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# Team composition, worker effort and welfare☆

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ABSTRACT

A successful organization needs the right team. We explore the optimal mix of familiar workers (who we call incumbents) and less familiar workers (newcomers) when production is group-based. If incumbents have a lower marginal return of effort, they will have less incentive to invest relative to newcomers. This is true, even when incumbents produce more for any given level of effort. This creates a tradeoff: less familiar agents will invest more whereas a more familiar team is inherently more productive. In our setup, the non-investing principal (weakly) prefers less familiar agents than the team that maximizes second-best surplus. On the other hand (symmetric) agents prefer a more familiar teammate compared with the second-best option. These insights have implications for team composition, job rotation and worker tenure.



## 1. Introduction

What does it take for success on Broadway? A Broadway production needs: a composer; a lyricist; a librettist who writes the dialogue and plot; a choreographer; a director; and a producer. But who should fulfill these roles? Analyzing Broadway shows between 1877 and 1990, Uzzi and Spiro (2005) find that financial and critical success is increasing in the number of the team members who previously worked together (incumbents), but only up to a point; too many incumbents decrease the likelihood of a production's success. Therefore, the most successful teams comprise of some incumbents, but also some newcomers.

Familiar workers – who have worked together before – have some natural advantages. They understand how each other works; they know others' strengths, weaknesses and communication idiosyncracies. Familiar team members often have a better sense of what the others will like and dislike, helping agents to avoid proposing and arguing for ideas that will never be part of the final product. Given the advantage of incumbents, why choose newcomers who have no experience of working with one another? Uzzi and Spiro (2005) emphasize that new team members bring fresh ideas to the collaborative effort, increasing overall quality. We focus on a similar rationale for using unfamiliar agents; previous experience of working together can decrease the incentive for agents to invest, ultimately reducing total output (or quality). In this framework we examine the preferred team composition (that is, the balance of familiar incumbents and unfamiliar newcomers) for the principal and the teammates themselves, and relate our findings to a variety of applications.

To analyze the choice of team composition we make two key assumptions. First, contracts are incomplete, creating an underlying hold-up problem. Second, final output depends on both the team experience of the workers and the efforts they make. Specifically, we assume that both the total and marginal return depend on the workers' familiarity. As a consequence, team familiarity will influence each worker's equilibrium effort.

In our model, two agents work in a team. The key choice when selecting a team is the level of familiarity between the workers; this choice is typically made by the principal. Worker familiarity helps determine effort and the output generated. For ease of exposition, we

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use the term *incumbent* for workers who are very familiar with each other. Alternatively, agents who have not had any previous work history are *newcomers*.[1]

Once the team is chosen, each agent makes a non-contractible effort. After these efforts are sunk, all parties negotiate and receive their share of ex post surplus. Teams made up of workers who are more familiar with each other, intrinsically produce greater output for any given level of effort. On the other hand, teams of unfamiliar agents, because they have never worked together, produce less surplus. We make the following important assumption: the additional surplus generated using incumbent agents relative to newcomers is decreasing in worker effort. In other words, unfamiliar workers can (partially) make up for the superior productivity of a familiar team by exerting effort. As a consequence, there is a tradeoff when choosing a team; while familiar workers produce more surplus for any given level of effort, unfamiliar workers put in more effort in equilibrium. This tradeoff gives rise to several results. First, if an enforceable contract can be written on effort, the principal will always opt for a team of incumbent agents (with the highest level of familiarity possible). This follows as surplus for any given effort level is always higher with more familiar agents. Second, if an enforceable contract cannot be written, the (second-best) welfare maximizing team may have workers with some level of unfamiliarity, just like many successful Broadway production teams. Third, we show that the different parties involved might have different preferences regarding team composition. If it is the principal who decides on the makeup of the team she will always choose a team that is more unfamiliar (or at least as unfamiliar) as would be chosen by an agent. Furthermore, a principal will choose a more unfamiliar team than required to maximize (second-best) surplus. On the other hand, if one of the agents decides on team composition, he could choose too much, too little or the second-best optimal level of familiarity with his teammate. If agents are symmetric, however, each worker always prefers too much familiarity amongst their co-workers relative to the second-best team structure.

There are many applications of our model. The model is directly relevant to team composition and job rotation.[2] Job rotation, by its very nature, breaks up old relationships and makes workers start afresh with at least some new members. This practice is used by many consulting firms; McKinsey & Company, for example, insists on rotating senior management roles. Our model suggests that there are potential benefits from committing to a job-rotation policy, as the agents, left to their own devices tend to choose too many teammates with whom they have previously worked, even if a more unfamiliar team would be more productive. This could also be suggestive as to why some firms use predetermined rotation rules so as to avoid influence costs (Milgrom and Roberts, 1990). In a similar manner to the Broadway study mentioned above, Guimera et al. (2005) find that the inclusion of newcomers in research teams increases the probability of a successful scientific collaboration in social psychology, economics, ecology and astronomy.

In another situation, some airlines integrate a permutation constraint in their cabin crew assignment algorithm that prevents familiar pilots from being assigned to the same flight.[3] There is likely to be a potential advantage from using familiar workers — for instance, crew members who know each other well probably communicate more easily — but these airlines explicitly forgo this benefit. Familiar crew may be dissuaded from undertaking the same level of effort when teamed with each other (checking and cross checking and so on) than when teamed up with a stranger. With lower effort, the outcome (in terms of safety incidents) could be worse when familiar agents are paired together, despite their intrinsic advantage. Teams of doctors – attending physicians, residents, interns and so on – are also rotated, both within and across hospitals. The same tradeoffs between effective communication amongst familiar workers and providing additional incentives for effort (or, equivalently, to remain attentive) could arise in this case as in the cabin-crew example above. Likewise, manufacturing teams are often rotated, potentially foregoing the incumbents' superior productive capability. In a similar way across a range of sports, even highly successful teams bring in new players (particularly in the off-season). Rotation of the team in our model does not rely on the need to replace deadwood or to achieve the right balance of skills; rather, our model suggests a tradeoff between experience and energy. The incumbent members know the team plays, structure, and so forth, so rotating the roster forgoes the complementarities that have developed over time. But new team members elicit greater effort from all players, old and new alike, and effort is crucial for sporting success.

The foundation for our analysis is essentially a moral-hazard-in-teams model (see Alchian and Demsetz, 1972; Holmstrom, 1982 and Che and Yoo, 2001). Given the externality between team members, there is always underinvestment in effort. In our paper, however, there is an additional consideration — the choice of team membership. This means that the principal (or the party deciding) also needs to take into account how the composition of the team affects agents' incentives. Our analysis suggests that the additional output between familiar agents can foster (relative) indolence. If this is the case, choosing unfamiliar workers might be preferred as such an arrangement leads to greater levels of effort (and surplus).[4]

There is an existing literature that examines incentive–contract design when there are externalities between agents — see for example, Segal (1999, 2003), Bernstein and Winter (2012) and Winter (2004, 2006). These models typically investigate optimal contracting when the potential externalities are fixed (that is, they do not vary with effort). In contrast to most of these models, we focus on the case when the externality varies endogenously in equilibrium. The paper in this literature most similar to ours is Winter (2010), who examines how the structure of information inside a firm affects agents' optimal incentive contracts. Specifically, he finds that creating an environment with greater information is beneficial when agents' efforts are complementary. This is because the dissemination of information about agents' effort (or lack thereof) can allow for effective punishment. The similarities in the two papers are that the work environment affects investment incentives. In Winter (2010) it is the flows of information; in our model it is the composition of the team. One key difference is that Winter explicitly considers individual incentive contracts based on output; in our model all parties receive a non-contractible share of group surplus ex post, as in Holmstrom (1982).

In a different context, Franco et al. (2011) consider how worker types are matched, when this choice affects the optimal incentive contracts, which depend on type and output. They find that a principal might prefer to forgo technological complementarities (by not matching two low-cost workers together) if this allows for a better outcome in terms of effort and the cost of incentive compensation.[5] Their result – that positive-associated matching need not hold once effort and incentive contracts are considered – parallels our prediction that new team members might be preferred. Note also that like in

[1] Note, we are explicitly referring to experience or familiarity of agents working together; in this sense 'experience' means experience on a particular team, and not to their knowledge or skills in the profession more generally. Similarly, 'newcomer' refers to a new member of *that* team, not an inexperienced worker per se. We also allow familiarity to be a continuous variable, rather than a binary choice, reflecting the differing work experience histories agents can have with one another.

[2] Other explanations for job rotation include: eliciting information from agents (Arya and Mittendorf, 2004); avoiding worker boredom (Azizi et al., 2010); and limiting scope for corruption (Choi and Thum, 2003).

[3] Anonymous industry source.

[4] Team membership has also been explained by the technological complementarities between tasks (Brickley et al., 2008) or arising from a multi-tasking incentive problem (see Holmstrom and Milgrom, 1991; Corts, 2006, for example).

[5] Kaya and Vereshchagina (2014) make a similar point regarding moral hazard in partnerships.