Drive out fear (unless you can drive it in): The
role of agency and job security in process
improvement

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Department of Operations Management / System Dynamics Group
Sloan School of Management, E53-339
Massachusetts Institute of Technology
Cambridge, MA USA 02142
Phone: 617-258-6889 Fax: 617-258-7579
E-Mail: nelsonr@mit.edu

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Abstract

Understanding the wide range of outcomes achieved by firms trying to implement TQM and similar process improvement initiatives presents a challenge to management science and organization theory: a few firms reap sustained benefits from their programs, but most efforts fail and are abandoned. A defining feature of such techniques is the reliance on the front-line workforce to do the work of improvement, thus creating the possibility of agency problems: different incentives facing managers and workers. Specifically, successfully improving productivity can lead to lay-offs. The literature provides two opposing theories of how agency interacts with the ability of quality-oriented improvement techniques to dramatically increase productivity. The 'Drive Out Fear' school argues that firms must commit to job security, while the 'Drive In Fear' school emphasizes the positive role that insecurity plays in motivating change. In this study a contract theoretic model is developed to analyze the role of agency in process improvement. The main insight of the study is that there are two types of job security, internal and external, that have opposite impacts on the firm's ability to implement improvement initiatives. The distinction is useful in explaining the results of different case studies and can reconcile the two change theories.

1. Introduction: The Improvement Paradox

Why don't more firms use quality-oriented process improvement techniques like Total Quality

Management (TQM)? The evidence suggesting that TQM and similar initiatives are powerful tools

for improving both quality and productivity is quite compelling: Many firms attribute much of their

success to the use of quality-related tools, the tools and disciplines associated with the quality

movement have become an accepted part of business school curricula, and empirical studies find

that firms using TQM outperform their competitors (Easton and Jarrell 1998, Hendricks and

Singhal 1996, Barron and Paulson Gjerde 1996). Yet, despite the widespread acceptance of the

quality philosophies and tools, and the evidence indicating that their use leads to improved

profitability, few firms have well-developed quality programs. A recent survey of management

trends reports that, among managers surveyed, quality is "...deader than a pet rock (Byrne 1997)."

Easton and Jarrell (1998) surveyed over 1,000 U.S. firms, including almost the entire *Fortune*

500, but could find fewer than 100 companies with ongoing TQM programs (those 100 firms

outperformed their non-TQM counterparts). Other studies report similar findings (Ernst and

Young 1991 and *The Economist* 1992). TQM and similar techniques are powerful tools for

improving both quality and productivity but, paradoxically, few firms actually use them.

Understanding why TQM can be so powerful in a few firms but a failure in many others is an

important question facing both managers and scholars. For managers, the benefits are obvious: a

robust improvement program creates competitive advantage. Empirical studies clearly show that

firms that develop such systems outperform their competitors (Easton and Jarrell 1998, Hendricks

and Singhal 1996). For scholars, the improvement paradox presents a challenge to management

theory. Dean and Bowen (1994) write "TQ initiatives often do not succeed, but as of yet there is

little theory available to explain the difference between successful and unsuccessful efforts."

Two major hypotheses have emerged to explain the paradox of a tool that can be so successful in a

few organizations but such a failure in many others. First, some argue that TQM simply does not

work and is another in a long line of management fads (Harte 1992). The empirical studies cited

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above rule out this explanation. A second and more compelling hypothesis is the firm-level heterogeneity argument often found in studies of technological adoption: Firms with well-developed TQM programs have chosen such a path because they have the appropriate context, while firms without quality programs have also made a desirable choice given their environment. This approach has been applied to TQM by Barron and Paulson Gjerde (1996), who based on a simple production model, argue that TQM is likely to be adopted by firms that are larger, have lower turnover, and more access to internal financing.

In this paper, rather than focus solely on the heterogeneity across firms, I study the potential agency problems created within a firm by the introduction of a productivity improvement effort. The main hypothesis is that agency—different incentives facing managers and workers—can create problems for firms trying to implementing process-oriented improvement efforts. It will be shown, however, that these problems do not occur in every situation. Instead, agency is only an issue when the firm faces a certain set of market conditions. Thus, my analysis does not reject the heterogeneity argument, but enriches it by developing a new layer of theory to explain why differences across firms actually matter when the try to implement TQM.

To that end, the paper is organized as follows. In section two the arguments underlying the agency hypothesis are presented. In section three the main model is developed to show two main results: 1) the conditions under which the firm can commit to job security; and 2) if workers do not have an opportunity to collude, then, even without a credible commitment to job security, the firm can implement improvement cheaply. In section four the model is extended to allow the possibility of collusion among workers. The main result here is that collusion greatly increases the firm's cost of implementing improvement. In section five the possibility of firm failure is introduced and section six contains discussion and concluding thoughts.

2. The Agency Hypothesis

The interest in the role of agency is motivated by the following observations. Many process improvement techniques rely on line workers to do the actual work of improvement. TQM advocates, for example, universally identify the production line as the locus of improvement (Shiba, Walden and Graham 1993; Deming 1986). Similarly, Wruck and Jensen (1994) suggest that the reliance on line personnel to do the work of improvement is a defining feature of TQM. The power of TQM, they argue, lies in its ability to utilize the local knowledge that operators accumulate while performing their daily tasks. When firms achieve high levels of participation in programs like TQM, the results can be impressive. For example, Analog Devices, a major semiconductor manufacturer, doubled its effective production capacity in less than three years using TQM and related techniques (Sterman, Repenning, and Kofman 1997). During that period product quality and delivery reliability also improved.

The reliance on line personnel to do the work of improvement does come with a cost: dramatic increases in productivity can create a situation in which taking full advantage of that improvement requires firing some portion of the workforce. If reductions are required, employees are presented with the possibility of 'improving themselves out of a job' and thus may not participate in the program. To continue the above example, after making such impressive improvements, Analog Devices laid off over ten percent of its workforce and then saw quality and productivity deteriorate for two years as participation in improvement efforts declined. In this case, agency–the desire of managers to induce the workers to do something–becomes an issue because managers and workers face different incentives: managers wish to see improvement, workers do not.

Currently the literature offers two competing hypotheses concerning the role of agency in participatory improvement efforts. Through his famous dictum "Drive Out Fear," Deming (1986) argues that, to become a 'quality' organization, a firm must assure the security of its workforce. He writes, "Top management should...publish a resolution that no one will ever lose his job for contribution to quality and productivity (Deming 1986:26)." Other proponents of TQM have

written about the beneficial effects of job security on improvement (Bluestone and Bluestone 1992;

Shiba et al. 1993), and a number of empirical studies reach similar conclusions (Levine and Tyson

1990; Cameron, Freeman and Mishra 1993; Cameron 1995).

A simple version of the agency hypothesis–people will not participate in improvement efforts if

they will be subsequently fired–is intuitively appealing but is not supported by all the available

data. In contrast to the studies cited above, McPherson (1995) reports that a division of AT&T laid

off over 6,000 workers–more than half its total workforce–on its way to winning the Malcolm

Baldrige National Quality Award and achieving record quality and productivity improvements.

Similarly, Reid (1990) discusses the case of the Harley-Davidson Motorcycle Company which laid

off almost half its workforce while adopting TQM and was able to make significant improvements

in quality, productivity, and profitability.

With such cases in mind, many organizational scholars and management consultants offer a

prescription diametrically opposed to "Drive Out Fear." Kotter (1995) suggests that a sense of

urgency and fear of failure may help organizations change, and cites cases in which managers

deliberately emphasize poor business results and the likelihood of future losses to motivate change

and improvement. Bailey (1997), a partner in a major US consulting firm, argues that fear of job

loss is a valuable ally to managers trying to introduce major organizational change. This view has

received both theoretical and empirical support. Schaefer (1998) develops a model of how

employees respond to impending organizational change. He finds that as a firm's prospects

decline (meaning the chance of failure increases) employees invest less effort in impeding

performance-improving organizational redesigns. Baker and Wruck (1989) discuss the case of

O.M. Scott in which external financial pressure caused by a heavy debt load led to impressive

change. Wruck (1994) provides an even more compelling example: Sealed Air Products

purposely paid an extraordinary dividend, taking on substantial debt in the process, to create

external pressure that subsequently led to improvement.

Thus, the literature offers contradictory recommendations: TQM proponents and human resource scholars argue that job security is a key to success; organizational scholars and management practitioners argue that fear of downsizing is a powerful tool for motivating change. The purpose of this paper is to reconcile these two competing views.

3. The Model

The environment modeled in this paper is one in which the firm is periodically presented with an improvement technique that, if adopted, increases the productivity of its workforce. The nature of these innovations is such that the firm cannot adopt them directly. Instead, the firm must provide incentives to induce the workforce to adopt the innovation. The types of innovations under consideration are, thus, not purely technical in nature–the firm cannot simply purchase them. Instead, they involve a combination of organizational methods and technical tools that allow workers to utilize their accumulated experience more effectively (*organizing technologies* in the language of Wruck and Jensen (1994)). A key feature of these tools is that, once used, the knowledge they generate becomes available to the firm. In the model, once a particular improvement has been made, it becomes a permanent part of the technology set available to the firm.

3.1 Model Set-Up

The model is a repeated game between an infinitely lived firm and the labor force it must hire. The model takes place in discrete periods. The length of a period corresponds to the frequency with which the firm is able to change its labor hiring (the length of the basic labor contract).

The Firm

The firm sells one type of product and requires only one input, labor (denoted L_t). The productivity of labor in period t is represented by α_t, and the total quantity the firm can produce in period t is $\alpha_t L_t$. The price for that product is fixed by the market at P. Demand, D_t, is determined by the following relation, $D_t = (1+\gamma)^t D$ where D is an i.i.d. random variable with a distribution function, Q, and γ is the fractional growth rate in demand. The firm values next period's earnings at δ.

The Workforce

Using the distinction made by Shiba *et al.* (1993), each member of the workforce can engage in two activities: normal work and improvement work. Normal work represents activities related to production and improvement work focuses on improving the production process. Normal work pays each worker a wage w in return for making productive efforts with a dis-utility of e. Workers are risk neutral and have a utility function that is linear in income and effort, $U(w,e)=w-e$. Critically, I assume that the equilibrium wage, w^*, is such that people strictly prefer employment within the firm to the best available alternative $-w^*>e$. Those fired in period t are assumed to earn 0 utility in all future periods. Workers value future earnings at r. Since it plays no role in the analysis, the cost of normal efforts, e, is set to zero.

Many of the results presented in this paper require the assumption that workers strictly prefer their jobs to being fired–there is little cost of agency if workers are indifferent between losing and keeping their jobs–so it requires some justification. First, there is ample empirical evidence to suggest that people are not indifferent between working and being laid off (e.g. Cameron 1995; Cameron *et al.* 1993). Second, if access to the labor market is restricted in some way, via union rules for example, then one should not expect market clearing wages. Third, even in non-unionized environments a variety of theories explain why people strictly prefer working to being fired. These include costly search and the equilibrium unemployment theory of Shapiro and Stiglitz (1984). The theory most relevant to discussion of TQM is advanced by Milgrom (1988): over time workers accumulate firm specific knowledge, so that, if a worker leaves, the firm incurs some additional costs. Wruck and Jensen (1994) support this assumption by suggesting that TQM is a system through which firms take better advantage of their employees' specific knowledge. In this case the equilibrium wage can exceed a worker's next best outside opportunity.[1]

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[1] It is important to note that using this theory to justify a non-market clearing wage can add complications. If the firm develops excess labor capacity, then the cost to the firm of losing a worker may decline since somebody else with similar specific knowledge may still work at the firm. This could potentially induce changes in the equilibrium wage, w^*. In this analysis I will not deal with these complications, but simply assume that w^* constant.

Productivity

Improvement work manifests as changes in α_t, the productivity of labor. Each period the firm learns of a new managerial innovation that has the potential to improve productivity. For the firm to reap the benefits of this innovation, it must induce each member of the workforce to engage in improvement work and *adopt* the innovation. At time t each worker i makes a binary choice, to adopt, $a_i=1$, or not adopt, $a_i=0$. Let $a=(a_1,...,a_I)$. If a worker adopts, she incurs a private cost $c>0$, representing the dis-utility of obtaining the required training and making any extra efforts required to use the new tools. The cost of adopting enters the utility function linearly, $U(w,e,a) = w-c\cdot a$. If all workers adopt, then the innovation produces the maximum gain in productivity, α'_{t+1}. Realized productivity is assumed to be increasing in the number of adopters, and for clarity, an additional adoption is assumed to reduce the *ex post* labor requirement by at most one job.[2]

Contracts and Reputation

Normal work and improvement work are governed by different contracting arrangements. Normal work is assumed to be governed by a complete contract. While natural for the basic wage–labor contracts are often adjudicated by courts–such an assumption is not appropriate for improvement work, the evaluation of which is subjective and is typically not governed by a formal arrangement. Thus, in contrast to normal work, the workers' efforts toward improvement, a_i, are assumed to be observable but *not* verifiable, and improvement work is governed by an implicit contract (Bull 1987, Kreps 1990). To induce workers to adopt the innovation, the firm offers a contract $b(a_i)=\{(0,0),(1,b)\}$ that pays a bonus, b, to each worker if she is observed to have adopted the innovation and 0 otherwise. The firm's payment of that bonus is only enforced via the value it places on having the reputation for honoring such agreements. To model reputation workers are assumed to play trigger strategies that dictate participating in the agreement (if it is in their best interests) as long as the firm has honored such agreements in the past. If the firm ever fails to

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[2] . Clearly this must be true for all n greater than some threshold, otherwise labor requirements would be negative if the innovation was fully adopted. Strengthening this requirement to all n simplifies many of the arguments that follow but is not necessary.

honor its commitments, then workers refuse to participate for ever after.

The issue of reputation is complicated by the existence of a single firm that hires many workers. Which transactions does a given worker observe when assessing the firm's reputation for honoring its agreements? One option is to assume that a given player assesses the firm's reputation based only on the transactions in which that player participates. Alternatively, one can assume that each worker is aware of every transaction and, if the firm ever fails to pay any worker, then all players will refuse to participate in future agreements. These different assumptions play a minor role in the basic model (the firm's cost of implementation is the same under either assumption), but become more important when the possibility of collusion is introduced (these implications are discussed in the section on collusion). To simply the exposition, the players are assumed to observe all of the firm's dealings with other players, and, if the firm ever reneges on an agreement with one player, from that date forward all players refuse to participate in future arrangements.

Timing

Within each period the model proceeds through four stages (see Figure 1). At the beginning of the period the firm learns of a new innovation and then offers workers a contract to induce them to adopt. After seeing the firm's offer, each member of the workforce decides whether or not to
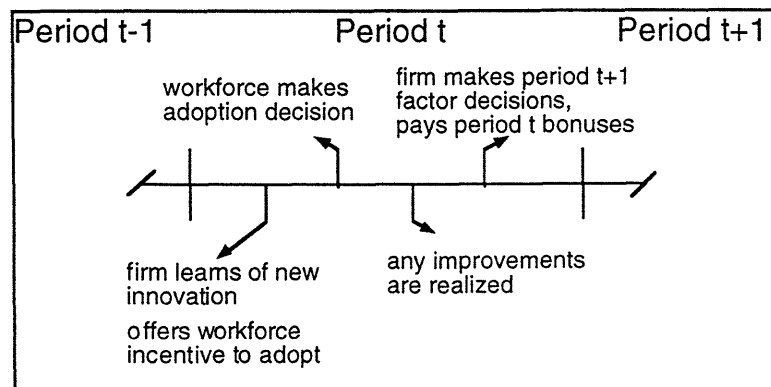

Figure 1

adopt. Following the adoption decision, any improvement is realized and the firm makes its

hiring/firing decisions for the following period. Finally, if the firm so chooses, it pays the

bonuses offered in the beginning of the period.

3.2 The Firm's Problem

In this subsection I analyze the firm's hiring problem and discuss the conditions under which the

firm can and cannot credibly commit to job security. Absent the agency concerns that will be the

main focus of this paper, the firm solves a fairly standard profit maximization problem in which it

chooses the labor level each period in the face of uncertainty about that period's demand:

$$\max_{L_t} \Pi = \underset{D}{E}\left(\sum_{t=1}^{\infty} \delta^{t-1}\left(P \cdot \min\left((1+\gamma)^t D, \alpha_t \cdot L_t \right) - w \cdot L_t \right) \right)$$

It is straightforward to show (see Heyman and Sobel 1984) that the firm's optimal hiring strategy

is characterized by the following fractile policy[3]:

$$Q\left(\frac{\alpha_t L_t^*}{(1+\gamma)^t} \right) = \frac{1}{P} \cdot \left(P - \frac{w}{\alpha_t} \right)$$

(3.1)

If, given (3.1), $L^*_t \geq L^*_{t-1}$ for all t, then there are no agency problems since lay-offs are never in the

firm's best interest. To see the conditions under which this will obtain, assume that Q is

differentiable, then the optimal labor level, L^*_t, is characterized by:

$$L_t^* = \frac{(1+\gamma)^t}{\alpha_t} \cdot Q^{-1}\left(\frac{1}{P} \cdot \left(P - \frac{w}{\alpha_t} \right) \right)$$

(3.2)

Then, since $Q^{-1}(\bullet)$ is increasing in α_t, comparing L^*_t to L^*_{t-1} yields a sufficient condition for a

credible commitment to job security:

$$\gamma \geq \frac{\alpha_t - \alpha_{t-1}}{\alpha_{t-1}}$$

(3.3)

Equation (3.3) shows that the firm can commit to job security if the fractional growth rate in

demand is greater than the fractional growth in productivity. Thus, even though the firm may have

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[3] . This is a variant of a model presented by Heyman and Sobel (1984) p.97.

excess capacity in a given period due to a low realization of demand, the firm is willing to hold that capacity as long it expects to need it in the future.

If (3.3) is not satisfied, then there is potential for downsizing. In this case the firm's optimization problem can be considerably more complicated since it must trade-off the cost of holding additional workers today against the benefit of future productivity improvement and the possibility of future demand growth. If the reverse inequality is satisfied and productivity growth always exceeds the underlying growth in demand, then it is tempting to conclude that the firm can *never* commit to job security. While this intuition is essentially correct, it is not true in all cases. In the appendix sufficient conditions are provided under which the firm cannot credibly commit to job security.

If the demand conditions are such that $L^*_t < L^*_{t-1}$ for all t, then the solution to the unconstrained problem is optimal irrespective of agency concerns *if* the firm is sufficiently patient, meaning δ is close enough to one. The reasoning is as follows: $L^*_t \leq L^*_{t-1}$ guarantees that, absent agency concerns, the optimal level of labor declines each period. Thus, if the firm commits to job security, it commits to keeping workers that it will *never* need. Unless workers do not discount future income, inducing a worker to adopt the innovation and then firing her has a finite cost (this will be proven later). The cost of keeping a worker will be the net present value of her per period wage, $w/(1-\delta)$. As δ approaches one, the cost of keeping the worker exceeds the lay-off cost and the firm is better off firing that worker.

Thus, to study the agency problem created by the potential for lay-offs, in the remainder of the paper I assume that demand is fixed at D, so given any productivity improvement the optimal labor level declines, $L^*_t < L^*_{t-1}$. To calculate the expected pay-off to various strategies in closed form, I add the additional assumption that the fractional reduction in the work force caused by a fully adopted innovation, $\phi_t = (\alpha^*_t - \alpha^*_{t+1})/(\alpha^*_{t+1})$, is constant. Assuming ϕ_t is constant simplifies the

presentation and, based on Schneiderman (1988), is a good approximation of actual process improvement experience.

3.3 The Contracting Problem

The game between the firm and the workers is analyzed using the behavioral assumption that players' strategies conform to a sub-game perfect Nash equilibrium (Fudenberg and Tirole 1992). Let (a_i, a_{-i}) denote player i's choice of action holding the choices of other players constant, and let the probability that a worker gets fired and does not continue working for the firm be $p_L(a_i, a_{-i})$. Then, in period t, the effective discount rate that workers apply to period $t+1$ is $r\cdot(1-p_L(a_i, a_{-i}))$. Let $V_i(a_i, a_{-i})$ represent a worker's expected pay-off in the continuation game *if* that worker is not fired. If it is in the firm's best interest to pay bonuses, then, since its reputation is based on its dealings with all of the workforce, the firm must pay a bonus b even to those it will subsequently fire to maintain its reputation. Thus, each player chooses a_i as follows:

$$a_i \in \arg\max \ w + b(a_i) - c(a_i) + r(1 - p_L(a_i, a_{-i}))V_i(a_i, a_{-i})$$

where $b(a_i)$ is the incentive scheme offered by the firm in stage one and p_L is the equilibrium lay-off vector. If it is not in the firm's best interest to pay the bonuses, then, in equilibrium, players know this and do not adopt.

The firm must make two decisions each period. In the first stage the firm must choose $b(a_i)$ the incentive scheme it offers to each member of the workforce. After any improvements have been realized the firm then chooses $p_L(a)$, the lay-off vector and decides whether or not to pay the bonuses it offered. $b(a_i)$ must be greater than or equal to zero since (a bonus rather than a fine), since there is no mechanism to enforce the payment of fines.[4] Thus the firm solves:

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[4]. The firm cannot reduce the wage, w, since it is governed by a complete contract.

$$\max_{b(a),L_t} \Pi = E\left(\sum_{t=1}^{\infty} \delta^{t-1}\left(P \cdot \min(D_t, \alpha_t \cdot L_t) - w \cdot L_t - \sum_I b_i(a_i)\right)\right)$$

$$s.t. \quad a_i \in \arg\max \ w + b(a_i) - c(a_i) + r(1 - p_i(a_i, a_{-i}))V_i(a_i, a_{-i})$$

$$b_i(a_i) \geq 0$$

3.4 Cost minimizing equilibrium contracts

The restrictions faced by the firm in laying off workers influence the cost minimizing contract that

can be implemented in equilibrium. In some cases the firm may not control both the *size* and

composition of a particular lay-off. If this is the case, the firm cannot engage in *punitive* lay-offs

and use downsizing as a direct threat to not adopting. Alternatively, the firm may have this control

and can use a strategy that dictates first firing those that do not adopt. In this section cost

minimizing equilibrium contracts are calculated under both assumptions and, it turns out, that as

the number of workers grows large, the difference between the two cases diminishes. The main

result developed is that, if workers have no opportunity to collude, the firm can implement

participatory productivity improvement at low cost.

Contracts without punitive lay-offs

To compute the cost of implementing improvement when punitive lay-offs are not allowed, I

assume that the firm uses a randomized strategy in which it lays-off each person with equal

probability, $p_L = \phi$. Then, to *sustain* a full adoption equilibrium the firm must set $b(1)$ such that the

expected pay-off to adopting is greater than that which can be achieved by a unilateral deviation:

$$w - c + b(1) + r(1 - p_L(1,1)) \cdot V(1,1) \geq w + r(1 - p_L(0,1)) \cdot V(0,1) \tag{3.4}$$

Similarly, to *eliminate* no-adoption as an equilibrium the firm must set $b(1)$ such that the pay-off to

adopting is sufficiently large that players will choose to deviate from a no-adoption equilibrium:

$$w - c + b(1) + r(1 - p_L(1,0)) \cdot V(1,0) \geq w + r(1 - p_L(0,0)) \cdot V(0,0) \tag{3.5}$$

(3.4) can be re-written as:

$$b(1) \geq \left(c + r \left(\begin{array}{c} (1 - p_L(0,1)) \cdot (V(0,1) - V(1,1)) \\ + \\ V(1,1) \cdot (p_L(1,1) - p_L(0,1)) \end{array} \right) \right)$$

and, similarly, (3.5) can be re-written as:

$$b(1) \geq \left(c + (1-r) \left(\begin{array}{c} (1 - p_L(1,0)) \cdot (V(0,0) - V(1,0)) \\ + \\ V(0,0) \cdot (p_L(1,0) - p_L(0,0)) \end{array} \right) \right)$$

The lay-off fraction each period is independent of the past history, so a deviation this period has no effect on the continuation pay-offs and both *[V(0,0) - V(1,0)]* and *[V(0,1) - V(1,1)]* equal zero. Thus full adoption is the unique equilibrium outcome as long as:

$$b(1) \geq c + r \cdot V(1,1)(p_L(1,1) - p_L(0,1)) \tag{3.6}$$

and

$$b(1) \geq c + r \cdot V(0,0)(p_L(1,0) - p_L(0,0)) \tag{3.7}$$

To determine the cost to the firm of this contract, notice that a unilateral deviation from any candidate equilibrium increases the *ex post* labor requirement by at most one job, so a deviation changes the probability of lay-off by at most $1/L_t$. Using this, and the fact that $V(0,0) = w/(1-r)$, (3.6) and (3.7) can be re-written as:

$$b_t \geq \left(c + r \cdot \frac{w}{1-r} \cdot \frac{1}{L_t} \right) \tag{3.8}$$

$$b_t \geq \left(c + r \cdot \frac{V(1,1)}{L_t} \right) \tag{3.9}$$

Then, since *w/(1-r)≥V(1,1)*, if *b(1)* satisfies (3.8), (3.9) is also satisfied, so (3.8) guarantees that the firm achieves the unique equilibrium in which everybody adopts the innovation. Thus the firm's minimum cost of guaranteeing full adoption without punitive lay-offs, TC_{np}, is:

$$TC_{np}(t) \leq c \cdot L_t + \frac{w}{1-r}$$

The firm's cost, in excess of the training cost $c \cdot L_t$, is equal to the expected loss in utility of *one* worker who is fired, independent of the size of the required lay-off. This occurs because, by using a random lay-off strategy, the firm effectively spreads the impact of one adoption decision over the entire workforce and minimizes the impact of an individual's decision on her own pay-off. As L grows large, the cost created by agency is, proportionally, very small.

Contracts with Punitive Lay-offs

If punitive lay-offs are allowed, the situation changes somewhat.[6] Here a contract contains three elements, the player's action, the pay-off contingent on those actions, and the probability of being fired contingent on those actions. Now the firm offers the following arrangement to its workers: $b=\{(1,c,p^-_L),(0,0,1)\}$ where p^-_L corresponds to a strategy of first firing all non-adopters with equal probability, and then if additional lay-offs are required, firing those who adopt with equal probability. In this contract the firm compensates the player who adopts for her private cost of adopting c, and agrees to only fire that player with probability p_L. If a player does not adopt, then she receives no bonus and is fired for sure. Under these conditions, since the probability of lay-off given a deviation from a full adoption equilibrium is *1*, equation (3.6) becomes:

$$b(1) \geq c - r \cdot V(1,1)(1 - p_L(1,1)) \tag{3.10}$$

Similarly, since the probability of lay-off given a deviation from a zero adoption equilibrium is *0*, equation (3.7) becomes:

$$b(1) \geq c \tag{3.11}$$

Thus with punitive lay-offs, inducing a player to adopt requires only c, the direct cost of adoption, and no compensation is required for the loss in expected utility due to potential downsizing. The firm now incurs no additional costs created by agency. These results suggest that firms can implement productivity improvements cheaply and bear little or no cost of the lost worker utility.

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[6]. Thanks to an anonymous referee who pointed out the difference between punitive and non-punitive lay-offs.

So far, Driving Out Fear does not appear to be necessary for the success of TQM.

3.5 The Reneging Constraint

It does remain, however, to be determined whether or not this contract is sustainable. The firm

might find it more profitable to renege on the relationship and not pay the bonus in which case

improvement cannot be implemented in equilibrium. Without loss of generality, let the period

under consideration be period one. For the relationship to be sustainable, the firm's profit must be

larger if it pays the bonus than if it chooses to renege. Thus the following must be satisfied:

$$w \sum_{t=2}^{\infty} \delta^{t-1} L_1 (1 - \phi) \geq c \cdot L_1 + (w + c) \sum_{t=2}^{\infty} \delta^{t-1} L_1 (1 - \phi)^{t-1} \tag{3.12}$$

The equation indicates that, for the relationship to be sustainable, the benefit of reneging on the

current payment, $c \cdot L_1$, and then paying wage w to $L_1(1-\phi)$ workers for ever after must be less than

paying the current bonus and then reaping the net benefits of future process improvement. Some

manipulation reduces (3.12) to the following:

$$\delta^2 \cdot w \cdot \phi \cdot (1 - \phi) \geq (1 - \delta) \cdot c \tag{3.13}$$

The equation indicates that the relationship can be sustained for any set of parameters as long as the

firm is sufficiently patient, and yields one fairly obvious but important insight: a more patient firm

is more likely to be successful with process improvement and achieve a long run improvement in

profitability. The relationship to ϕ, the fractional reduction in per period labor requirements, is also

interesting. The left-hand side of (3.13) is maximized with respect to ϕ when $\phi=1/2$ and

approaches zero as ϕ approaches 0 or 1. (3.13) cannot be satisfied when ϕ is small because the

future benefits of improvement, although persistent, are small, and the cost of such adoption, $c \cdot L$,

does not depend on ϕ. Similarly, when ϕ is large the relation cannot be satisfied and the firm is

again tempted to renege. In this case the savings to future improvement are also small, when

measured on an absolute scale, because so much improvement occurred in the first period.

Although tangential to the main focus of this analysis, (3.13) provides an interesting interpretation

of the relative successes of TQM and another popular improvement method, Business Process

Reengineering (BPR). While the failure rates have been high for TQM, they have been even

higher for BPR. Even its founders estimate that such efforts fail over seventy percent of the time

(Hammer and Champy 1993). Unlike TQM advocates who argue for incrementally improving

productivity over time, proponents of BPR argue for radical change (corresponding to a high ϕ).

Thus the failure rate of such initiatives might be attributed in part to the fact that, in the absence of

growth, the firm cannot provide incentives to participate in such programs.

4. Collusion

So far, the analysis suggests that if the reneging constraint is satisfied, productivity-improving

innovations can be adopted at low cost to the firm. The results do not support the arguments of

those who claim that job security is required for successful productivity improvement. This stands

in contrast to some of the empirical evidence: many firms struggle to implement such programs,

and improvement efforts often fail due to lack of commitment from the workforce. The main

driver of the results so far is the fact that workers do not take into account the negative effect of

their actions on others. Such an assumption is unrealistic in many contexts. Workers have a

number of institutions that may allow them to internalize the costs that they impose on others. To

capture these effects, in this section the model is extended to account for possible collusion.

The welfare of the work force is clearly higher if it colludes to prevent adoption, and, since the

game is a repeated one, collusion can potentially be sustained. The set-up is similar to the infinitely

repeated prisoner's dilemma (Fudenberg and Tirole 1992). Assume that players use trigger

strategies that dictate cooperation if the cooperative outcome occurred last period and otherwise

play the non-cooperative equilibrium strategies described earlier. In a one-shot version of this

game each player would defect from the cooperative equilibrium if $b(1)>c$. In a repeated game,

cooperation can be sustained if the discounted benefit of cooperating exceeds the pay-off obtained

from defecting.

Sustained cooperation implies that the probability of lay-off is zero in every period and that the total pay-off is equal to $w/(1-r)$. If a player deviates from the collusive equilibrium, she earns $w+b-c$ in the period of the deviation and then the continuation pay-off to the punitive lay-off, non-cooperative equilibrium discussed earlier, $V(1,1)$. Cooperation can occur in equilibrium if:

$$\frac{w}{1-r} > w + b(1) - c + r(1 - p_L(1,1)) \cdot V(1,1)$$

Thus, to prevent collusion and induce full adoption the firm must set $b(1)$ such that:

$$b(1) \geq c + \frac{r \cdot w}{1-r} - r(1 - p_L(1,1)) \cdot V(1,1) \tag{4.1}$$

To compute the cost of this contract, substitute in the steady state pay-off to the punitive lay-off equilibrium, $V(1,1)=w/(1-r(1-p_L))$. Some manipulation then yields:

$$b(1) \geq c + p_L \cdot \frac{r \cdot w}{1-r} \cdot \frac{1}{1-r(1-p_L)} \tag{4.2}$$

Thus the addition of collusion increases the firm's cost. The equation shows that the payment in excess of the cost of adopting is now proportional to $p_L w/(1-r)$ the expected loss in utility from adopting the innovation *this* period. The second term captures the fact that, if the player is not fired this period, she faces the same expected loss next period, and so on. Whereas before workers were only compensated for the direct cost of adoption, c, the addition of collusion means the firm must now compensate workers for all of their loss in expected utility.

While the workers are better off, the firm clearly is not. The question arises, can the firm sustain its commitment to paying bonuses in such a regime? In order for the firm to obtain an equilibrium in which people adopt, the reneging constraint must be satisfied:

$$w\sum_{t=2}^{\infty} \delta^{t-1} L_1 (1-\phi) \geq L_1 \left(c + w \cdot r \cdot \left(\frac{1}{1-r} - \frac{1 - p_L(1,1)}{1-r(1-p_L(1,1))} \right) \right) + (w+c)\sum_{t=2}^{\infty} \delta^{t-1} L_1 (1-\phi)^{t-1} \tag{4.3}$$

Some manipulation reduces this to:

$$\delta w(1 - p_L(1,1))\left(\frac{1}{1-\delta} - \frac{1}{1-\delta(1-p_L(1,1))}\right) - \frac{c}{1-\delta(1-p_L(1,1))} \geq rw\left(\frac{1}{1-r} - \frac{1-p_L(1,1)}{1-r(1-p_L(1,1))}\right)$$

The left-hand side represents the expected net benefit of having an additional player adopt the innovation each period. The right-hand side represents the firm's cost of bribing one player. Thus, there are conditions under which the firm would be willing to honor this contract, for example when δ is very high and r is very low, but, as the discount factors become similar, the condition cannot be satisfied. If $r = \delta$, then the equation reduces to:

$$\frac{-\delta \cdot w \cdot p_L(1,1)}{1-\delta} \geq \frac{c}{1-\delta(1-p_L(1,1))}$$

Clearly such an equation cannot be satisfied for any feasible parameter set. The intuition is fairly straightforward. If the discount rates are equal, then *before* improvement occurs, the firm is indifferent between keeping the worker and firing her since it must pay that worker exactly the present value of what it saves by firing her. *After* the improvement has occurred, however, the firm is strictly better off reneging since it gets one period's improvement for free. Thus improvement cannot be an equilibrium outcome.

The potentially prohibitive cost of implementing TQM when collusion obtains suggests that the firm may resort to other methods to break the collusive agreement and return to the non-collusive regime. Given the simple strategies assumed (do not adopt as long as no one has adopted previously), one obvious strategy for the firm would be to bribe one player to adopt, thus breaking the collusive agreement at the cost of only one adoption. This strategy is only feasible, however, under very special conditions.

If the firm can engage in punitive lay-offs, bribery cannot be an equilibrium outcome since, after having convinced a single player to deviate and thus breaking the collusive agreement, the firm is better off not paying the bribe and firing the worker in question. If the firm cannot engage in

punitive lay-offs, then a player that does not receive a bribe has two possible courses of action.

First, the player can punish the firm by not adopting the innovation in the future but, as long as the

firm and the player have sufficiently similar discount rates (including when they are equal), the

player's own actions are not sufficient to create a bribe that the firm will honor (contact the author

for details). Second, that player could also try to convince the other players that the firm has

reneged on an implicit contract and thus is not trustworthy. If option two is feasible, a single bribe

can be sustained in equilibrium. This happens because the firm, if it fails to pay, loses all future

benefits of improvement since all employees no longer participate in the contract. Such an

arrangement requires the fairly unreasonable assumption that the player who failed to receive the

bribe is able to convince his compatriots, for whom he has just caused a substantial loss in utility,

that the firm is no longer trustworthy and should be punished. Other players are not likely to be

particularly sympathetic to the unpaid defector. [7]

Since the firm may have difficulty breaking the collusive agreement through side contracts, it may

consider other alternatives. One possibility would be to implement a strategy of replacing a

significant fraction of the workforce in each period that the innovation was not fully adopted. If f

represents the replacement fraction, the firm simply needs to set it larger than p_L and players will be

better off adopting, the collusive agreement is broken, and the firm can maintain a stable labor

force ever after. Such a strategy does have implementation difficulties. First, in unionized

environments it is simply not feasible. Second, in professions that require significant skill and

experience, the costs may outweigh the benefits. The fact that the model requires $w>e$ is consistent

with this barrier since it suggests that workers are earning rents due to accumulations of specific

knowledge. Thus this strategy should only be observed in low skill labor markets.

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[7]. To place this line of reasoning within the optimization paradigm, assume that, *ex ante*, players are allowed to *choose* which subset of the firm's action they will observe in determining the firm's reputation. In the case of collusion, the workers are better off if they choose to ignore the payment of bribes, or failure there of, in determining the firm's reputation.

Thus, with the addition of collusion the model can help explain why some firms do not adopt TQM or have a difficult time trying. One obvious institution that facilitates such collusion is unions. With the addition of collusion the results are consistent with the claims of Deming and other proponents of binding commitments to job security: the possibility of lay-offs substantially raises the cost of implementing improvement. The model also offers a different explanation for the role of unions than has appeared in the literature. Grossman (1983) and Weiss (1985) argue that unions maximize the utility of their senior members, perhaps at the expense of more junior ones. In the model presented here union-like arrangements may arise endogenously to better distribute the gains from productivity improvements between the firm and its employees.

5. The Role of Fear

With the addition of collusion, the model offers an explanation for the difficulty that firms experience in trying to implement programs like TQM. It also supports the claims of those who advocate job security as the key to successful improvement. It does not, however, offer a convincing explanation for the experience of organizations like AT&T's Network Systems and Harley-Davidson, both of which had unionized workforces and yet managed to implement successful improvement programs while laying off substantial fractions of their workforces.

An important feature of both cases is that the organization's survival was in jeopardy. A complete model of this phenomenon would include competitors and link the probability that a firm fails to its profitability, capital expenditure, etc. A more stylized approach is taken here. Assume that it is in the best interest of the firm to shut down if it does not achieve some level of adoption. Such an assumption is based on the relationship between adoption and profitability; if the firm cannot achieve a given level of adoption and subsequent profit, it can liquidate the enterprise and invest the money elsewhere. Let the probability that the firm shuts down at the end of period t be represented by p_s and assume that p_s is a decreasing function of the adoption vector a.

Previously, to prevent cooperation the firm chose $b(1)$ to satisfy (4.1). Now, assuming the shutdown strategy is applied at the end of every period, to induce adoption $b(1)$ needs to satisfy:

$$w + b(1) - c + r(1 - p_S(1,1))(1 - p_L(1,1)) \cdot V(1,1) \geq \frac{w}{1 - r(1 - p_S(0,0))} \tag{5.1}$$

With the possibility of shutdown the expected continuation pay-off to the full adoption equilibrium, $V(1,1)$, is:

$$V(1,1) = \frac{w}{1 - r(1 - p_L(1,1))(1 - p_S(1,1))} \tag{5.2}$$

Substituting (5.2) into (5.1) and some manipulation yields:

$$b(1) \geq c + w \left(\frac{1}{1 - r(1 - p_S(0,0))} - \frac{1}{1 - r(1 - p_S(1,1)(1 - p_L(1,1)))} \right)$$

Further algebraic manipulation results in the following equation:

$$b(1) \geq c + r \cdot w \cdot \left(\frac{p_L(1 - p_S(1,1)) - (p_S(0,0) - p_S(1,1))}{(1 - r(1 - p_S(0,0))) \cdot (1 - r(1 - p_S(1,1))(1 - p_L(1,1)))} \right) \tag{5.3}$$

The numerator of (5.3) shows that, in determining her threshold for adoption, a worker now trades off the probability of being laid-off if she adopts, $p_L(1-p_s(1,1))$, against the increased chance of firm failure in the no-adoption equilibrium, $p_s(0,0)-p_s(1,1)$.

Equation (5.3) shows the most important result of this study: the probability of shut-down and the probability of lay-off play opposite roles in determining the firm's cost of implementation. As p_L rises, the cost increases, but as the difference between the shutdown probabilities $(p_s(0,0)-p_s(1,1))$ increases, the firm's cost declines.

Additional intuition can be gained by considering the case, in which $p_s(0,0)=1$ and $p_s(1,1)=0$. Under these assumptions the firm survives for sure if everybody adopts the innovation, and is shut down for sure if nobody does. Under these conditions (5.3) reduces to:

$$b(1) \geq c - r \cdot w \cdot \left(\frac{1 - p_L}{1 - r(1 - p_L)} \right)$$

Here, the threshold value of $b(1)$ that prevents collusion is less than c. With the shutdown strategy in place, workers actually collude to adopt the innovation since the welfare of the workforce is greater if everybody adopts.

Thus fear of shutdown can substantially decrease the firm's cost of implementing the innovation. The cost is reduced because the possibility of the firm's failure increases the pay-off to adopting– the chance of the firm surviving is increased–and reduces the pay-off to participating in collusive agreements. If the firm can credibly communicate that its survival depends upon the innovation being adopted, it can reduce the cost of implementation.

An obvious information problem arises in this setting: managers have a strong incentive to overstate the company's probability of failure since they are then able to implement innovations at a lower cost. Institutions that allow managers to credibly communicate the firm's health thus play an important role in implementing programs like TQM. In particular, if managers develop a reputation for manipulating internal reports, workers are likely to discount this information.

6. Discussion: Drive Fear In or Drive Fear Out?

The key insight arising from the analysis of the model is that there are two types of job security that play opposite roles in determining the firm's cost of implementing productivity improvement. *Internal* job security, represented in the model by p_L, is a function of the firm's willingness to lay off workers to improve profitability and is determined by the relative rates of demand growth and productivity improvement. *External* job security, represented by p_s, is determined by the firm's position in its market. As internal job security declines (meaning the probability of lay-off increases) the firm's cost increases, but as external job security declines (meaning the probability of shutdown increases) the firm's cost decreases. Once the different types of job security are recognized the competing Drive In Fear and Drive Out Fear theories of change can be reconciled

and extended.

Drive Out Fear advocates focus on the role of internal job security. Deming's proscription that the firm should commit to never firing anybody for improving quality and productivity is an exhortation to maximize internal job security. In contrast, Drive In Fear advocates focus on external security. Kotter (1995) and Bailey (1997) both emphasize the importance of *communicating* the current state of the firm's prospects to induce change. Wruck (1994) presents a case in which a firm deliberately put itself at risk of failure to create organizational change.

The analysis reveals key assumptions previously implicit in each theory. In the case of Driving Out Fear, the model shows that for such a strategy to be successful, demand must grow to offset the increase in productivity. A firm can only maximize internal job security when it is growing quickly enough to absorb increases in productivity. Firms growing slowly may never need the excess capacity created by productivity improvements, thus making it impossible to credibly commit to job security. Dial and Murphy (1995), in their study of General Dynamics, make a convincing argument for why firms cannot keep workers that will never be needed.

In the case of Driving In Fear, the analysis shows the importance of a credible signal of potential firm failure. The firm can implement change efforts more cheaply *if* the workforce believes the firm's survival is in jeopardy. Firms need credible ways of communicating this information since they have a strong incentive to "drive in fear". If a firm appears profitable and competitive, management may have a difficult time convincing its workforce that an improvement initiative and consequent downsizing are really needed. For example, at Harley-Davidson, union leadership required management to show them detailed financial statements concerning the company's profitability and cash flow before they would agree to a lay-off and accept TQM (Reid 1990).

The interacting effects of demand growth and credible signals of failure highlight the key differences between this analysis and the paper most similar to this one, Schaefer (1998). He finds

that firms with a higher probability of failure are less prone to employees engaging in non-productive influence activities. On this dimension, the results of the two studies are similar: fear of firm failure causes employees to act in a way that is more consistent with the firm's interests. This occurs in both models because, as the firm's prospects decline, dividing the pie becomes less important than having a pie to divide. Schaefer does not discuss the incentive that management has to overstate the firm's dire straits and, thus, the importance of credible signals of potential failure.

A more important difference between the two analyses arises when the firm's prospects are rosier. In Schaefer's model, influence costs, and thus the deadweight losses to the firm, are increasing in the firm's prospects. In my analysis, when the firm's prospects are good, meaning growth is high, agency problems disappear. This happens, of course, because lay-offs are no longer a possibility. Schaefer's example of General Motors (GM) and Toyota is particularly instructive as to the different explanatory power of the two frameworks. He suggests that in the 1980s GM lost substantial sales to Toyota because it was slow in replacing an outdated product development process, and only began to change when its losses reached dramatic proportions. Such an observation is consistent with both models: fear of failure leads to change.

What is not answered by the influence framework is how Toyota achieved such prowess in the first place. Toyota has been an almost constant innovator in both product development and manufacturing, and by the mid 1980s was itself a successful company. Why was it not subject to the same constraints as GM? It is difficult, at least at present, to imagine a company whose long term viability is more certain than Toyota's. Why then could Toyota continue to change when GM could not? One hypothesis, suggested by the model developed here, is that relative to GM, Toyota was a smaller company in a rapidly growing economy and could thus absorb substantial productivity improvement without raising the possibility of downsizing. In contrast, GM was a large company in the much slower-growing US economy and could only change when the probability of failure increased sufficiently to offset the loss in utility caused by potential lay-offs.

The influence cost framework does not suggest this insight.

The connection between demand growth and successful adoption of TQM is supported by two

empirical studies. Easton and Jarrell (1998) test the hypothesis that gains from TQM derive from

downsizing and find no evidence to support this contention. Instead, they find weak evidence that

firms maintaining steady employment when implementing TQM outperform those that downsize.

Similarly, Barron and Paulson Gjerde (1996) find that firms that successfully adopt TQM

experience higher rates of sales growth. They argue that the growth is a consequence of adopting

TQM, but the causality could run in the opposite direction. My analysis suggests that firms in

rapidly growing markets may be more successful in adopting TQM since they do not suffer from

agency problems.[8]

The connections between this model and Schaefer's suggest a direction for future work on

economic models of organizational change. The influence cost approach has proven to be a

powerful framework for explaining organizational phenomena. Schaefer uses it to understand why

organizational change efforts may fail and Meyer, Milgrom and Roberts (1992) use it to understand

why firms may divest themselves of poorly performing units. In both of these cases the modeling

develops new understanding as to why fear of failure leads to change. Less has been written about

what might cause the continued success of an organization. Why is it, for example, that Toyota

has been able to constantly out-perform its competitors? This analysis arrives at a different

conclusion than those based on the influence cost framework because it captures an additional level

of organizational detail and connects the worker's actions to the firm's profit function at a more

operational level. In contrast to the influence framework, this analysis, in an admittedly simple

fashion, captures both the *costs* and *benefits* of a particular firm level activity, process

improvement. The powerful framework offered by the influence cost approach may be usefully

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[8]. Barron and Paulson Gjerde point out that their analysis cannot resolve the issue of causality.

supplemented with additional operational detail. Here management scientists and economists may find a profitable exchange of ideas.

The analysis also has more specific implications for future work. First, it suggests that future empirical studies need to consider the context in which improvement programs are implemented. The growth rate of demand, macroeconomic conditions, employee turn-over, and the firm's financial health may all contribute to the firm's ability to implement and reap the full benefit of a program like TQM. More data are needed on both the case-specific and aggregate levels. Second, there are a number of directions in which the model might profitably be extended. For example, the analysis ignores competitive dynamics. Many firms adopt such techniques because competitors use them. Firms that cut costs through productivity improvement and lay-offs may force their competitors to do the same or risk ceding valuable market share. The development of industry level models of the adoption of new improvement techniques appears to be an important area for future modeling efforts.

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Appendix A1

First assume that $L_{*_t} < L^*_{t-1}$ for all t, then the conditions under which this is true will be established. If it is true, then the firm will incur downsizing costs each period. Under this assumption the problem can be reformulated and the optimal solution is again a fractile policy of the following form (a similar problem is solved by Heyman and Sobel 1984):

$$Q_t \left(\frac{\alpha_t L^*_t}{(1+\gamma)^t} \right) = \frac{1}{P} \cdot \left(P - \frac{(w + b_t(1-\delta))}{\alpha_t} \right) \tag{A1}$$

In the presence of downsizing costs, the critical fractile is now greater. However, as δ approaches one, the two solutions obviously converge.

This solution is valid as long as:

$$(1+\gamma) \cdot \left(Q_0^{-1} \left(\frac{1}{P} \cdot \left(P - \frac{(w + b(1-\delta))}{\alpha_t} \right) \right) \middle/ Q_0^{-1} \left(\frac{1}{P} \cdot \left(P - \frac{(w + b(1-\delta))}{\alpha_{t-1}} \right) \right) \right) < \frac{\alpha_t}{\alpha_{t-1}} \tag{A2}$$

Here the condition is more complicated because productivity affects the demand for labor in two ways. An increase in productivity decreases the demand for labor directly, via the $1/\alpha_t$ term. But there is also an indirect effect. As productivity increases, the critical fractile grows, thus increasing the demand. In order for labor demand to decline, the direct effect of productivity growth must offset both growth in demand and the indirect impact of productivity growth.