share s_j: Then, even though there is a market for authority, and ¯rms can choose what share to o®er to newly entering juniors, no ¯rm will o®er a share di®erent than any other ¯rm. If it would do so, that would violate the junior's incentive compatibility constraint. As a result, all possible combinations of f within the feasible range are possible (f 2 [:42; :94] in the ¯rst example and f 2 [0; :79] in the second).

L.A. f 2 [:42; :94] (r = ® = 0:05) L.A. f 2 [0; :79] (r = 0:3; ® = 0:1)

.A f = (r 0: ; ® 0:) U. . f 0: 9 (= 0 01 ® = :1

Th th rd nd he ou th an l d pi t t e o po it ca e o un im te au ho it (U A. . W at ve sh re $_j$ o he ¯r s o er se io in um en s i cr as th ir pt on al e b o® ri g t e l we t junior share possible without violating the IC_j constraint. In the third panel that implies that norms of cooperation simply do not exist (f hits zero before the IR constraint is binding). In the fourth panel, the seniors are constrained by the IR condition to o®er shares above $\underline{s}_j$. Hence the only equilibrium is one with unlimited authority but where a fraction of roughly half of the firms has a norm for cooperation.

Note that in general, it is ambiguous whether f is increasing in s_j or not. To see this, consider the binding IC constraint

$$u_j^o + \alpha(m-1)\delta = u_j^d\gamma + u^*(1-\gamma)$$

Then from the implicit function theorem

$$\frac{df}{ds_j} = -\frac{\frac{du_j^o}{ds_j} - \gamma\frac{du_j^d}{ds_j} + \alpha(m-1)\frac{d\delta}{ds_j}}{-\left(u_j^d - u^*\right)\frac{d\gamma}{df}}$$

the sign of which only depends on the sign of the numerator as $u_j^d \geq u^*$ and $\frac{d\gamma}{df} > 0$. Though in the numerator $\frac{du_j^o}{ds_j} + \alpha(m-1)\frac{d\delta}{ds_j} > 0$; it may not be larger than $\gamma\frac{du_j^d}{ds_j}$:

5 Robustness

In this section, we verify whether the results derived are robust to changes in the assumptions. We consider the introduction of capital in production, a general monitoring technology, non-linear sharing rules, and deviations by coalitions.

5.1 Production with Capital

Consider the model from section 3, with capital, competing for labor. The output production function is Cobb-Douglas with capital in addition to additively separable effort

$$y = f(e;k) = \left(\sum e_i\right)k^a$$

This represents a situation as before: the firm can announce wages depending on the whole bundle e of effort choices. Firms and workers simultaneously choose capital and effort, respectively. Given an effort bundle e, a firm hires capital k at a capital rental rate R in order to maximize profits $\pi = y - mw(e) - kR$, where $mw(e)$ is the total wage bill that is paid by the firm, which is shared according to the sharing rule $\{s_i\}$. This implies the first order condition

$$ak^{a-1}\left(\sum e_i\right) = R$$

The equilibrium level of capital k

$$k = \left(\frac{aQ}{R}\right)^{\frac{1}{1-a}}$$

The first order condition for labor is

$$\frac{dw(e)}{de_i} = \frac{dy}{de_i} = \frac{d\sum e_i}{de_i}k^a$$

he nc ea e i th wa e f r e tr e® rt s e ua to he nc ea e i th ad it on l p od ct on f o tp t. s b fo e, e l ok or qu li ri wi h e ua e® rt up ly y a l w rk rs it in ne rm Th n t e ¯ st rd r c nd ti n f r e = e 8i s

$$\frac{d \ (e}{de} \quad k^a$$

si g (in e Q me

$$k = \frac{am}{R}^{\P}\frac{}{1 \ ¡}$$

If he e i a t ta am un of ap ta $\bar{k}$ i th ec no y, he th re ta ra e o ca it l R s d te mi ed nd ge ou ly y e ua in su pl of ap ta wi h d ma d

$$Z \ \frac{am}{R}^{\P}\frac{}{1 \ ¡} \ d\frac{F \ e)}{} = \bar{k}$$

hi h g ve R = $^{R}\frac{1}{m}$ (me $\frac{1}{1 \ a}$ d (e ´ 1 a w er F( ) i th cu ul ti e d st ib ti n o al wo ke s, it m o th m i ea h ¯ m. e c n n w s bs it te

$$\frac{w(\ )}{d} = {}^{\mu}\frac{me}{}^{\P}\frac{a}{¡ \ a}$$

hi h a te in eg at on iv s t e w ge ch du e (it K t e c ns an of nt gr ti n)

$$(e \ = (\ ¡ \ a \ {}^{\mu}\frac{a}{R}^{\P}\frac{}{1 \ ¡} \ e^{\frac{1}{¡ \ a}} \quad K$$

A d s bs it ti g f r t e e ui ib iu am un of ap ta k

$$w \ e) \quad (1 \quad a) \ k^a \quad C$$

T e t ta wa e b ll s m (e = m 1 ¡) e ^{a} + K a d p ym nt o c pi al s e ua to y; o t at he er pr ¯t on it on mp ie th t K 0. he ag bi l i a ¯ ed ro or io of : m (e = (¡ a y. hi co pe it ve qu li ri m i pl es ha ca it l i e± ie tl hi ed gi en he rm s b li f a ou th e® rt up ly of he or er . T e t ta wa e b ll w( ) = 1 ¡) m k^a or es on s t to al ut ut va la le o t e w rk rs s m de ed ef re

$$(e \ = (\ ¡ \ a \ {}^{3}X \ ´ \ ¡ \ a$$

I th s s tt ng ca it l i pr po ti na to he ®o t l ve in he rm nd s a es lt ap ta yi ld th sa e r tu n i al ¯r s, rr sp ct ve f t e n rm Ca it l d es ot ar a h gh r r tu n i th ¯r s w th no m o co pe at on Th ug th s i sp ci c t th as um ti n o a C bb Do gl s f nc io al or , r ce t e pi ic l w rk y C pp ll an Ne ma k (99) s pp rt th s a su pt on Ca pe li nd eu ar re or ev de ce ha "h gh er or an e" or pr ct ce in re se ab r p od ct vi y. t t e s me im , t es wo k p ac ic s r is la or os an em lo ee om en at on wh le ee in th re ur on ap ta co st nt "H gh er or an e" or pr ct ce ar go d f r e pl ye s a d h rm or ur em lo er . T ey on lu e t at hi h r ad hu an es ur es ra ti es o r is em lo ee om en at on it ou a® ct ng he rm s (.e th ca it l') c mp ti iv ne s.

5.2 A General Monitoring Technology

The assumption in the model is that at the end of production, when Q is observed, the firm observes the identity of the deviating individual with probability 1. Suppose now that deviators in m-worker teams can be detected with probability $\beta(m)$, where $\beta' \le 0$ and $\beta(2) = 1$. The value function for a deviator then becomes

$$rV^d = u^d + (\alpha + \beta(1-\alpha))\left[EV - V^d\right] \tag{25}$$

As in Theorem 2 we can derive for the generalized problem the incentive compatibility condition $V^o \ge V^d$, which implies a modified version of (9)

$$u^o \ge \gamma' u^d + (1-\gamma')u^* \tag{26}$$

where

$$\gamma' = \frac{r + p + \alpha(1-p)}{r + \alpha + \beta(1-\alpha) + p[1-\alpha-\beta(1-\alpha)]} \tag{27}$$

Calculating the proportion of cooperating firms gives

$$f(\beta) = 1 - \frac{\left(u^d - u^*\right)(r+1)}{u^o(r+\beta) - ru^d - \beta u^*}\frac{\alpha}{1-\alpha} \tag{28}$$

And it is straightforward to get

$$\frac{\partial f(\beta)}{\partial \beta} = \frac{(u^o - u^*)\left(u^d - u^*\right)(r+1)}{[u^o(r+\beta) - ru^d - \beta u^*]^2}\frac{\alpha}{1-\alpha} > 0$$

The higher the probability of detecting a free rider, the higher the proportion of cooperating firms. Punishment is harsher as more agents who free ride will be caught. As a result, even with less low norm firms, the IC constraint is satisfied.

Earlier, we found that the effect of larger firms, i.e. larger m, decreases the proportion of cooperating firms: for a given sharing rule, the benefits from free riding are higher in a large firm, which requires more non-cooperating firms to punish deviators. Now, this direct effect still exists, but in addition, if larger firms have a lower probability of detecting deviators, $\beta'(m) < 0$, the total effect on f is even larger through the indirect effect from m on β

$$\frac{df(\beta)}{dm} = \frac{\partial f(\beta)}{\partial m} + \frac{\partial f(\beta)}{\partial \beta}\frac{d\beta}{dm} < 0$$

.3 on li ea Sh ri g R le

We on tr ct si pl¯e ve si n o ou mo el wh re he ta ic ec si n i re re en ed y t e f ll wi g 2 la er or al or ga e:

		en or	
			D
un or	C	¡2 c; 1 ¡ ¡) ¡ c	^0_j c; ¡ s_j
	D	^0_j 1 ¡ ^0_j c	0 0

w er ea h p ay r c n e th r d ci e t pl y C co pe at on r D de ec io . T e j ni r p yo is he rs of he wo al es n e ch ox nd he en or ay ® i th se on . T e p yo s a e d te mi ed s f ll ws Th jo nt ur lu if ot pl y C s Q = 2 If ot pl y D it s Q = 0 nd f t ey la a d®e en st at gy t i Q^d 1: ot l s rp us s s ar d a co di g t sh ri g r le ¡ a d s = 1 s_s Th co t o e® rt s c he co pe at ng nd wh n d fe ti g. o h ve hi st li ed er io ¯t ol st Ä (1 82 , a su e c s i th ne gh or oo of bu st ic ly ma le . N te ha th sh ri g r le s n n- in ar s i ge er l s 6= ^0_j By et in s^0 < s ; t e s ni r c n p ni h t e d vi ti g j ni r p op rt on ll ha de fo ex mp e. et ¡ = $\frac{}{2}$ a d s_j = $\frac{}{4}$; he ba an ed ud et mp ie th t 1 s^0 = $\frac{3}{}$: D vi ti g h s b co e e en or at ra ti e f r t e s ni r.

t i im ed at ly le r f om hi ex mp e t at he e i no ¡ t at il ac ie e¯ st es (t e H lm trom 19 2) es lt . T e q es io is ha th s w ll mp y f r t e d na ic am . W th re or lo k a th in en iv co pa ib li y c ns ra nt of un or an se io s. he e a e d ri ed n t e a pe di un er he ro f o Pr po it on . E ua io s (0) nd 31 ar gi en y

$$u_j + \quad (m \quad 1) \qquad ¸ \; u_j ° \quad u^¤ \; 1 ¡ \quad)$$

$$u_s + \quad (1 \quad ®) \qquad ¸ \; u_s ° \quad u^¤ \; 1 ¡ \quad)$$

W at ro os ti n 2 ta es s t at or u± ie tl lo r a d ® IC is lw ys in in . W th on li ea sh ri g r le an fo su ci nt y l w s_j, he ti it fr m d vi ti n u_j b co es o l w t at C_j s n t b nd ng Ho ev r, it bu ge ba an in , t is mp ie th t u_s p op rt on ll in re se . A a r su t, he el va t c ns ra nt ha is in in is C_s It an e s ow th t f r f 1; hi co st ai t i no bi di g (ot th t t e i di id al y r ti na it co st ai t l im li s t at lo er ^0_j mp ie a h gh r l we bo nd $\_{j}$ a d h nc a s al er et f f as bl ¢) im ly ng ha th st at¯c ti n p rs st ev n w th on li ea sh ri g r le . T is om s n t a a s rp is as he at on le or he ne ci nc in he ep at d g me s i en ic l t th on in he ta ic am . I th st ti ga e, t i sh wn ha th in ±c en y r su t d es ot ep nd n l ne ri y o sh ri g r le , b t o th as um ti n o a b la ce bu ge .

5 4 D vi ti ns y c al ti ns

qu li ri m d ri ed er is on co pe at ve in he en e t at nl de ia io s b on in iv du l a th ti e a e c ns de ed Th re re wo el va t i su s t at ay e c ns de ed On is en go ia io proofness when one individual has deviated. The second is deviations by coalitions of all m members of a firm with a norm of non-cooperation.

Renegotiation proofness is certainly a serious problem when $m = 2$: Punishment of the co-worker who deviates also implies self punishment. "Firing" your partner implies that you are unmatched yourself and that you will be randomly assigned a new partner afterwards. If you were cooperating, punishing your partner implies that you get expected value EV which is lower than V^o: As a result, both parties would gain from renegotiating the "threatened" separation through any split of the ensuing surplus. In our model, $m > 2$ and by the assumption that only one worker is exogenously separated from the firm with a norm of cooperation, incumbents never get a lower option value V^o by punishing a deviating co-worker. For them the continuation payoff of punishment is not dominated, and hence satisfies the criterion for renegotiation proofness in Farrell and Maskin (1989).

Allowing for deviations by coalitions of workers certainly does change the equilibrium. In particular, a firm with a low norm of cooperation would always gain by starting to cooperate. Because the firm has zero mass in the economy, it is a dominant strategy for all firms to cooperate. However, cooperation in all firms would not be an equilibrium since individual workers in a firm now gain from deviation: the outside option is equally good as all firms are cooperating, so non-cooperation is a dominant strategy. It follows that equilibrium does not exist. Note also that a mixed strategy by coalitions would be problematic. Given a mixed strategy by all other firms, one firm's best response is to cooperate with probability one. Being of zero mass, this does not change the incentive compatibility constraint of one individual worker. This is a dominant strategy as the payoff from cooperating is higher than not cooperating. The result is that an equilibrium that allows for deviations by coalitions of workers does not exist, neither in pure nor in mixed strategies. This is of course not a new discovery, because there is no general existence proof for equilibrium of large sequential games of incomplete information.

6 Extensions

We consider two extensions to the model of section 3.

6.1 Worker Heterogeneity

Consider two types θ of workers, h and l and such that, in addition to effort, the worker types are inputs in production. A worker's type θ is observable. Let firms consist of $m = 2$ workers. For sorting to matter, let worker types be complementary inputs: $Q = \gamma_{\theta\theta} \sum_i e_i$: There is now a productivity gain from matches that are positively assorted, as for a given level of effort, $Q(h;h) + Q(l;l) > 2Q(h;l)$. In the earlier sections, rematching is assumed to be frictionless.[18] That implies

[18] Eeckhout (1999) derives an equilibrium with endogenous class formation, provided there are frictions in the matching process.

h t n hg t p c n l a s e e t l w y e a d e r w p r n r n i s e e s n t e hg t p . e o m d f t e o e s i h l a d e a e t m k o e r w r m h p o o u m t h d e p r o . e a s t e au o n t e n m t h d o n o e s o m l z d o e o i a w y pa s t re ai ma ch d, ve if ha in lu es eg ti el so te ma ch s (;l :

N w, ®o t c oi e b hi h t pe in lu es he on id ra io of ba " (;l ma ch s, n a di io to he os ib li y o be ng n a h;) m tc wi h a or fo no -c op ra io . A l h gh yp s w ll mm di te y w nt o s pa at fr m a at h w th lo ty e i pl in th re s n co pe at on n m xe ma ch s. he i® re ce et ee h a d l an he ce he ar in l p od ct vi y o e® rt n d ®e en ma ch s i no cr ci l i de er in ng qu li ri m. it a h gh i® re ce al hi h t pe wi l b in uc d t co pe at as he e i su ci nt un sh en in he hr at f b in ma ch d t a t pe : S th he er ge ei y h s a e± ie cy ai by nd ci g a l t e h gh yp s t co rd na e. on id r n w t e l w t pe . T ey ti l n ed u± ie t m tc es it a n rm or on co pe at on in rd r t cr di ly us ai co pe at on n o he s. ow ve , t er is ls a p ss bi it of ei g rematched to an exogenously separated high type worker. The larger the difference between low and high types, the higher the benefit to a low type and the higher here incentive to try a rematch each time. This will induce her not to cooperate even if she is matched to another low type, as she wants to try her luck by possibly rematching a high type. While increasing dispersion in the types provides incentives for the high types to cooperate, it provides incentives for the low types not to cooperate. The result is that the initial dispersion is exacerbated in the payoffs through effort choice.

6.2 Complementary Inputs

When inputs are complementary, multiple static Nash equilibria can exist. The marginal productivity of a worker's effort increases as effort by other workers in the firm increases. As a result, multiple fixed points to the static game can exist.[19] Suppose there are two pure strategy Nash equilibria with utilities associated $\underline{u}^* < \overline{u}^*$ such that $\underline{u}^* < \overline{u}^* < u^o < u^d$. Let the corresponding option values be $\underline{V}^*$ and $\overline{V}^*$ be defined as above. To derive the equilibrium distribution of firm norms in this economy, consider the following expected valuation of being rematched: $EV = p_1 V^o + p_2 \underline{V}^* + p_3 \overline{V}^*$ where p_1 is the probability of matching to firm with a norm for cooperation and $p_1 + p_2 + p_3 = 1$:

An equilibrium distribution will now depend on what the level of effort is in the firms without a norm for cooperation. The condition (5) will now write $u^o \geq \gamma_1 u^d + \gamma_2 \underline{u}^* + \gamma_3 \overline{u}^*$: If $p_2 = 0$ (and hence $\gamma_2 = 0$); the fraction of cooperating firms f where the IC constraint is binding will

[19]Consider an example with $m = 3$; but where the production function is now multiplicative (i.e. effort is a complementary input) $Q = 3\prod_i e_i$ and cost of effort is $c(e_i) = \frac{e_i^4}{4}$; which implies $c' = e_i^3$. When output is equally shared, there are two pure strategy Nash equilibria: $\overline{e}^* = 1$ and $\underline{e}^* = 0$. Then either $\overline{u}^* = \frac{1}{2}$ or $\underline{u}^* = 0$: The Pareto optimal level of effort is $e^o = 3$; implying that $u^o = \frac{27}{4} \approx 6{:}75$. The utility from deviation is given by $u^d = 9e_i - \frac{e_i^4}{4}$; which solves $e^d = \sqrt[3]{9} \approx 2{:}08$ and yields $u^d = \frac{3}{4}9^{\frac{4}{3}} \approx 14{:}04$:

be smaller than if $p_2 = 1 - p_1$: In fact, as p_2 is increasing, f is decreasing. The value of being in a firm with a norm for non-cooperation $\underline{e}^*$ is the lowest possible, which implies that punishment is sufficiently severe that a large number of firms with a norm for cooperation can be sustained. In principle, any distribution of between p_2 and p_3 can be envisaged, as long as it satisfies the constraint.

Now consider the following case: let $\overline{V}^* > EV$: Then a worker in a firm with a norm for non-cooperation (the higher one of the two), will not want to separate as the current value is higher than the expected value of rematching. However, even if these non-cooperating stay together, it will not be an equilibrium to start cooperating if the IC constraint is binding with equality. Hence there is an equilibrium with three types of norms: high turnover, low non-cooperative effort; low turnover, high non-cooperative effort; cooperation. We now derive distribution, always under the assumption that $\overline{V}^* > EV$:

7 Concluding Remarks

The theory of competing norms provides an explanation for the coexistence of heterogeneous norms and the endogenous stratification of corporate cultures. The crucial premise is that organizational forms are in competition through the labor market. The organizational characteristics are not explained by transaction cost differences between firms and markets (Coase (1937), Williamson (1975)), nor as a result of non contractible, unforeseen contingencies where ownership constitutes the residual claimant (Grossman and Hart (1986)). We offer a complementary explanation in the line of Kreps (1990). The norm in our model is an implicit contract that is self enforcing. The market environment in which this norm operates determines the outside option for workers and is crucial for the feasibility of this implicit contract. No firm with a norm of cooperation can coexist unless there are sufficient bad norms. This is far from a theory of the firm (the boundaries of a firm here are exogenous). Rather, it is a theory of inequality of the firm.

Since there is a gap between the utility for an entrant in a bad norm compared to the utility for entry in a good norm, authority naturally arises by the incumbent high norm members. Wage payments that differ between seniors and juniors are the result from this discrepancy between the utility derived in different norms. As in Simon (1951), a new entrant is willing to enter into an authoritative employment contract as long as that contract is better than the employment contract in a bad norm. The important caveat of the competing norms model is that even authority is limited by the implicit contract. We show that the implicit contract restricts the rents that the authority of senior incumbents can extract. The nature of authority is determined/limited by the competitive environment through the implicit contract. Authority does not, in general, eradicate bad norms.

8 Appendix

Proof of Lemma 2

Given that the incentive compatibility constraint is binding, IR requires that $V_j^o = V_j^d \geq V^*$. From equations (14) and (4), IR then implies

$$\frac{u_j^d + EV}{1+r} \geq \frac{u^* + EV}{1+r}$$

and hence $u_j^d \geq u^*$. Where the IR constraint is binding, $u_j^d = u^*$ can be rewritten as $\underline{s}_j \left(Q^d \right) - C(e_j^d) = u^*$, where $\underline{s}_j$ is the the minimal s_j. This is a lower bound because u_j^d is increasing in s_j. ■

Proof of Proposition 2

To prove this Proposition, we proceed by showing two Lemmata. In Lemma 5, for a given sharing rule $\{s_j; s_s\}$, common to all firms, we derive the equivalent distribution function as in Theorem 2. In Lemma 6, assumption A allows us to determine that IC_j is binding, and we show exisitence.

Lemma 5 For any given sharing rule $\{s_j; s_s\}_c, \forall c \in C$ the fraction f_1 of firms with a norm for cooperation, is given by

$$f_1 = 1 - \frac{\left(u_j^d - u_j^o \right)(r+1) + \alpha(m-1)\cdot}{u_j^o(r+1) - r u_j^d - u_j^* + \alpha(m-1)(1+r)\cdot} \frac{\alpha}{1-\alpha} \tag{29}$$

provided $\frac{u_s^o - u_j^o}{r + m\alpha} \geq \frac{u_s^d - u_j^d}{r+1}$ and provided equilibrium exists.

Proof. Consider the same strategies as in Theorem 2. Then the proportion p of cooperating firms is given by equation (7). The expected value of rematching is now $EV = pV_j^o + (1-p)V^*$. Substituting EV in equations (11), (14) and (4), using (13) implies

$$\begin{aligned} rV_j^o &= u_j^o + \alpha\left[(1-p)\left(V^* - V_j^o \right) + (m-1)\cdot \right] \\ rV_j^d &= u_j^d + (1-p)\left[V^* - V_j^d \right] \\ rV^* &= u^* + p\left[V_j^o - V^* \right] \end{aligned}$$

Satisfying the incentive compatibility constraint of the junior $V_j^o \geq V_j^d$, we get condition IC_j

$$u_j^o + \alpha(m-1)\cdot \geq u_j^d \gamma + u^*(1-\gamma) \tag{30}$$

where γ is as before and given by equation (10).

The value equations for the senior workers are similar: V_s^d for deviators and V^* non-cooperators: For cooperators, the option value is $rV_s^o = \alpha[(1-p)(V^* - V_s^o) - p\Delta]$: We then get a similar condition IC_s for the senior workers derived from $V_s^o \geq V_s^d$

$$u_s^o + p(1-\alpha)\Delta \geq u_s^d\gamma + u^*(1-\gamma) \tag{31}$$

Both IC_j and IC_s need be satisfied. To determine which one of the two is binding, consider

$$V_j^o \geq V_j^d$$
$$V_s^o \geq V_s^d$$

Now given the definition of $\Delta = V_s^o - V_j^o$; we can write IC_s as

$$V_j^o + \Delta \geq V_j^d + \frac{u_s^d - u_j^d}{r+1}$$

since

$$V_s^d - V_j^d = \frac{u_s^d - u_j^d}{r+1} > 0$$

This implies that IC_j is binding iff $\Delta \geq \frac{u_s^d - u_j^d}{r+1}$ and IC_s if $\Delta \leq \frac{u_s^d - u_j^d}{r+1}$ (note that both are binding at $s_j = s_s$: then $\Delta = 0$ and $u_s^d = u_j^d$). From the definition of Δ

$$IC_j \text{ binding} \Leftrightarrow \frac{u_s^o - u_j^o}{r+m\alpha} \geq \frac{u_s^d - u_j^d}{r+1} \tag{32}$$

Assuming existence of a non degenerate distribution, we now proceed as in the proof of Theorem 2 by calculating the distribution. If (32) holds, from (30) (holding with equality), we can calculate f_1 which gives (18). This completes the proof. ■

In the following Lemma, we make use of assumption A in order to determine when IC_j is binding.

Lemma 6 Under assumption A; and for any sharing rule $\{s_j; s_s\}$, with $s_j \in [\underline{s}_j; s_s]$, there exists a pair $(r_1; \alpha_1)$ such that for any $r \in (0; r_1]$; and for any $\alpha \in (0; \alpha_1]$, IC_j is binding.

Proof. We show that $u_s^o - u_j^o \geq u_s^d - u_j^d$: The left hand side can be written as $s_s(Q^o) - s_j(Q^o)$: The right hand side is $s_s(Q_s^d) - s_j(Q_j^d) - [c(e_s^d) - c(e_j^d)]$: For any $s_j \leq s_s$; and given A1 and A2 it follows that $e_j^d \leq e_s^d$ (from $\frac{\partial u}{\partial e_i} = s_i Q_e - c'(e_i) = 0$; and c convex the envelope theorem implies that $\frac{\partial e_i}{\partial s_i} < 0$) and as a result, $Q_s^d \geq Q_j^d$: Since $Q^o > Q^d$; it immediately follows that $u_s^o - u_j^o \geq u_s^d - u_j^d$: For a finite m; there always exists a pair $(r;\alpha)$ small enough such that equation (32) is satisfied. To see this, for any r; let $\alpha \leq \frac{1}{m}$, which is sufficient. Then let $(r_1;\alpha_1)$ be chosen such that (32) holds with equality. From Lemma 5, it follows that the binding constraint is IC_j. ■

We can now finalize the proof of Proposition 2 and derive the distribution f. As in theorem 2, there exists a pair $(r;\alpha)$ such that (30) holds with equality. To see this, note that $\lim_{r\to 0}\lim_{\alpha\to 0}\alpha(m -$

$1)\Delta = \frac{m-1}{m}\left(u_s^o - u_j^o\right)$, so that in the limit, the left hand side of IC_j in equation (30) is equal to $u_j^o + \frac{m-1}{m}\left(u_s^o - u_j^o\right) = \frac{1}{m}Q^o - c(e^o) > u^*$. Choose (r_2, α_2) to satisfy (30) with equality. Let $(\hat{r}, \hat{\alpha}) = \min\{(r_1, \alpha_1), (r_2, \alpha_2)\}$. Then, under assumption A, Lemma 6 holds, so that from Lemma 5, it follows that $f = f_1$

$$f = 1 - \frac{\left(u_j^d - u_j^o\right)(r+1) + \alpha(m-1)\Delta}{u_j^o(r+1) - ru_j^d - u_j^* + \alpha(m-1)(1+r)\Delta}\frac{\alpha}{1-\alpha}$$

This completes the proof of Proposition 2. ■

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