Downsizing and Job Insecurity*

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Abstract

This article offers an explanation of why firms' downsizing patterns may vary substantially in magnitude and timing, taking the form of one-time massive cuts, waves of layoffs, or zero layoff policies. The key element of this theory is that workers' expectations about their job security affect their on-the-job performance. In a situation where firms face adverse shocks, the productivity effect of job insecurity forces firms to balance laying off redundant workers and maintaining survivors' commitment. The cost of ensuring commitment differs between firms with different characteristics and determines whether workers are laid off all at once or in stages. However, if firms have private information about their future profits, they may not lay off any workers in order to signal a bright future, boosting workers' confidence.

JEL Classifications: J21, J23, D21, D82

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1 Introduction

In 2002, companies in the United States announced layoffs of 1.96 million workers, with firms such as American Express, Lucent, Hewlett-Packard, and Dell Computer conducting multiple rounds in the same year.[1] The tragedy of 9/11 had reverberated throughout the economy, leaving businesses scrambling to adjust. Workers had to face the consequences and those consequences were grim - Farber (2003) estimates that for displaced workers the average decline in weekly earnings was 10.6 percent and the re-employment probability for a male college graduate was 88.5% percent.[2] Despite the potentially large impact on welfare, there is no clear picture about how downsizing is conducted. In this paper, we investigate factors that affect both the *amount* and *timing* of downsizing.

We present a simple model of firms' downsizing decisions when they face adverse shocks. Firms must take into account that uncertainty about the possibility of being laid off tomorrow affects workers' performance today. This creates a link between current and future employment decisions of the firm and implies that the firm will not automatically adjust its workforce to coincide with the current shock. Instead, the firm will try to strike a balance between laying off redundant workers and maintaining the survivors' commitment to their work. This framework permits us to clearly identify conditions which lead to waves of downsizing, one-time massive cuts, and zero-layoff policies.

We formalize the notion that the timing of downsizing can vary substantially. It is quite common to hear about massive layoffs and/or waves of downsizing. On average, two-thirds of firms that lay off employees in a given year do so again the following year.[3] Specifically, we call a one time sweeping

[1] See Cascio (2002) for details.

[2] The re-employment probability uses Farber's linear probability model estimates (Table 1, Farber (2003)) for a male college graduate in 2001 whose age is between 35 and 44, has 4-10 years of tenure on the job, and for whom it has been 3 years since he was displaced. The earnings number is for workers in 2001 who suffered a displacement between 1999 and 2001. The consequences may be even more severe: Jacobson, Lalonde, and Sullivan (1993) estimate that high tenure workers who had been displaced suffered a loss of 25 percent of their predisplacement earnngs even five years after having separated from their former firms.

[3] Taken from U.S. Department of Labor. Moreover, although one may think that downsizing is 'lumpy' due to factory and office closings, Davis, Haltiwanger and Schuh (1996, p.17) find that among manufacturing firms, only "23% of job destruction takes place at

cut in the workforce a "big-bang" and waves of cuts "gradualism" and provide an explanation based on job insecurity for why either may be chosen.[4] Baron and Kreps (2000), in their textbook on human resources, discuss the basic costs and benefits of the approaches and state, "by moving boldly and rapidly, companies may minimize the long-term psychological damage" while "a one-time massacre runs the risk of cutting too much". Within the model we are able to be very precise about what factors determine which policy is used. We find that a big-bang benefits the firm by increasing survivors' commitment to their work (through the elimination of job insecurity) while imposing a cost on the firm of excessive layoffs. The big-bang is more likely when (i) workers' outside job prospects are better and (ii) the firm's marginal profitability is lower due to either technology or demand shocks.

More downsizing is not always the solution to controlling job insecurity. In fact, when firms have private information about their profitability, we find that reducing layoffs (even to the point of zero layoffs) diminishes job insecurity by allowing firms to signal that their future is bright. Examples of zero layoff employment practices abound. In the aftermath of the 9/11 disaster, airlines reduced their staff by 20% on average in response to dramatically reduced business. Southwest Airlines, on the other hand, did not lay off or furlough anyone.[5] And despite strong downturns in the financial markets, financial firms Lehman Brothers and Edward Jones insisted on keeping their staff intact.[6]

The model has two periods. Firms face an unexpected negative shock (which is observed simultaneously by a firm and its workers) in period one. In period two, the profitability of a firm can either rebound or face a further negative shock; this information is known to the firm ex-ante but may or may not be known to workers. This second shock may reflect fluctuations specific

plants that shut down".

[4] Dewatripont and Roland (1992a, 1992b, 1995) were the first to study gradualism versus big-bang strategies in the context of reforms in transition economies, focusing on private information and learning.

[5] Cascio (2002), p. 87.

[6] From Fortune (January 22, 2002, www.fortune.com) and BusinessWeek (January 14, 2002, p.57), respectively. In fact, informal zero layoff policies are not infrequent (47 of the 100 companies that made Fortune's 2002 list of the "100 Best Companies to work for" have them, Fortune (January 22, 2002, www.fortune.com)). While firms may use zero layoff policies as ex ante implicit commitments (for example, see Kanemoto and MacLeod, 1989), in this paper we use the term "zero layoff policies" to characterize the situation in which firms retain all workers despite an unexpected negative shock.

to the firm and/or the firm's preparation or sensitivity to downturns. We model perceived job insecurity as a worker's expected probability of being let go in the future. Increased job insecurity can reduce workers' commitment to their work and make them more likely to look for other positions. Incentives for working are provided through the wage - higher job insecurity implies higher wages must be paid, forming the basis for our results.

A fundamental assumption of the paper is that job insecurity demotivates workers. Demotivation as a consequence of downsizing is well known among managers. In Bewley's 1999 survey, 41% of businesses responded that layoffs hurt the morale of survivors for a long time. Greenhalgh (1982) discusses the negative impacts of job insecurity, and proposes that "decisions regarding change must optimize job security to minimize dysfunctional worker response".[7] Moreover, workers are very aware of the uncertainty that faces them. Schmidt (1999), looking at the General Social Survey, finds that workers' beliefs about the probability of job loss track the unemployment rate and aggregate downsizing patterns quite well.

The issues we analyze are related to two strands of the labor market contracting literature. The relational contracting literature (Bull (1987), Baker, Gibbons and Murphy (1994), MacLeod and Malcomson (1989), and Levin (2003)) models a firm's reputation in the labor market as a zero-one variable in an infinitely repeated game, making the framework difficult to adapt for the analysis of how a firm should design its downsizing policy when faced with unexpected shocks. The implicit contract literature (Azariadis (1975), Bailey (1974), and Gordon (1974)) assumes the commitment of a firm to wages contingent on anticipated shocks as well as risk aversion.

Moral hazard forms the basis of our analysis. The main effect that drives our results, that workers must be compensated for job insecurity, also appears in efficiency wage models that extend Shapiro and Stiglitz (1984) to product market fluctuations - namely Rebitzer and Taylor (1991) and Saint-Paul (1996). Lastly, Jeon and Laffont (1999 and 2006) study downsizing in the public sector as a static mechanism design problem where workers have private information about their ability.

In section 2, we define the model. In section 3 we analyze the game under complete information. Section 4 examines the asymmetric information game. In section 5 we conclude.

[7] Greenhalgh (1982), p.156. Brockner (1988) provides a review of the management literature on job insecurity, finding somewhat mixed results.

2 Environment

2.1 Workers

There is a mass 1 of homogeneous workers and two periods. We consider a very simple model of moral hazard. An employed worker has two possible choices of unobservable effort, high ($e = 1$) or low ($e = \alpha$) with $0 < \alpha < 1$. There are two possible outputs, a high one equal to y_h and a low one equal to 0, where the probability of producing the output of y_h is equal to e. We model two different benefits of shirking ($e = \alpha$) that a worker may gain utility from. First, as usual, his disutility of working increases with the level of effort. More precisely, let the disutility of effort associated with e be given by e^2. Second, shirking gives the worker more time to search for other jobs.[8] Specifically, conditional on being laid off at the end of period 1, a worker who exerted effort e in period 1 has probability $(1 - \gamma_E e)a$ (with $\gamma_E \in (0, 1)$) of finding a job in period 2, where a represents labor market tightness in period 2.[9]

To formalize the idea of job insecurity, let p^i be the expected probability of a worker employed by a type i firm (firm types will be defined in section 2.2) in period 1 remaining employed at the same firm in period 2. Given the total number n_1^i of workers employed by a type i firm in period 1, we define p^i=min$\left\{\frac{En_2^i}{n_1^i}, 1\right\}$ where En_2^i is the expectation of workers in period 1 about firm i's employment level in period 2. We assume for now that the firm cannot commit to long-term contracts.[10] Let $\bar{w}_1^i$ and $\underline{w}_1^i$ be firm i's wages[11]

[8] There is a large literature about on-the-job search. A survey can be found in Pissarides (2000).

[9] Hence a is a function that is decreasing in the number of unemployed workers u, is increasing in the number of vacancies v, and is between 0 and 1. We fix a as exogenous. In Jeon and Shapiro (2006), we allow for it to be endogenous and find that multiple equilibria may exist depending on how large the matching frictions are.

[10] In Jeon and Shapiro (2006), we analyze the case of long term contracts. Such contracts increase employment for some parameters (and maintain it for the rest of the parameter space) for the bad firm. Long-term contracts make workers cheaper by allowing firms greater control over job insecurity. Nevertheless, the patterns of massive cuts and layoff waves still remain.

[11] We allow the firm to use two kinds of wages. If it could use only a single wage as in a standard efficiency wage model, it would not be able to induce effort in any finite period model with short-term contracts: all workers would shirk in the last period for any given wage, inducing the firm to choose the minimum wage for that period, which in turn would make all workers shirk for the next to last period, etc. As long as the firm can use two

associated with high and low output respectively in period 1. We assume that workers are protected by limited liability such that the wages must be larger than w_m; for example, w_m could represent a minimum wage, utility from self-employment, or unemployment benefits.

A worker employed by firm i in period 1 thus has the following utility depending on his choice of effort:

$$\begin{aligned} U_1(e) &= e\bar{w}_1^i + (1-e)\underline{w}_1^i - e^2 + \delta[p^i V_2^{E,in} + (1-p^i)(1-\gamma_E e)aV_2^{E,out} + \\ &\quad (1-p^i)(1-(1-\gamma_E e)a)V_2^U] \end{aligned}$$

where V_2^s is the expected value in period 2 of remaining employed within the firm (superscript s="E,in"), working at a different firm (superscript s="E,out"), and being unemployed (superscript s="U") and δ is the discount rate common to firms and workers.

Assuming the firm wants to implement high effort[12], the incentive constraint takes the form of $U_1(1) \geq U_1(\alpha)$, which reduces to:

$$(IC_1^i) \quad \bar{w}_1^i - \underline{w}_1^i \geq 1 + \alpha + \delta(1-p^i)\gamma_E a(V_2^{E,out} - V_2^U)$$

Since all that matters for giving incentives is the difference between the wages, and since wages are costly for the firm, this implies that the firm will set $\underline{w}_1^i$ as low as possible (i.e. $\underline{w}_1^i = w_m$). Hence, we have:

$$\bar{w}_1^i = w_m + 1 + \alpha + \delta \max\left\{1 - \frac{En_2^i}{n_1^i}, 0\right\} \gamma_E a(V_2^{E,out} - V_2^U) \equiv w^i(n_1^i) \quad (1)$$

wages, adding a third instrument of firing a worker for low output does not affect our result qualitatively since the main idea that more job security (higher p_t^i) reduces the amount needed to compensate the worker still holds; hence adding conditional firing complicates the analysis without changing the intuition. As mentioned in the introduction, this effect also can be found in pure shirking stories (without on-the-job search) à la Shapiro and Stiglitz (1984). Rebitzer and Taylor (1991) don't allow for discontinuity in p_t^i (they have no min operator), while Saint Paul (1996) does. Saint Paul, however, assumes that firms can commit today to employment and wage levels tomorrow (tomorrow's shocks are known), which is what provides workers employed today with incentives for effort. This makes his focus substantially different than ours: we allow firms to react immediately to shocks, and allow these shocks to be unexpected. We also look at the tradeoff between downsizing today versus downsizing tomorrow in this context.

[12] A sufficient condition for any firm to want to implement high effort for all of their workers is $f_1(\overline{n}_2^{oG}, \theta_1) > \frac{1+\alpha}{1-\alpha}$, where the notation is defined in sections 2.2 and 3.1. A proof of sufficiency is available from the authors upon request.

It is reasonable to assume that $V_2^{E,out} > V_2^U$. The optimal wage thus takes into account both the possibility of job loss and expected returns to job search. More job insecurity or better outside offers make the worker less attached to her current job. A higher wage must then be paid to maintain worker effort.

Plugging in the optimal wage, the utility conditional on being employed in firm i at time 1 (given p^i) is given by:

$$U_1(1) \equiv w_m + \alpha + \delta \left\{ p^i V_2^{E,in} + (1-p^i) a V_2^{E,out} + (1-p^i)(1-a) V_2^U \right\}$$

In period 2, the contracting environment remains the same, but with the exception that there is no continuation game. Job search and future employment becomes irrelevant and $\bar{w}_2^i = w_m + 1 + \alpha$. Consequently, $V_2^{E,in} = w_m + \alpha$. Since the second period is the last period for all firms, it must be that $V_2^{E,out} = w_m + \alpha$ as well.

Lastly, we assume that if a worker is unemployed for a period, she receives w_m and her probability of finding a job in the next period is $(1-\gamma_U)a$, with $\gamma_U \in (0,1)$. Then the utility of an unemployed person in period 1 is equal to $V_1^U \equiv w_m + \delta[(1-\gamma_U) a V_2^{E,out} + (1 - a(1-\gamma_U)) V_2^U]$. Therefore, the participation constraint is satisfied if the following holds:

$$(PC_1^i) \quad U_1(1) \geq V_1^U$$

The participation constraint strictly holds[13] for any p^i. Hence, employed workers earn rents from moral hazard. In a potentially richer model, the participation constraint may bind; in this case, the job insecurity effect would still be present, but the firm's wages would rise, further reducing employment.[14]

2.2 The Firm

We focus on one firm in an industry. The firm has two possible sources of labor supply, its workers from the previous period (whom we will call original workers) and workers from the general labor market (whom we will

[13] Given that $V_2^{E,in} = V_2^{E,out}$, which we previously argued is true.

[14] These effects would be exacerbated if we included labor market competition. In the current formulation we implicitly assume that upon rejecting an offer, workers become unemployed for the period.

call new workers). We assume that original workers are more productive for the firm than new workers, i.e. there exists firm-specific human capital. Original workers thus produce $y_h^o = 1$ and new workers produce $y_h^n = \phi$ with $0 < \phi < 1$. Define the total output of the workers to be $N_t^i = n_t^{oi} + \phi n_t^{ni}$, where $t = 1, 2$. In our formulation, wages are not connected to y_h; hence the firm strictly prefers re-hiring original workers to replacing them with new workers.[15]

In period one, the industry has an adverse shock and the firm has the profit function gross of the wage payment $f(N_1^i, \theta_1)$, where θ_1 is a parameter which represents the shock that is common to the industry. Therefore the firm will downsize its labor force in period one (we will formalize this in section 3.2). In addition, in period one, the firm discovers how well it is prepared to deal with the unexpected shock. More precisely, the firm is either well prepared and has the profit function $f(N_2^G, \theta_2^G)$ in period 2 or is poorly prepared and has the profit function $f(N_2^B, \theta_2^B)$ in period 2. We call the firm with $\theta_2 = \theta_2^G$ the good type and the firm with $\theta_2 = \theta_2^B$ the bad type. Formally, the index $i \in \{G, B\}$ denotes the firm's type.[16]

We make the following assumptions about the profit function of the firm:

Assumption 1:

$$\begin{aligned} f(N, \theta_2^G) &> f(N, \theta_1) > f(N, \theta_2^B) \\ f_1(N, \theta_2^G) &> f_1(N, \theta_1) > f_1(N, \theta_2^B), \\ f_{11}(N, \theta) &< 0 \text{ for all } \theta \in \left\{\theta_1, \theta_2^G, \theta_2^B\right\}. \end{aligned}$$

This implies that the good (bad) firm has higher (lower) profits and marginal profits, conditional on having the same output, in period two than in period one. Lastly, profits are concave in output. Shocks are defined here as affecting the profit function - hence a shock could be related to either

[15] Making wages conditional on productivity wouldn't change results as long as a firm still strictly prefers original workers to new workers. For example, suppose original workers and new workers had different outside options, w_m^o and w_m^n respectively. Wages paid would then be heterogeneous. A sufficient condition for a firm to prefer original workers (and obtain the results in the paper) is $w_m^o + 1 + \alpha < \frac{w_m^n + 1 + \alpha}{\phi}$.

[16] In Jeon and Shapiro (2006), we extend the model to allow second period shocks to be stochastic (with type redefined as the probability a good shock will occur) and find that our results are robust.

the demand side or the cost side. An example of a function that satisfies Assumption 1 is $\theta f(N)$, where $\theta_2^G > \theta_1 > \theta_2^B$.

2.3 Timing

There are two periods. The timing within a period t ($t = 1, 2$) is given by:

1. A shock θ_t hits the firm and is observed by both the firm and its workers.
2. The firm decides the number of original workers to retain and their wage.
3. Original workers decide whether to accept or reject the firm's offer.
4. The firm decides the number of new workers to hire and their wage.
5. New workers decide whether to accept or reject the firm's offer.
6. Workers exert effort, production occurs, profits are realized, and payments are made.

There are two things to remark about the timing. First of all, the parameter θ_2 is known by the firm in period one. In our complete information analysis, the workers will know in period one what type of shock the firm faces in period 2, while in the asymmetric information analysis the workers will be uncertain about which shock will hit the firm. Secondly, in the first period, by assumption, the firm is downsizing. Consequently there will be no hiring of new workers in period 1.

3 Complete Information

We begin the analysis by working backwards and looking first at period two. The second period analysis will be the same under both complete and asymmetric information, since there is no job insecurity problem.

3.1 The Second Period

Since the second period is the last period and there is no continuation payoff for workers, the wage for both types of firm is equal to $w_2 = w_m + 1 + \alpha$. Firm i's maximization problem in period two is defined as:

$$\max_{n_2^{oi}, n_2^{ni}} f(n_2^{oi} + \phi n_2^{ni}, \theta_2^i) - w_2 n_2^{oi} - w_2 n_2^{ni}$$
$$s.t. \quad n_2^{oi} \leq n_1^i, \;\; n_2^{ni} \geq 0$$

From the first order conditions and using the facts that the marginal product of labor is positive and $\phi < 1$, it is clear that at least one of the constraints binds. The solution depends on how many original workers are left from the previous period. When there are a large number of original workers (n_1^i large), the firm lays off original workers and does not hire any new workers. The optimal number of original workers to retain in this case is given by $\bar{n}_2^{oi}$, where:

$$f_1(\bar{n}_2^{oi}, \theta_2^i) = w_2 \tag{2}$$

Therefore, for any $n_1^i > \bar{n}_2^{oi}$, $n_2^{oi} = \bar{n}_2^{oi}$ and profits are independent of n_1^i.

For $n_1^i < \bar{n}_2^{oi}$, all original workers are kept ($n_2^{oi} = n_1^i$). The firm decides to hire new workers if the number of original workers is very small. We define n_2^{*ni} as the number of new workers hired and $\tilde{N}_2^i$ as the total effective labor output from new and original workers, which both follow from the equation:

$$f_1(\tilde{N}_2^i, \theta_2^i) = \frac{w_2}{\phi} \tag{3}$$

The number of new workers hired is $n_2^{*ni} = \frac{\tilde{N}_2^i - n_1^i}{\phi}$, and new workers are hired only when $n_1^i < \tilde{N}_2^i$.

Lastly, for the range $\tilde{N}_2^i < n_1^i < \bar{n}_2^{oi}$, no new workers are hired and all the original workers are retained. To summarize, we define the profits in period two as:

$$\pi_2^i(n_1^i) = \begin{array}{ll} f(\tilde{N}_2^i, \theta_2^i) - w_2 \frac{\tilde{N}_2^i - (1-\phi) n_1^i}{\phi} & \text{if } n_1^i \leq \tilde{N}_2^i \\ f(n_1^i, \theta_2^i) - w_2 n_1^i & \text{if } \tilde{N}_2^i < n_1^i \leq \bar{n}_2^{oi} \\ f(\bar{n}_2^{oi}, \theta_2^i) - w_2 \bar{n}_2^{oi} & \text{if } n_1^i > \bar{n}_2^{oi} \end{array}$$

3.2 The First Period

Suppose that the firm's type is common knowledge in period one. Workers are concerned about their probability of being retained in period 2. From the previous section, we saw that all original workers are retained when $n_1^i < \bar{n}_2^{oi}$, so p^i=min$\left\{\frac{\bar{n}_2^{oi}}{n_1^i}, 1\right\}$. We assume that both types of firms are downsizing in period one (the condition $\bar{n}_2^{oG} < 1$ is sufficient to guarantee this).

Firm i's maximization problem[17] in period one is defined as:

$$\max_{n_1^i} f(n_1^i, \theta_1) - w^i(n_1^i)n_1^i + \delta\pi_2^i(n_1^i)$$

The first order condition sets marginal profitability $f_1(n_1^i, \theta_1)$ equal to the marginal cost of retaining an additional original worker $MC^i(n_1^i)$:

$$MC^i(n_1^i) = \begin{array}{ll} (w_m + 1 + \alpha)\,(1 - \delta\frac{1-\phi}{\phi}) & \text{if } n_1^i \leq \tilde{N}_2^i \\ (w_m + 1 + \alpha)\,(1 + \delta) - \delta f_1(n_1^i, \theta_2^i) & \text{if } \tilde{N}_2^i < n_1^i \leq \bar{n}_2^{oi} \\ (w_m + 1 + \alpha) + \delta\gamma_E \alpha a & \text{if } n_1^i > \bar{n}_2^{oi} \end{array} \quad (4)$$

The marginal cost factors in the period one wage cost *and* the effect that retaining one more worker has on period two profits. Firstly, if the firm retains a small number of workers in period 1 ($n_1^i \leq \tilde{N}_2^i$), retaining an extra worker decreases its marginal cost because the extra worker will be retained in period 2 and replace a less productive new worker. Secondly, if the firm retains a medium number of workers in period 1 ($\tilde{N}_2^i < n_1^i \leq \bar{n}_2^{oi}$), the extra worker will be retained in period two but won't replace a new worker. Lastly, if the firm retains too many workers in period 1 ($n_1^i > \bar{n}_2^{oi}$), it will have to lay off some in period 2 and must therefore pay more in period 1 to compensate for the job insecurity that is created.

Let n_1^{*i} denote the solution, which is unique. Furthermore, let n_1^* denote the optimal static level of employment. This is the optimal level of employment in t=1 when $\delta = 0$ and is defined by:

$$f_1(n_1^*, \theta_1) = w_m + 1 + \alpha.$$

We are now ready to describe the equilibrium employment levels.

[17] Note that we can simplify $w^i(n_1^i)$ (previously defined in equation 1) notationally, since it is reasonable to assume that all firms in the industry offer the same wage in period 2; hence $V_2^{E,out} - V_2^U = \alpha$.

Proposition 1 *With complete information about θ_2 and assumption 1,*

1. The good type chooses $n_1^{*G} \in (n_1^*, \bar{n}_2^{oG}]$ in period 1. In period 2, it doesn't fire anyone and hires either zero or a positive number of new workers.

2. The bad type either chooses a big-bang strategy $\left(n_1^{*B} = \bar{n}_2^{oB}\right)$ or a gradual downsizing strategy $\left(n_1^{*B} \in \left(\bar{n}_2^{oB}, n_1^*\right)\right)$. In the first case, there is no further downsizing in period 2 while in the second case, downsizing occurs in both periods and $n_1^{*B} - \bar{n}_2^{oB}$ workers are laid off in period two.

The proof is in the appendix.

The actions of the good firm are very intuitive: since demand rebounds in period two, a good type firm retains more original workers than the static optimal level in period one and has no reason to fire any of them in period two. It may in fact hire new workers in period two.

Job insecurity concerns induce the bad firm to retain less than the static optimum[18] ($n_1^{*B} < n_1^*$) and create two types of equilibria (conditional on the parameters), one where $n_1^{*B} = \bar{n}_2^{oB}$ and one where $n_1^{*B} > \bar{n}_2^{oB}$. In the first case, the bad firm, which faces adverse shocks in both period one and period two, lays off workers only once - in period one. In period two the firm makes no further labor force adjustments. We call this strategy "big-bang", since the firm drops the axe on its employees in one blow. When the firm lays off workers in both periods (i.e. when $n_1^{*B} > \bar{n}_2^{oB}$), we say that the firm resorts to a policy of "gradualism", where the firm adjusts its labor supply every time there is an adverse shock.

In Figure 1, we depict the downsizing behavior of both types of firm. The dashed line represents the marginal cost for the good firm of retaining an additional worker in period 1 (summarized in equation 4). The dotted line represents the marginal cost for the bad firm. We have superimposed two examples of first period marginal productivity curves (f_1^* and f_1^{**}). Note that a first period marginal productivity curve is the same for both types of firm since they face the same shock. The firm chooses a retention level where its marginal productivity intersects its marginal cost. Given marginal productivity f_1^*, the good firm chooses a level in period two where it will retain everyone and hire new workers (point G1) and the bad firm chooses a big-bang solution where it lays off everyone at once in period one and retains all remaining workers in period two (point B1). Given marginal productivity

[18] In other words, job insecurity makes the bad firm over-adjust its labor force. Meyer, Milgrom and Roberts (1992) find that firms can over-adjust their labor force when a bad shock occurs due to agents engaging in influence activities.

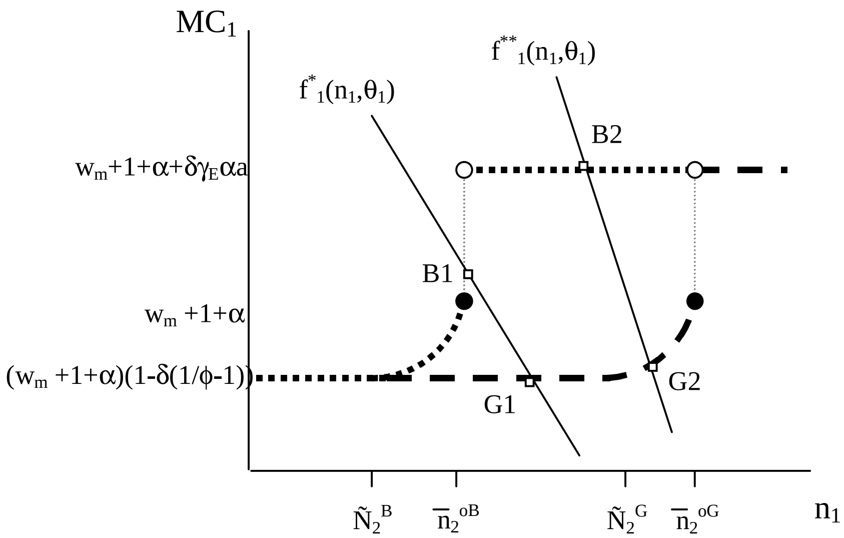

Figure 1: First Period Employment Choice

f_1^{**}, the good firm chooses a level such that in period two it will retain everyone and not hire new workers (point G2) and the bad firm chooses a gradualism solution where it lays off workers in stages (point B2).

It is important to point out that in either a big-bang or gradualism, the number of workers retained by a bad type at the end of period two is the same ($\bar{n}_2^{oB}$). If job insecurity didn't affect the survivors' effort levels, a bad type would keep n_1^* number of workers in period one and lay off $n_1^* - \bar{n}_2^{oB}$ of them in period two. However, job insecurity reduces survivors' commitment to their job, forcing the firm to pay higher wages to induce high effort. Therefore, when choosing n_1^{*B}, a bad type faces a trade-off between increasing the number of workers retained in period one and reducing their job insecurity. This trade-off can make it optimal to completely remove job insecurity of the survivors by choosing a big-bang strategy ($n_1^{*B} = \bar{n}_2^{oB}$).[19]

We can now analyze what determines whether a firm engages in a big-bang

[19] This trade-off disappears when retention levels are chosen by a social planner. Big-bang is never socially optimal because the social planner internalizes workers' utilities and any wage increase due to job insecurity has no impact on her objective function. A more thorough welfare analysis is available in Jeon and Shapiro (2006).

or gradual downsizing strategy. In general, given a level of job insecurity, the larger the expected returns to job search, the higher a premium the workers command, making the big-bang more likely. The expected returns to job search depend on employment opportunities, job search effectiveness, and labor market tightness. In addition, lower marginal productivity for the firm can make it more likely to make sweeping cuts. This may be due to its fundamental production process, or the shocks which hit the firm. A larger negative shock in period one reduces the marginal productivity of all workers, making a high wage more costly and big-bang more likely. A smaller negative shock in period two increases $\bar{n}_2^{oB}$ and implies that the number of people to be downsized is smaller in both periods. With more workers retained, the marginal productivity of the last worker in period one is lower, making it too costly to pay a high wage and big-bang more likely. We summarize these determinants in the following corollary:

Corollary 1 *Big-bang is more likely if*

1. Workers' outside job prospects are better, i.e. if

(i) On-the-job search is effective (γ_E high)

(ii) The labor market is very tight (a high)

(iii) The value of finding employment in the following period is large ($V_2^{E,out} - V_2^U$ high)

2. The firm's marginal productivity is low

(i) In absolute terms: due to technology or product market competition

(ii) Relative to wages: when the first period shock is worse or the second period shock is not as bad

It is natural to wonder about how gradualism takes place - does the majority of downsizing take place in period one or period two? That answer is also given to us by the corollary. Conditional on being in a regime of gradualism, the factors which made the big-bang more likely also make the amount of downsizing larger in period one relative to period two.

Although an empirical analysis is outside the scope of this paper, it is worth examining which directions the corollary points us towards. Waves of layoffs create job insecurity for survivors, increasing the firm's marginal cost of retaining a worker in period one. Greenhalgh, Lawrence, and Sutton (1988) find similar results when reviewing the management literature: "The negative effects of waves of layoffs have been reported in case studies of the Atari Corporation (Sutton, Eisenhardt, and Jucker (1986)), Amax (Reibstein

(1985)), and American Telephone and Telegraph (Guyon (1986)), and they have been noted in the decline of the hospital industry (White (1985)). To avoid this stress, managers make cuts that exceed the expected oversupply".[20]

Wages may be different between firms in period 1 if the bad firm has a policy of gradualism. The bad firm must pay higher wages to compensate for job insecurity.[21] In some sense, this is a compensating differential, although the worker is not directly choosing between jobs at a good and a bad firm. Examples of a wage premium for job insecurity are plentiful:

- At United Airlines, most of the "75,000 employees... had bought a majority stake in the airline, taking huge pay cuts in return for a commitment that none of United's employee-owners would be laid off for five years". Moreover, "the list of pilots seeking jobs at United has swelled to more than 10,000, even though the airline now pays less than some of its biggest rivals".[22]

- Moretti (2000) examines the compensating differential in the agricultural sector for temporary work over permanent work and find that it is between 9.36 and 11.9 percent of the average worker's hourly wage.[23]

- Dial and Murphy (1995), in their study of General Dynamics, observe that the wage premium for working in "the competitive defense industry" reflected specialized skills and a "compensating differential for risky employment in an industry with historically variable demand".[24]

The productivity results in the corollary suggest that industries may differ substantially in their layoff policies. High productivity or profitability industries should be more stable. Davis and Haltiwanger (1999) state that for manufacturing "the relative volatility of destruction [to job creation] falls with trend growth and rises with firm size, plant age and the inventory-sales ratio" while Farber (1997) notes that professional services have low

[20] Greenhalgh, Lawrence, and Sutton (1988), p.246.

[21] In a case study involving 4 different downsizing/ restructuring events at a financial services firm, Oyer (2002) finds mixed evidence about how wages change leading up to a layoff.

[22] Sanger and Lohr (1996), p.195 and p.202.

[23] He also provides a literature review of compensating differentials related to unemployment risk. The results are mixed, but most previous estimations suffered from sample selection problems and unobserved individual heterogeneity.

[24] Dial and Murphy (1995), p.303.

and consistent rates of job loss. On the negative side, Bewley (1999, section 13.3) provides evidence that managers don't consider labor market conditions when making layoff decisions, although they are aware of on-the-job search for other jobs.

4 Asymmetric information

A key result of the complete information solution is that massive one-time layoffs can reduce job insecurity. Nevertheless, there are cases when firms will not conduct layoffs in response to large negative shocks.[25] Our explanation for such zero layoff policies lies in signaling; a good firm may use retentions (and possibly wages) to reassure workers that the future is promising, and thereby reduce job insecurity costs. "People appreciate hearing [about a no-layoff policy]" says a vice president in a large public relations firm, "Everyone knew what was going on in the economy and knew that our business had been affected."[26]

We now assume that the firm has private information about the period two shock. Workers at the firm have an ex-ante belief that with probability ν, $\theta_2 = \theta_2^G$ and with probability $1-\nu$, $\theta_2 = \theta_2^B$. The private information may reflect a firm's superior knowledge of how well prepared it is for demand shocks or of overall market conditions and trends.

The good firm has no incentives to masquerade as the bad firm since it could easily have done so in complete information, but found it optimal not to do so. The bad type, on the other hand, was restricted in its choices because it had to offer higher wages to compensate workers for a higher probability of being laid off in the second period.[27] The minimum wage that the bad firm could offer was $w^B(n_1) = w_m + 1 + \alpha + \delta \max\{(1 - \frac{\bar{n}_2^{oB}}{n_1}), 0\}\gamma_E \alpha a$.

[25] In the wake of September 11th, many businesses explicitly reassured workers that no layoffs would occur. Those include firms outside of the airplane and financial sectors discussed in the introduction - in such diverse sectors as steel, law, and public relations (see "Some companies choose no-layoff policy", by Stephanie Armour, *USA Today*, December 17, 2001).

[26] from "Some companies choose no-layoff policy", by Stephanie Armour, *USA Today*, December 17, 2001

[27] A necessary condition for the existence of an adverse selection problem is $f(n_1^{*G}, \theta_1) - (w_m + 1 + \alpha)n_1^{*G} > f(n_1^{*B}, \theta_1) - w^B(n_1^{*B})n_1^{*B}$. For this section, we assume that this condition holds.

We study the fully separating equilibrium[28]. The equilibrium concept employed is Perfect Bayesian Equilibrium and we refine the set of equilibria using the Cho-Kreps (1987) intuitive criterion. The model presents a two-dimensional signaling problem: the firm may use both the period 1 employment level and wages of original workers to signal. This problem is similar to that of Milgrom and Roberts (1986).[29]

In the separating equilibrium, the good firm chooses in period 1 an employment level n_S and a wage w_S for workers such that the bad firm does not have any incentives to masquerade as the good firm. Specifically, we define the belief structure of workers, $\mu(n_1, w_1)$, as the probability that the firm is good given its first period employment and wage decisions. This then implies that in the separating equilibrium $\mu(n_S, w_S) = 1$. Moreover, if the separating equilibrium exists, the bad firm is recognized as bad. It will then choose its employment and wage optimally, opting for the solution to the complete information case $(n_1^{*B}, w^B(n_1^{*B}))$, meaning that $\mu(n_1^{*B}, w^B(n_1^{*B})) = 0$.

Two incentive constraints define the set of separating equilibria (n_S, w_S). First, the bad firm must prefer being recognized and choosing $(n_1^{*B}, w^B(n_1^{*B}))$ to masquerading by selecting (n_S, w_S). Second, the good firm must prefer separating with (n_S, w_S) to being perceived as the bad firm. When the good firm is perceived to be the bad firm, the wage level necessary to prevent quits is the same as the one the bad firm must use: $w^B(n_1)$. Since beliefs are not pinned down off the equilibrium path, we assume that the beliefs of workers are such that any feasible choice of the bad firm (i.e. an n_1 and $w_1 \geq w^B(n_1)$) is believed to have come from the bad firm[30], or $\mu(n_1, w_1) = 0$. We denote $(n_{GB}, w^B(n_{GB}))$ as the optimal choice of the good type when workers believe that it is the bad type.

We will establish the result using a graphical argument, depicted in Figure 2. For now, we assume that the optimal complete information choice for the bad firm was that of gradualism, where the solution was n_1^{*B} and $w^B(n_1^{*B})$ (point B). The results for a big-bang solution are qualitatively the same.

We begin the analysis by defining isoprofit curves in (n_1, w_1) space. The

[28] We ignore semi-separating equilibria, where a firm may have mixed strategies. Pooling equilibria may exist, and are fully analyzed in Jeon and Shapiro (2006). We comment on the qualitative aspects of pooling equilibria at the end of this section.

[29] Milgrom and Roberts also have two dimensions of signaling, prices and advertising. Another paper along these lines is Bagwell and Ramey (1988).

[30] Cho-Kreps is not of any use here, since both firms' equilibrium choices will dominate the payoffs of choices where $w > w^B(n_1)$.

curve ISO_B represents all of the employment-wage pairs for the bad firm which yield the same profits as its complete information choice. The curve ISO_G depicts the employment-wage pairs for the good firm which yield the same profits as its choice when it is believed to be the bad firm, $(n_{GB}, w^B(n_{GB}))$, denoted by point C. By definition, these curves are the minimum level of profits that the firms can achieve in a separating equilibrium (n_S, w_S). The curves are both tangent to the $w^B(n_1)$ curve at points $(n_1^{*B}, w^B(n_1^{*B}))$ and $(n_{GB}, w^B(n_{GB}))$. From the isoprofit curve of the bad firm, we see that, 1) Gradualism is preferred to big-bang (point B is preferred to point A) and 2) the bad firm prefers the good firm's complete information choice to its own (point D is preferred to point B).

The isoprofit curves intersect only once since they satisfy a weak single crossing property: $(\frac{dw_1}{dn_1}\mid_{\theta_2=\theta^G} - \frac{dw_1}{dn_1}\mid_{\theta_2=\theta^B}) \geq 0$. This implies that the slope of the isoprofit curve for the good firm is always greater than or equal to the slope of the curve for the bad firm. This is straightforward to show, and follows from the fact that keeping an extra worker in the first period is (weakly) more profitable for the good firm. The inequality is strict everywhere except when $n_1 < \tilde{N}_2^B$ and $n_1 \geq \bar{n}_2^{oG}$.[31]

The area below the isoprofit curve for the good firm and above the isoprofit curve for the bad firm satisfies both incentive constraints. All choices in this area are thus equilibrium dominated for the bad firm, hence Cho-Kreps assigns $\mu(n_1, w_1) = 1$ to these choices. The signaling problem then amounts to the good firm maximizing its profits subject to the condition that the bad firm must receive as much profits as in complete information.[32]

The solution (n_S, w_S) is characterized by:

Proposition 2 *With asymmetric information and assumption 1, a separating equilibrium will take one of two possible forms:*

1. The good firm chooses $n_S \in (n_1^{*G}, \bar{n}_2^{oG}]$ and $w_S = w_m + 1 + \alpha$ in period 1 and retains all workers (possibly hiring new ones) and pays the same wage in period 2.

[31] The former inequality will never be relevant, since profits for the bad firm in this region are smaller than those in complete information. In the case of the latter inequality, both types of firms lay off workers in period two and their second period profits do not change with n_1, implying that the slope of their isoprofit lines is the same.

[32] We did not discuss beliefs for the area below the curve $w^B(n_1)$ and above the upper envelope of the two isoprofit curves because for any beliefs these choices would yield lower profits for the firms.

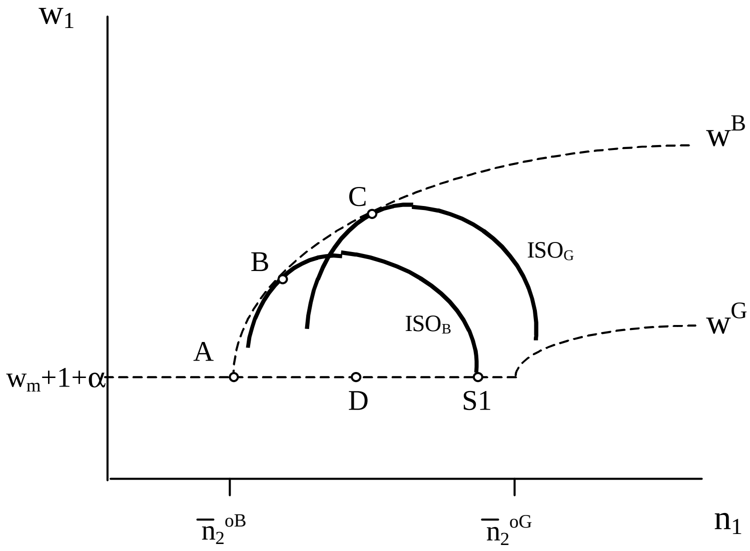

Figure 2: The Separating Equilibrium

2. The good firm chooses $n_S > \bar{n}_2^{oG}$ and $w_S > w_m + 1 + \alpha$ in period 1 and chooses $\bar{n}_2^{oG}$ and $w_m + 1 + \alpha$ in period 2.

In both solutions, the bad firm chooses its complete information levels as characterized in Proposition 1.

The first result of the proposition is depicted in figure 2. Here, the asymmetric information problem is 'small' in the sense that point D (the good type's complete information solution) would increase the bad firm's profits only a small amount. In this case, the good firm uses only increased employment levels to signal, holding the wage fixed at $w_m + 1 + \alpha$. Since the good firm's isoprofit curve always has greater slope than the bad firm's, the tangency can only occur at the kinked part (point S1). In the second result of the proposition, the asymmetric information problem is 'large'; the bad firm has large incentives to masquerade as the good one. In this case, there are a range of tangencies, since both firms' isoprofit lines have the same slope in the area where $n_1 \geq \bar{n}_2^{oG}$. All of these solutions involve the good firm increasing its level of employment above n_1^{*G} and its wage strictly above $w_m + 1 + \alpha$.

Under asymmetric information, a good type can reduce the job insecurity of survivors only by retaining more workers than necessary in period one.[33] The reduction in downsizing may be so large as to imply zero layoffs in period one for the good firm despite the optimality of positive layoffs in complete information. The effectiveness of signaling comes from the fact that it is less costly for the good firm to reduce its downsizing in period 1 in the interval $\bar{n}_2^{oB} < n_1 < \bar{n}_2^{oG}$. A wage increase will be a part of the signal when employment increases so much that the good firm creates some job insecurity.

5 Conclusion

Managing job insecurity ranks as one of the central human resource tasks of a firm when faced with a shaky economic climate. The balance between laying off redundant workers and maintaining some level of job security forms the basis for a broad set of layoff patterns. These patterns, which differ in their amount of layoffs and timing, can have substantial effects on the welfare of workers and the economy in general.

This paper has offered as simple a model as possible to characterize the layoff practices of firms. We found that downsizing patterns (one time massive cuts versus waves of downsizing) can be distinguished and we isolated the contributions of firm productivity and labor market conditions to the firm's decision. Moreover, we were able to explain zero-layoff policies as firms signaling that their future prospects are bright.

Our paper represents a call for further empirical research into the specific causes of downsizing. As Butcher and Hallock (2004) state, "there is little academic work in economics that investigates how, when, and why firms make layoff decisions". Underlying trends have become much clearer in the past 10 years thanks to Davis, Haltiwanger and Schuh (1996), Davis and Haltiwanger (1999), Farber (2003), and Baumol, Blinder, and Wolff (2003), while managerial intentions have been captured in Hallock (2003) and Bewley (1999). Although difficult because of data concerns, our analysis suggests that firm level analysis across sectors could yield rich insights.

[33] When pooling equilibria exist, both firms raise their employment levels above their complete information levels and pay a wage above $w_m + 1 + \alpha$ in the first period. Both firms then downsize in the second period.

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6 Appendix

We offer a proof of Proposition 1 in two parts. First we consider the good firm:

Lemma 1 *Under assumption 1, a type G firm*

1. Never fires workers in period two ($n_1^{*G} \leq \bar{n}_2^{oG}$)*;*

2. Retains in period one strictly more original workers than the static optimal level: $n_1^{*G} > n_1^*$*;*

3. Hires new workers in period two if and only if $\widehat{N}_1^G < \tilde{N}_2^G$, where $\widehat{N}_1^G$ is defined by

$$f_1(\widehat{N}_1^G, \theta_1) \equiv (w_m + 1 + \alpha)\,(1 - \delta\frac{1-\phi}{\phi}).$$

Proof. 1. Suppose that a good firm lays off some original workers at period two, in which case $n_1^G > \bar{n}_2^{oG}$. This implies from assumption 1 that $f_1(n_1^G, \theta_1) < f_1(\bar{n}_2^{oG}, \theta_1) < f_1(\bar{n}_2^{oG}, \theta_2^G)$. On the other hand, from the first order condition with respect to n_1^G, we have $f_1(n_1^G, \theta_1) = (w_m+1+\alpha)+\delta\gamma_E\alpha a$ and, from the definition of $\bar{n}_2^{oG}$, we have $f_1(\bar{n}_2^{oG}, \theta_2^G) = w_m + 1 + \alpha$. Hence, we have $f_1(n_1^G, \theta_1) > f_1(\bar{n}_2^{oG}, \theta_2^G)$, which is a contradiction.

2. From part 1, we know $n_1^{*G} \leq \bar{n}_2^{oG}$. Consider first the case $n_1^{*G} < \bar{n}_2^{oG}$ and suppose $n_1^{*G} \leq n_1^*$. On the one hand, $n_1^{*G} \leq n_1^*$ implies $f_1(n_1^{*G}, \theta_1) \geq f_1(n_1^*, \theta_1)$. On the other hand, from the first order condition with respect to n_1^{*G}, we know $f_1(n_1^{*G}, \theta_1) < w_m + 1 + \alpha = f_1(n_1^*, \theta_1)$ for $n_1^{*G} < \bar{n}_2^{oG}$. Hence, there is a contradiction. Consider now the case $n_1^{*G} = \bar{n}_2^{oG}$. Since $f_1(n_1^*, \theta_1) = w_m + 1 + \alpha = f_1(\bar{n}_2^{oG}, \theta_2^G)$ holds, from assumption 1 we must have $n_1^* < \bar{n}_2^{oG}$.

3. If $\widehat{N}_1^G < \tilde{N}_2^G$ holds, it is optimal for the firm to keep $\widehat{N}_1^G$ number of original workers in period one. Hence, in period two, it is optimal to hire $(\tilde{N}_2^G - \widehat{N}_1^G)/\phi$ of new workers in period two. If $\widehat{N}_1^G \geq \tilde{N}_2^G$ holds, it is optimal for the firm to have $n_1^{*G} \geq \tilde{N}_2^G$. Hence, there is no hiring in period two. ■

Second, we consider the bad firm.

Lemma 2 *Under assumption 1, a type B firm*

1. Never chooses $n_1^{*B} < \bar{n}_2^{oB}$, which implies that it never hires in period two;

2. Retains strictly less original workers than the static optimal level in period one: $n_1^{*B} < n_1^*$;

Proof. 1. Suppose that a type B firm chose $n_1^{*B} < \bar{n}_2^{oB}$. This implies that $f_1(n_1^{*B}, \theta_1) < w_m + 1 + \alpha = f_1(\bar{n}_2^{oB}, \theta_2^B)$. However, by assumption 1, $f_1(\bar{n}_2^{oB}, \theta_2^B) < f_1(\bar{n}_2^{oB}, \theta_1)$ and by concavity, $n_1^{*B} < \bar{n}_2^{oB}$ also implies that $f_1(\bar{n}_2^{oB}, \theta_1) < f_1(n_1^{*B}, \theta_1)$, which gives us a clear contradiction.

2. From part 1, we know $n_1^{*B} \geq \bar{n}_2^{oB}$. Consider first the case $n_1^{*B} > \bar{n}_2^{oB}$ and suppose $n_1^{*B} \geq n_1^*$. One the one hand, $n_1^{*B} \geq n_1^*$ implies $f_1(n_1^{*B}, \theta_1) \leq f_1(n_1^*, \theta_1)$. On the other hand, from the first order condition with respect to n_1^{*B}, we know $f_1(n_1^{*B}, \theta_1) = (w_m + 1 + \alpha) + \delta\gamma_E\alpha a$ for $n_1^{*B} > \bar{n}_2^{oB}$, which is

strictly larger than $f_1(n_1^*, \theta_1) = w_m + 1 + \alpha$. Hence, there is a contradiction. Consider now the case $n_1^{*B} = \bar{n}_2^{oB}$. Since $f_1(n_1^*, \theta_1) = w_m+1+\alpha = f_1(\bar{n}_2^{oB}, \theta_2^B)$ holds, from assumption 1, we must have $n_1^* > \bar{n}_2^{oG}$. ■