Labor Market Frictions, Job Insecurity, and the Flexibility of the Employment Relationship[*]

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Abstract

We analyze a search model of the labor market in which firms and workers meet bilaterally and negotiate over wages in the presence of private information. We show that a fall in labor market frictions induces more aggressive wage bargaining behavior which in turn leads to a costly increase in job insecurity. This adverse insecurity effect can be so large that firms and workers who are in an employment relationship can be made worse off by a fall in labor market frictions. In contrast, firms and workers who are not in an employment relationship and are searching the market for a counterpart are always made better off by such a fall in labor market frictions. We then endogenize the organizational structure of the employment relationship and show that a fall in labor market frictions induces a one off reorganization in which firms and workers switch from a rigid employment relationship to a flexible one. This reorganization leads to a large, one off increase in job insecurity and unemployment.

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1 Introduction

During the last decade a growing number of commentators in the public media have argued that recent economic and technological developments, such as increased international competition, labor market deregulation, and the rise of the internet, have increased job insecurity in developed countries and have thereby made some groups in society worse off. There is a widely held view that this increase in insecurity has been caused both by an increase in the probability of job separation for given employment arrangements and also by a shift towards more flexible, and intrinsically more instable, employment arrangements.[1] In this paper we present a model of the labor market that is consistent with these developments.

A number of recent studies have shown that, at least in some countries and for some groups of workers, job insecurity was higher in the 1990s than the 1980s. For France, for intance, Givord and Maurin (2003) find evidence that job security was "structurally lower in the 1990s than the 1980s." Similarly, Bergemann and Mertens (2001) find a significant increase in job instability in the late 1980s and early 1990s in Germany. The evidence for the US appears to be more mixed than that for some Western European countries. Nevertheless, there are a number of papers that provide evidence for an increase in job insecurity for some groups of American workers in the 1990s. For instance, Neumark (2001) summarizes the evidence emerging from a collection of papers that investigate the US case as follows:

"Overall, my reading of the evidence [on job insecurity and instability in the US] is that the 1990s have witnessed some changes in the employment relationship consistent with weakened bonds between workers and firms. Although the magnitudes of these changes sometimes suggest sharp breaks with the recent past, they nonetheless indicate that these bonds have been only weakened, not broken. Furthermore, the changes that occurred in the 1990s have not persisted long enough even to earn the label "trends." This makes it at least as plausible, based on what we know at this point, to conclude

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[1]For instance, in an article entitled "The End of Jobs for Life?", The Economist (1998) writes: "The alleged decline in job tenure is usually blamed on three factors: globalisation, technological change and labour-market deregulation. Fiercer foreign competition and the faster spread of new technology are forcing firms to become more flexible. In countries where laws do not make it difficult to do so, the critics moan, companies adapt by firing staff more often and relying more on temporary or casual workers." For a more recent article along these lines see "The Sink-or-Swim Economy", The New York Times, June 8, 2003. See also the many references in McLaren and Newman (2002).

that these changes are the unique product of changes in the corporate world in the 1990s rather than longer-term developments that will necessarily persist or accelerate in the near future."

Finally, there are also a number of papers that employ survey data and show that large groups of workers perceive their current jobs to be more insecure than they were in the past (Schmidt (1999), Scheve and Slaughter (2002)).

There is also some evidence that the way in which employment relationships are structured has indeed become more flexible. A number of authors have, for instance, documented the remarkable growth of the temporary help services industry in the US (Segal and Sullivan (1997), Autor, Levy, and Murnane (1999)). Since 1972 the employment in this industry has grown at an annual rate of 11%, increasing its share of total employment in the US from 0.3% in 1972 to 1.8% in 1995. Between 1992 and 1995 employment growth in this industry accounted for approximately 10% of US employment growth. It has also been documented that in 1995 about 12 million workers in the US, approximately 10% of the US labor force, were in 'alternative employment relationships,' that is they worked as independent contractors, temporary help agency workers, contract company workers, or on-call workers, without an expectation of ongoing employment (Cohany (1996)).[2] The shift towards more flexible employment relationships that these numbers suggest is not unique to the US. For France, Thesmar and Thoenig (2002) report an increase in the share of total employment constituted by workers hired under fixed term contracts from 2% in 1982 to 6% in 1999. Among workers with less than 6 months seniority the share increased from 17% in 1982 to 28% in 1999. Another piece of evidence that points towards more flexible employment relationships is the major shift in pension coverage in the US over the last 20 years. Friedberg and Webb (2003) report that the share of full-time employees with defined contribution pension plans increased from 40% in 1983 to 79% in 1998 while the share of full-time employees with defined benefits pension plans fell from 87% to 44%. A key difference between defined benefit and defined contribution pension plans is that the former make it costly for workers to change employer by making the benefits increase disproportionately with tenure whereas the latter do not. Thus, a move towards defined contribution plans suggests a trend towards more flexible employment

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[2]Of the 12 million workers in alternative employment arrangements, 8.3 million worked as independent contractors, 2 million as on call workers, 1.2 million as temporary help agency workers, and 650,000 as contract company employees (Cohany, 1996).

relationships. While regulatory changes may play an important role in explaining the shift in pension coverage, they are unlikely to be the only factor that contributed to this development (Friedberg and Owyang (2002)).

While there is some evidence that job insecurity has increased for some groups of workers and that firms have adopted more flexible employment relationships, the underlying reasons for these changes are much less clear. In particular, there are very few theoretical papers that identify the mechanisms through which these changes may have occurred. The aim of this paper is to suggest one such mechanism. We start from the premise that recent economic and technological changes have reduced labor market frictions and thus made it easier for firms and workers to search for, and contract with, alternative trading partners. We show that such a seemingly beneficial change in the economic environment can easily lead to more job insecurity and potentially reduce the well being of those firms and workers who are currently in an employment relationship. We then consider a possible organizational response by firms and workers to the endogenous increase in job insecurity. We show that as market frictions are reduced firms and workers have an incentive to switch from 'rigid' employment relationships, in which it is very costly for them to change their current counterpart, to 'flexible' ones, in which it is less costly for them to do so. This one off change in the structure of the employment relationship leads to a large, one off increase in job insecurity and unemployment.

More specifically, we consider a standard search model of the labor market in which individual firms and workers meet randomly, negotiate a wage, and, in case of agreement, start their productive relationship (see, for instance, Pissarides (2000)). In contrast to the existing literature on search models of the labor market we assume that wage bargaining between the firm and the worker is hindered by the presence of private information. This may be the case, for instance, because the firm knows more about its profits than the worker or the worker knows more about her opportunity costs than the firm. We make this assumption, which is central to our analysis, both because we think that it is realistic and because it is well known in the labor literature that bargaining inefficiencies can be an important cause of inefficient job separations (see Hall and Lazear (1984) and Hall (1995)).[3] In particular, it is well known that

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[3]While we follow Hall and Lazear (1984) in assuming that wage bargaining takes place in the presence of private information, our analysis differs from theirs in that we develop a general equilibrium model of the labor market and analyze the effects of a reduction in search frictions on the wage

when wage bargaining takes place in the presence of private information, the firm and the worker bargain too aggressively and, as a result, often do not agree on a wage although it would be efficient for them to do so (see Hall and Lazear (1984) and Myerson and Satterthwaite (1983)). In a search model in which wage bargaining takes place in the presence of private information a fall in labor market frictions has a direct benefit for a worker and a firm who are negotiating a wage since it reduces the time necessary for them to find alternative trading partners in case they were to disagree and separate (which happens with positive probability in equilibrium). However, precisely because the cost of separation is reduced, the firm and the worker bargain even more aggressively, which in turn increases the likelihood of separation. Thus, once one allows for inefficient wage bargaining, reductions in search frictions can lead to an increase in job insecurity which is 'costly,' in the sense that it has a negative effect on the expected joint surplus of a firm and a worker who are currently in a relationship.[4] We show that this negative insecurity effect can dominate the direct benefit of a fall in search frictions and thus make the firm and its worker jointly worse off.

Having established a straightforward channel through which a fall in labor market frictions can lead to a costly increase in job insecurity we then extend our analysis to investigate the organizational response to such a change in the economic environment. To do so we allow a firm and a worker to contract over the 'flexibility' of their employment relationship before any private information is revealed. The degree of flexibility simply determines the extra costs that the firm and the worker incur in case they separate in the future. In other words, we assume that a firm and a worker can complement the exogenously given rigidities that they face in an imperfect labor market with their own, 'self-imposed rigidities' that make it more costly for them to separate in the future. We show that it is optimal for firms and workers to adopt a rigid employment relationship if labor market frictions are above a certain threshold and to adopt a flexible employment relationship if labor market frictions are below that threshold. Essentially, when labor markets work badly it is important for firms

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bargaining process and on the structure of the employment relationship.

[4]In a standard search model with heterogeneous workers and in which wage bargaining takes place under perfect information (see, for instance, Pissarides (2000)) a reduction in search frictions also leads to more separations. Note, however, that these separations are always privately efficient so that the firm and the worker are made jointly better off by a fall in search frictions.

and workers to ensure that their relationship does not break down easily and one way to do this is to make separations costly. When labor markets work well, however, separations are very likely to occur anyway and it then becomes important to reduce the costs of these separations. Thus, as labor market frictions fall there is a one off reorganization in which firms and workers switch from a rigid to a flexible employment relationship which, in turn, leads to a large, one off increase in job insecurity and in the unemployment rate.

Our paper is related to recent contributions by McLaren and Newman (2002), Ramey and Watson (2001), and Thesmar and Thoenig (2002). In McLaren and Newman (2002) a fall in market frictions reduces the extent to which firms and workers are willing to insure each other against idiosyncratic income shocks and thus increases the degree of wage volatility. Ramey and Watson (2001) present a model in which a fall in search frictions can lead to welfare losses. In their model firms have to give workers incentives to exert high effort, and they can do so by investing in technologies that increase the relative gains from exerting high effort over exerting low effort. Since, all else equal, a fall in search frictions makes it less costly for workers to shirk, firms have to compensate by increasing their initial investment, and this over-investment is the source of welfare losses. Thesmar and Thoenig (2002) present a model in which an increase in the use of outsourcing by industrial firms leads to an increase in the volatility of labor demand.

The rest of the paper is organized as follows. The next section presents the structure of the model. In Section 3 we solve a benchmark version of the model in which there is no private information at the wage bargaining stage. In Section 4 we solve the model with private information and discuss the implications of an exogenous fall in market frictions. In Section 5 we extend our basic model by endogenizing the organizational structure of the employment relationship. Finally, in Section 6 we check the robustness of our results to our assumptions on the bargaining game. We do so by allowing for two-sided asymmetric information and 'efficient' bargaining games.

2   The Model

We consider a dynamic market in which time is continuous and runs indefinitely. All agents are risk-neutral, liquidity unconstrained, and discount the future at rate r.

There are two types of agents: 'workers' and 'firms.' At every point in time an exogenous mass n of new workers is born. Every worker enters the labor market as unemployed and searches for a job. As long as the worker remains unemployed he receives utility flow b per unit time. If instead the worker becomes employed he receives a wage w and experiences a disutility from effort equal to γ per unit time. As will be made clear below, this disutility γ varies across different worker-firm matches and is furthermore privately observed only by the worker at the moment of contracting over the wage. The consequences of the informational problems introduced by these assumptions are at the heart of our contribution to the study of labor markets. Finally, we assume that workers die according to a Poisson process with arrival rate δ that is the same for employed and unemployed workers.

On the other side of the market, firms can recruit workers in order to produce a final good. In particular, each firm has only one position that, when filled by a worker, produces one unit of the final good, worth p, per unit time until the worker dies, in which case the position is destroyed. If instead the position is vacant, the firm has to pay a cost c per unit time until the position is filled. To maintain symmetry in the modelling of the worker's and of the firm's problem, we assume that vacant positions are destroyed with an exogenously given Poisson arrival rate δ. Firms are free to enter and exit the market and will therefore open a vacancy that yields a positive expected profit and close one that yields a negative expected profit. We will also discuss how our results would be affected by abandoning this assumption and solve for a model with a fixed number of firms in the Appendix.

Vacancies and unemployed workers are brought together by a random (Poisson) matching process. In particular, the total number of contacts per unit time is given by the matching function $M = am(u, v)$, where u and v denote the number of unemployed workers and of open vacancies, respectively. We assume that this function is increasing, continuous, and homogeneous of degree one in both arguments. The parameter a captures the efficiency of the matching process and we are particularly interested in the effects that changes in this parameter have on the equilibrium outcome. The fact that the matching function displays constant returns to scale allows us to write the (Poisson) arrival rate with which a vacancy meets a worker as $am(u, v)/v = am(u/v, 1) = aq(\theta)$, where $\theta \equiv v/u$ is a variable that captures the degree of labor market 'tightness'. The properties of the matching function imply that $q'(\theta) < 0$ and the elasticity of q

with respect to θ is less than one. Analogously, we have that the arrival rate with which an unemployed worker finds an open vacancy is $am(u, v)/u = a\theta q(\theta)$, and that $\mathrm{d}(a\theta q(\theta))/\mathrm{d}\theta > 0$.

The set up of the model is so far standard.[5] The contracting over the wage rate that takes place when a firm with a vacant position and an unemployed worker have met is where our approach departs from existing literature. In particular we assume that once a worker and a firm have met, the worker privately observes a particular realization γ of his disutility from working at the firm. This realization is drawn from a publicly observable distribution with cumulative function $G(\gamma)$ and density function $g(\gamma)$ on $\gamma \in [0, \infty)$ and is not correlated with the disutility that the worker might experience working at other firms. We denote the inverse of the hazard rate by $H(\gamma) \equiv G(\gamma)/g(\gamma)$ and make the standard assumption that it is monotonically increasing.[6] The firm does not observe the realization γ and has to make a take-it-or-leave-it wage offer to the worker. If this offer is accepted by the worker, the position is filled, the firm receives a product p and pays a wage w per unit time until the worker and the firm die, in which case production stops and the position is destroyed. If instead the offer is rejected both the firm and the worker return to the search pool and wait for another match.

Having outlined the structure of the model that we use in this paper, it is worth briefly discussing the reasons for and the implications of three of our simplifying assumptions. First, for most of the paper we assume a very simple bargaining game in the presence of one-sided private information. We do so because of the simplicity of this set up and because in many markets firms do indeed have a substantial degree of monopsony power. In this environment with one-sided private information, the informational inefficiency could be completely solved if the offer were made by the informed party, i.e. by the worker. In Section 6, however, we show that in a more realistic environment with two-sided private information our conclusions apply also when the parties use much more general bargaining games.[7] Second, we assume that the worker's disutility γ is subject to a random shock only at the beginning of the relationship and never again during the relationship. In other words, in our simplified model, firms and workers might fail to start a profitable working relationship upon

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[5]It indeed follows Pissarides (2000) very closely.

[6]This monotone hazard rate condition is satisfied by a large number of common distributions.

[7]See also Matouschek (2004) for a detailed discussion of these issues.

meeting but they never willingly separate after this relationship has started. This is only a simplifying assumption and the same qualitative results that we obtain in the present model would also be obtained in a model in which workers and firms start their relationship with public information and experience a productivity shock later on in their relationship.[8] Finally, we assume throughout the paper that the worker's disutility of effort, γ, is employer-specific. This assumption might approximate reality quite well in labor markets in which firm-specific skills are very important. It also has the merit of greatly simplifying the analysis and therefore to allow us to take a first step towards understanding the role played by private information in labor markets.

Before proceeding to solve the model with private information as described above, it is useful to briefly solve, analyze, and discuss the same model in the public information case in which the worker's disutility is observable to the firm at the moment of contracting over the wage. Besides laying out many of the basic equations that hold also in the private information model, the analysis of this standard case with public information constitutes a very useful benchmark against which to evaluate the consequences of private information.

3   The Public Information Benchmark

Consider a worker who has just met a firm with an open vacancy. Assume that the worker experiences disutility γ from working at this particular firm and has been offered a wage w. If the worker accepts this offer and becomes employed at the firm, his lifetime expected utility $W(\gamma)$ is

$$W(\gamma) = \frac{w - \gamma}{r + \delta}, \tag{1}$$

whereas if he rejects the offer he will remain unemployed, which yields expected lifetime utility equal to U.[9] A firm that can observe the worker's disutility γ, as is assumed to be the case in this section, maximizes profits by offering the lowest possible wage rate w that is accepted by the worker, provided that hiring the worker at this wage is

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[8]To yield the same results as those of our model, such a model should also allow workers to have some bargaining power, for example by allowing them to make wage offers with some probability. Details of such an alternative model are available from the authors upon request.

[9]Note that, since the disutility γ is employer-specific, the expected utility of an unemployed worker does not depend on it.

more profitable for the firm than keeping the vacancy open and waiting for a better match with a new worker. Therefore, if the firm decides to hire the worker at all, it offers him a wage such that $W(\gamma) = U$, or, using (1)

$$w(\gamma) = \gamma + (r + \delta)U. \tag{2}$$

However, if the profit that the firm would obtain by hiring the worker at this wage, $[p - w(\gamma)]/(r + \delta)$, is less than the utility the firm could derive by keeping the vacancy open, V, the worker is not hired. Using this fact in conjunction with the expression for $w(\gamma)$ given in (2), we therefore have that a worker-firm match is successfully formed if and only if

$$\gamma \leq \hat{\gamma} \equiv p - (r + \delta)S, \tag{3}$$

where $S \equiv U + V$ denotes the joint value of search to the worker and the firm. Equation (3) implies that all mutually beneficial matches are formed, a result owing to the public availability of information assumed in this section. The probability that a firm and a worker separate is then given by $1 - G(\hat{\gamma})$ and, for the remainder of this paper, we refer to this probability as the extent of 'job insecurity.'

We next turn to solving for the equilibrium value of U and V. The equilibrium value of V is straightforward to determine since free entry ensures that it is equal to zero. The expected utility for unemployed workers, U, satisfies

$$(r + \delta)U = b + a\theta q(\theta) \left[W^e - U\right], \tag{4}$$

where

$$W^e = \int_0^{\hat{\gamma}} \frac{w(\gamma) - \gamma}{r + \delta} dG(\gamma) + [1 - G(\hat{\gamma})]U \tag{5}$$

is the expected utility of a worker who is matched but does not yet know the realization of his disutility γ. The Bellman equation (4) can be given the usual interpretation according to which U can be thought of as the asset value of the option to search. In equilibrium the return on this value, rU, must be equal to the income flow provided by the asset, b, plus the expected capital gains or losses, $a\theta q(\theta) \left[W^e - U\right] - \delta U$. Substituting (2) and (3) into (5) gives $W^e = U$ which implies that a worker is indifferent

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between being matched and realizing W^e and being unemployed and realizing U. This is a consequence of the assumption that the firm has all the bargaining power and thus captures all the gains from trade. Substituting $W^e = U$ into (4) then gives the following equilibrium value of unemployment

$$U = b/(r + \delta). \tag{6}$$

The last endogenous variable for which we need to solve is θ. We can do so by using the following Bellman equation for the value of a vacancy

$$(r + \delta)V = -c + aq(\theta)\left[J^e - V\right], \tag{7}$$

where

$$J^e = \int_0^{\hat{\gamma}} \frac{p - w(\gamma)}{r + \delta} dG(\gamma) + [1 - G(\hat{\gamma})]V \tag{8}$$

is the expected value of a firm that is matched but does not yet know whether its wage offer will be accepted. The interpretation of equation (7) is analogous to that of equation (4). Substituting (2), (3), and the free entry condition $V = 0$ into (7) and rearranging gives

$$\int_0^{(p-b)} \frac{p - b - \gamma}{r + \delta} dG(\gamma) = \frac{c}{aq(\theta)} \tag{9}$$

which pins down the unique equilibrium level of market tightness θ and completes the description of the equilibrium in the model with public information.

Note that in the simple model with public information analyzed in this section, a fall in labor market frictions, i.e. an increase in a, does not affect the value of being unemployed U or the value of an open vacancy V. This is due, respectively, to the assumptions of monopsony power and of free entry. As a result, job insecurity and the expected payoffs from being matched W^e and J^e are also not affected by an increase in a. The only change that occurs in this simple model is that more new firms enter the market when a increases, since it is now easier for them to be matched with a worker, and this increases market tightness.

4 The model with private information

Consider now the full model outlined in Section 2, in which the firm does not observe the worker's disutility γ when making the wage offer. Since firms do not observe γ they cannot make their wage offers contingent on it and have to offer a unique wage w to all the workers whom they meet. As in the previous section, workers accept this wage offer w if and only if $W(\gamma) \geq U$, or, after using equation (1), if and only if

$$\gamma \leq \tilde{\gamma} \equiv w - (r + \delta)U. \tag{10}$$

The firm chooses the wage rate w in order to maximize its expected profit $G(\tilde{\gamma})(p - w)/(r + \delta) + [1 - G(\tilde{\gamma})]V$. Since (10) establishes a one-to-one relationship between the wage rate w offered by the firm and the marginal worker $\tilde{\gamma}$ who accepts it, in order to solve the firm's expected profit maximization problem we can think of the firm choosing the marginal worker $\tilde{\gamma}$. The firm therefore solves

$$\max_{\tilde{\gamma}} \ G(\tilde{\gamma}) \frac{p - \tilde{\gamma} - (r + \delta)U}{r + \delta} + [1 - G(\tilde{\gamma})] V$$

The first order condition of this problem is

$$\tilde{\gamma} + H(\tilde{\gamma}) = p - (r + \delta)S, \tag{11}$$

where $H(\gamma)$ is the inverse of the hazard rate. Note that it would be ex post efficient for the worker and the firm to start an employment relationship whenever, $\gamma \leq \hat{\gamma}$, where $\hat{\gamma}$ is defined in (3). In the presence of private information, however, employment relationships are formed only if $\gamma \leq \tilde{\gamma}$. The presence of $H(\tilde{\gamma})$ in (11) above implies that $\tilde{\gamma} < \hat{\gamma}$ and that 'inefficient separations' (see Hall and Lazear (1984)) occur whenever $\gamma \in [\tilde{\gamma}, \hat{\gamma}]$. The probability that a firm and a worker inefficiently separate is then given by $[G(\hat{\gamma}) - G(\tilde{\gamma})]$ and, for the remainder of this paper, we refer to this probability as the extent of 'excessive job insecurity.'

Before proceeding to close the model, it is useful to discuss the implications of a fall in market frictions for the outcome of the wage bargaining process that we have just described. Note that a fall in market frictions, i.e. an increase in a, affects the bargaining game only by increasing the joint value of search S, as will be shown below.

Because of the assumption that $H'(\gamma) > 0$, the first order condition (11) implies that an increase in the value of search S reduces $\tilde{\gamma}$ and thus increases the degree of job insecurity $[1 - G(\tilde{\gamma})]$. Essentially, an increase in S induces at least one of the agents to adopt more aggressive bargaining strategies, i.e. the firm offers a higher wage and/or the worker is more likely to reject any given offer. These more aggressive bargaining strategies lead to more separations in equilibrium. This increase in job insecurity is 'costly', in the sense that it has a negative effect on the joint expected utility of a firm-worker match. To see this, note that the expected utility W^e of a worker who is matched with a firm but does not yet know the realization of his disutility γ is given by

$$W^e = \int_0^{\tilde{\gamma}} \frac{w - \gamma}{r + \delta} dG(\gamma) + [1 - G(\tilde{\gamma})] U = U + \int_0^{\tilde{\gamma}} \left(\frac{w - \gamma}{r + \delta} - U \right) dG(\gamma), \qquad (12)$$

and the expected value J^e of a firm that is matched with a worker but does not yet know if its wage offer will be accepted is given by

$$J^e = G(\tilde{\gamma}) \frac{p - w}{r + \delta} + [1 - G(\tilde{\gamma})] V = V + G(\tilde{\gamma}) \left[\frac{p - \tilde{\gamma}}{r + \delta} - S \right]. \qquad (13)$$

Adding up equations (12) and (13) we obtain the expected joint utility $(W^e + J^e)$ of a firm-worker pair before the productivity shock γ is realized

$$W^e + J^e = \int_0^{\tilde{\gamma}} \frac{p - \gamma}{r + \delta} dG(\gamma) + [1 - G(\tilde{\gamma})] S = S + \int_0^{\tilde{\gamma}} \left(\frac{p - \gamma}{r + \delta} - S \right) dG(\gamma). \qquad (14)$$

The marginal effect of a change in S on the joint expected utility $(W^e + J^e)$ is then given by

$$\begin{aligned} \frac{d(W^e + J^e)}{dS} &= \frac{\partial(W^e + J^e)}{\partial S} + \frac{\partial(W^e + J^e)}{\partial \tilde{\gamma}} \frac{\partial \tilde{\gamma}}{\partial S} \\ &= [1 - G(\tilde{\gamma})] - \frac{G(\tilde{\gamma})}{1 + H'(\tilde{\gamma})}. \end{aligned} \qquad (15)$$

The first term in (15) represents the direct marginal benefit of an increase in S: whenever the firm and the worker disagree, which happens with probability $[1 - G(\tilde{\gamma})]$,

they obtain a higher payoff the higher is S. The second term in (15) represents the marginal cost of an increase in S: the more aggressive bargaining leads to more job separations, i.e. $\partial\tilde{\gamma}/\partial S < 0$, which has a negative effect on the agents' expected utility. This is the case since it can be proved that in equilibrium $\partial(W^e + J^e)/\partial\tilde{\gamma} > 0$, i.e. the agents trade 'too little'. In other words, the second term represents the costs that are associated with an increase in job insecurity, in the sense that some jointly profitable employment relationships are dissolved.[10]

To evaluate the total effect of an increase in S on the joint expected utility of a firm-worker match, we need to sign (15). In order to grasp the intuition behind the signing of this derivative, it is useful to first sign it for very large and very small values of S, before signing it for all possible values of S. When $S \to p/(r+\delta)$, which happens when $a \to \infty$, we have that $\tilde{\gamma} \to 0$ by (10). In words, when matching frictions vanish, the agents can afford to wait until the best possible match arrives, which implies that only matches with arbitrarily small γ's will be formed. This in turn implies that $G(\tilde{\gamma}) \to 0$ in (15) and therefore that $\mathrm{d}(W^e + J^e)/\mathrm{d}S > 0$. The joint welfare of a firm-worker match is therefore always increasing in S when S is very large to start with. The intuition behind this result is as follows. When S is large, the gains from trading with the current counterpart are not very large, since it is easy to find another counterpart if trade were to break down with the current one. This also means that there is a high probability that the agents fail to agree and that they have to resort to searching the market again, which makes an increase in S very beneficial for them.

On the other hand, when $a = 0$ no match ever takes place so that S reaches its lower bound $b/(r+\delta)$ and $\tilde{\gamma}$ reaches its upper bound $\tilde{\gamma}_0$, where, using (11), $\tilde{\gamma}_0$ is given by $\tilde{\gamma}_0 + H(\tilde{\gamma}_0) = (p - b)$. Note that $\tilde{\gamma}_0$ is higher the greater $(p - b)$ is, i.e. the greater

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[10]It is worth pointing out that in a standard model with public information as the one discussed in Section 3 an increase in S also leads to more job insecurity, as can be seen from the fact that (3) implies a negative relationship between $\hat{\gamma}$ and S. However, in the case of public information, such an increase in job insecurity is not costly for the firm and the worker, since the employment relationships that are destroyed at the margin have no value. To see this note that in the public information case

$$\frac{\mathrm{d}(W^e + J^e)}{\mathrm{d}S} = \frac{\partial(W^e + J^e)}{\partial S} + \frac{\partial(W^e + J^e)}{\partial\hat{\gamma}}\frac{\partial\hat{\gamma}}{\partial S} = [1 - G(\hat{\gamma})].$$

The direct marginal benefit of an increase in S, captured by the first term above, remains the same as in the private information case. It is also still the case that $\partial\hat{\gamma}/\partial S < 0$, but we now have that in equilibrium $\partial(W^e + J^e)/\partial\hat{\gamma} = 0$, i.e. the marginal employment relationship has no value. The latter result is simply an application of the envelope theorem, since $(W^e + J^e)$ is maximized at $\hat{\gamma}$ in the public information case.

the net marginal product of a worker is. This is because when production is very valuable the parties are more likely to form any given match, which implies a large $\tilde{\gamma}_0$. Inspection of (15) reveals that when $\tilde{\gamma}_0$ is large we have $\mathrm{d}(W^e + U^e)/\mathrm{d}S < 0$ at $S = b/(r + \delta)$ (or $a = 0$). In other words, if $(p - b)$ is sufficiently large, it can be the case that the joint expected utility of matched workers and firms is decreasing in S at low values of S. The logic behind this result is analogous, *mutatis mutandis*, to that presented for the case in which $S \to p/(r + \delta)$ (or $a \to \infty$); when a is small and $(p - b)$ is large agents are very likely to trade when they meet, implying that they are unlikely to have to search the market because of trade breakdowns. Therefore the increase in the value of search caused by the increase in a does not benefit the agents very much, but has a negative effect on their trading probabilities. This negative effect is all the more damaging the more valuable trade is, i.e. the larger $(p - b)$ is. Therefore an increase in the effectiveness of the matching technology can decrease the joint welfare of a worker-firm pair when the matching technology is inefficient to start with and $(p - b)$ is large.

We furthermore note that the second derivative of $(W^e + J^e)$ with respect to S is

$$\frac{\mathrm{d}^2(W^e + J^e)}{\mathrm{d}S^2} = g(\tilde{\gamma}) \left\{ \frac{H(\tilde{\gamma})H''(\tilde{\gamma})}{[1 + H'(\tilde{\gamma})]^2} - \frac{[2 + H'(\tilde{\gamma})]}{1 + H'(\tilde{\gamma})} \right\} \frac{\mathrm{d}\tilde{\gamma}}{\mathrm{d}S}. \tag{16}$$

Since $\mathrm{d}\tilde{\gamma}/\mathrm{d}S < 0$, we have that, provided that $H''(\tilde{\gamma})$ is not too positive, the term in brackets is negative and hence $(W^e + J^e)$ is convex in S and thus quasi-convex in a by the monotonicity of $S(a)$. The assumption that $H''(\tilde{\gamma})$ is not too positive is not overly restrictive, and is for example satisfied by the uniform and the exponential distributions, for which $H''(\gamma) = 0$. Figure 1 represents a case in which $(p - b)$ is large and $H''(\tilde{\gamma})$ is not too positive, so that $(W^e + J^e)$ is decreasing for small S and everywhere convex in S. We can summarize our findings as follows:

Result 1 *The joint expected utility of a worker-firm match, $(W^e + J^e)$, is decreasing in the joint value of search, S, if S is small relative to the net marginal product, $(p - b)$, and is increasing in S if S is large relative to $(p - b)$. Under mild assumptions about the distribution of γ, $(W^e + J^e)$ is convex in S.*

It is also of some interest to look at the distributional consequences of changes in U and V considered separately. Differentiation of (12) and (13) shows that W^e is

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increasing in U and decreasing in V while J^e is increasing in V and decreasing in U. This is intuitive since it simply says that the payoff that an agent expects to realize in the wage bargaining game is increasing in his disagreement payoff and decreasing in that of the potential trading partner. Since, as we will see below, a fall in labor market frictions increases U and, because of the free entry assumption, does not change V this immediately implies that matched workers always benefit from a fall in labor market frictions while matched firms always lose. Note, however, that this particular result depends crucially on the free entry assumption which ensures that firms with open vacancies do not benefit from an increase in a. In Appendix A we show that if the number of firms is taken as given, as it might be in the short run, a fall in labor market frictions increases both U and V and, through this channel, can make matched workers worse off and matched firms better off.[11] All the other results of the model in Appendix A are exactly as in the present version of the model with free entry.

Having established how changes in the joint value S of search for a firm-worker pair affect $\tilde{\gamma}$ and $(W^e + J^e)$, we now close the model and in so doing establish the existence and uniqueness of the equilibrium and the fact, which has been assumed to hold so far, that $\mathrm{d}S/\mathrm{d}a > 0$. The first thing to note is that the equilibrium value of a vacancy is equal to zero by free entry of firms. The fact that in equilibrium $V = 0$, and thus $S = U$, allows us to represent the problem graphically in (U, θ) space, which we do in Figure 2. Equations (11) and (12) imply that $(W^e - U)$ is decreasing in $S = U$. Using this fact in (4) provides a continuous and increasing relationship between U and θ which is represented by the AA curve in Figure 2. Analogously, equations (11) and (13) imply that $(J^e - V)$ is decreasing in $S = U$. Using this fact in (7) provides a continuous and decreasing relationship between U and θ which is represented by the JJ curve in Figure 2. The existence and uniqueness of the equilibrium is then established in a straightforward manner by inspection of Figure 2.

Furthermore, we can use this graphical apparatus to study the effects on the equilibrium of changes in a. As can be seen in Figure 3, an increase in a shifts the JJ curve upward and the AA curve downward. This has ambiguous effects on the equilibrium value of θ but causes an unambiguous increase in the equilibrium value of U.

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[11]In particular, a fall in labor market frictions will make a matched worker worse off if his expected gains from trade $W^e - U$ are small relative to the total gains from trade $W^e + J^e - U - V$ and it makes the matched firm worse off if its expected gains from trade are small relative to the total gains from trade.

In other words, Figure 3 confirms the intuitive fact that an exogenous improvement in the effectiveness of the matching technology a increases the equilibrium value U of unemployment for workers and, given that $V = 0$, the joint value of search $S = U$. This in turn implies that workers become more selective and that the equilibrium value of $\tilde{\gamma}$ decreases, as shown by (11), with the consequence that the probability $G(\tilde{\gamma})$ that any worker-firm match successfully leads to stable employment and production decreases. In this sense an improvement in the effectiveness of the matching technology a can lead to an increase in instability in the labor market. We have therefore established the following:

Result 2 *A fall in labor market frictions, i.e. an increase in a, increases the joint value of search, S, and leads to a costly increase in job insecurity. If a is initially small relative to the marginal product, $(p - b)$, firms and workers are made jointly worse off by an increase in a. If instead a is initially large relative to $(p - b)$, firms and workers are made jointly better off by an increase in a.*

We have observed above that, by increasing S, a fall in labor market frictions leads to more job insecurity, i.e. it increases the probability of separation $[1 - G(\tilde{\gamma})]$. We conclude this section by analyzing the implications of a fall in labor market frictions for the extent of *excessive* job insecurity, i.e. for the probability that a firm and a worker separate although it would be ex post efficient for them to form an employment relationship. Recall that in this model with private information, inefficient separations occur whenever $\gamma \in [\tilde{\gamma}, \hat{\gamma}]$, where $\tilde{\gamma}$ and $\hat{\gamma}$ are defined in (11) and (3), respectively. Note that while both $\tilde{\gamma}$ and $\hat{\gamma}$ are decreasing in S, $\tilde{\gamma}$ decreases at a slower rate than $\hat{\gamma}$. In particular,

$$\frac{d\hat{\gamma}}{dS} = -(r + \delta) < \frac{d\tilde{\gamma}}{dS} = -\frac{(r + \delta)}{1 + H'(\tilde{\gamma})}. \tag{17}$$

Since S is monotonically increasing in a, this implies that a fall in labor market frictions reduces the range $[\tilde{\gamma}, \hat{\gamma}]$ in which inefficient separations take place. To see when the reduction in this range translates into a reduction in the probability of inefficient separation, $[G(\hat{\gamma}) - G(\tilde{\gamma})]$, consider

$$\frac{d\left[G(\hat{\gamma}) - G(\tilde{\gamma})\right]}{dS} = -(r + \delta)\left[g(\hat{\gamma}) - g(\tilde{\gamma})\frac{1}{1 + H'(\tilde{\gamma})}\right]. \tag{18}$$

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Therefore a sufficient condition for a fall in labor market frictions to lead to a reduction in the degree of excessive job insecurity is $g(\widehat{\gamma}) \geq g(\widetilde{\gamma})$. This condition is satisfied for a number of common distributions, including uniform and exponential distributions. Moreover, this condition is satisfied for any unimodal distribution for sufficiently large S (or equivalently a). Essentially, when labor markets work sufficiently well further reductions in labor market frictions unambiguously reduce the degree of excessive job insecurity. We summarize these findings as follows:

Result 3 *For a number of common distributions, including uniform and exponential distributions, a reduction in labor market frictions reduces the degree of excessive job insecurity. For any unimodal distribution, a reduction in labor market frictions reduces the degree of excessive job insecurity if labor market frictions are initially sufficiently low.*

5   Self-Imposed Rigidities

We now investigate the organizational response of firms to a fall in labor market frictions. To do so we extend the model of Section 2 by assuming that, upon being matched and before any private information is revealed, a firm and a worker can contract over the extra costs that they incur in case they separate in the future and we refer to these costs as 'self-imposed rigidities'.[12] There are a number of ways in which firms and workers can, and do, structure their employment relationship to influence the costs of future separations. For instance, separation between a firm and a worker will be much less costly if the worker is employed as an independent contractor than if he is employed as a full time employee. Employer-provided pension plans are another way in which the cost of future separation can be influenced, since the benefits of a defined benefit pension plan are typically reduced if the worker changes jobs while the benefits of a defined contribution plan are not affected by job changes (Friedberg and Webb (2003)). The observation that firms often deliberately impose rigidities on their relationships with employees has also been made in the management literature. In the context of Japan, for instance, Dore (1996) states that *"What was not always recognized [...] was the importance of self-imposed rigidities, most fully exemplified in*

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[12]Matouschek and Ramezzana (2003) present an analysis of exclusive contracts between sellers and buyers in a matching market that shares many of the features of the model discussed in this section.

the Japanese firm. By self-imposed rigidities, I mean the acceptance, by managers, of a wide range of constraints on their freedom of action - lifetime employment guarantees, tight seniority constraints on promotion, acceptance of the need to engineer consent, to maintain close consultation with employees or their unions [...]." In this section we show that if future wage bargaining takes place in the presence of private information it may indeed be optimal for firms and workers to make separation more costly, by imposing additional rigidities on their relationship. We show that an improvement in the labor market, due to a fall in search frictions, can lead to a one off reorganization in which firms and workers switch from rigid to flexible employment relationships and that this reorganization can lead to a large increase in job insecurity and unemployment.

Reconsider the model from Section 2 and suppose that upon being matched, but before any private information is revealed, the firm and the worker can contract over the level of self-imposed rigidities. In particular, they can contract over the additional cost $x \in [0, \overline{x}]$ that the firm incurs in case their relationship breaks down, that is in case they disagree on the wage. We assume that the firm and the worker Nash bargain over x and that they have equal bargaining power.[13] The transfer that the firm pays the worker at the contracting stage is denoted by t. Finally, assume that $H''(\gamma)$ is not too positive, in the sense that (16) is positive, so that $(W^e + J^e)$ is convex in the joint value of the outside option. The rest of the model is exactly as described in the Section 2.

Suppose that a firm and a worker are matched and bargain over x. Since they are risk neutral and not liquidity constrained they agree on the level of x that maximizes their joint expected surplus. Following the same analysis as in the previous section and substituting $(S - x)$ for S in (14) and (11), their joint expected surplus is given by

$$J^e + W^e = \int_0^{\widetilde{\gamma}} \frac{p - \gamma}{r + \delta} \mathrm{d}G(\gamma) + [1 - G(\widetilde{\gamma})] (S - x), \qquad (19)$$

where $\widetilde{\gamma}$ solves the first order condition

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[13]The assumption that the firm and the worker have equal bargaining power is not crucial. Our results generalize to any distribution of bargaining power.

$$\widetilde{\gamma} + H(\widetilde{\gamma}) = p - (r + \delta)(S - x). \tag{20}$$

As can be seen with the help of Figure 1, the convexity of $(W^e + J^e)$ implies that when the agents can manipulate the sum of their outside options by choosing x for any given S, they always want to either set $x = 0$ or $x = \bar{x}$. Furthermore, the optimal organizational choice is for them to do the former if S is sufficiently large and to do the latter otherwise. Specifically, let $\tilde{S}$ be that value of S at which $J^e + W^e$ evaluated at $x = 0$ is the same as $J^e + W^e$ evaluated at $x = \overline{x}$. Then there exists a unique $\tilde{S}$ such that the optimal level of self-imposed rigidities is

$$x = \begin{cases} \overline{x} & \text{if } S \geq \tilde{S}, \\ 0 & \text{otherwise.} \end{cases} \tag{21}$$

A simple, intuitive proof of this result is given by looking at Figure 4, which represents $W^e + J^e$ as a function of S for $x = 0$ (the leftmost curve) and for $x = \bar{x}$ (the rightmost curve). Notice that the latter is simply the horizontal translation of the former by a distance $\bar{x}$. There is a unique $\tilde{S}$ at which the two curves intersect. Furthermore, for $S < \tilde{S}$ the joint value of the pair is higher for $x = \bar{x}$ than for $x = 0$, whereas the opposite is true for $S > \tilde{S}$.

Since, as we show formally below, a reduction in search frictions, i.e. an increase in a, increases S monotonically, it follows that when a grows above a certain threshold $\tilde{a}$ we have a one off reorganization in which the firms and the workers switch from a rigid relationship with $x = \overline{x}$ to a flexible one with $x = 0$ and that this reorganization leads to a large, discrete increase in the probability of separation, i.e. to a discrete fall in $\tilde{\gamma}$. The intuition behind this result is as follows. On the one hand, self-imposed rigidities make it more costly for the firm and the worker to separate, which happens with positive probability in equilibrium. On the other hand, however, precisely because they make separation more costly, they also induce less aggressive bargaining strategies which makes inefficient separations less likely. It follows from (21) that the benefit of self-imposed rigidities dominate the costs if S is small and that the opposite holds if S is large. The reason is that, when S is small, it is very costly for the firm and the worker to disagree and therefore they make sure that this does not happen by adopting inflexible arrangements. In this sense self-imposed rigidities complement the

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rigidities caused by the existence of market frictions. If, however, S is sufficiently large, then searching the market is a sufficiently attractive option, the worker and the firm are hence likely to disagree often, and are not willing to bear the costs of self-imposed rigidities. As we have already mentioned above, this reorganization does not happen gradually but instead takes place instantly, leading to a discrete increase in job insecurity. This is an interesting result in light of the evidence, briefly discussed in the introduction, that organizational changes in the 1990s may have contributed to a structural increase in job insecurity for some groups of workers.

The fact that when a, and thus S, increases above a certain threshold, $\tilde{\gamma}$, and thus the probability of agreement, jumps downward has some interesting consequences for the unemployment rate. The steady state equilibrium level of the unemployment rate in our economy is[14]

$$u = \frac{\delta}{a\theta q(\theta)G(\tilde{\gamma}) + \delta}. \tag{22}$$

Note that equation (22) is the Beveridge curve that relates the number of unemployed workers u to the number of vacancies v (see, e.g., Pissarides, 2000). The effects of an increase in a on u are in general ambiguous, as an increase in a increases the rate at which firms and workers meet, i.e. $a\theta q(\theta)$, but it also decreases the probability $G(\tilde{\gamma})$ that any given match is successful. However, when a crosses the threshold at which firms switch from inflexible to flexible employment relationships, we have the following discontinuity in the behavior of the unemployment rate.

Result 4 *A fall in labor market frictions, i.e. an increase in a above $\tilde{a}$, leads to a one off reorganization of the employment relationship, which changes istantly from rigid, i.e. $x = \bar{x}$, to flexible, i.e. $x = 0$. This reorganization causes a discrete increase in job insecurity, i.e. a discrete increase in $[1 - G(\tilde{\gamma})]$, and in the unemployment rate u.*

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[14]This rate is computed as follows. The dynamics of the number of unemployed workers is $\dot{N_u} = n - a\theta q(\theta)G(\tilde{\gamma})N_u - \delta N_u$, where n is the exogenous inflow of workers (all workers begin their lives in unemployment), $a\theta q(\theta)G(\tilde{\gamma})N_u$ is the flow of workers who find employment and δN_u is the flow of unemployed who die. The steady state number of unemployed workers is therefore $N_u = n/[a\theta q(\theta)G(\tilde{\gamma}) + \delta]$. Analogously, the dynamics of the number N_e of employed workers is given by $\dot{N_e} = a\theta q(\theta)G(\tilde{\gamma})N_u - \delta N_e$ and their steady state number is $N_e = a\theta q(\theta)G(\tilde{\gamma})N_u/\delta$. The total number of workers in the economy is therefore $N = N_u + N_e = n/\delta$ and the unemployment rate $u = N_u/N$ is as given in (22).

The reason for this fact is that, when a grows and reaches $\tilde{a}$, $\tilde{\gamma}$, and thus $G(\tilde{\gamma})$, jumps downward, whereas θ is continuous and does not jump, as proven below.

We now close the model and show that the equilibrium exists and is unique for any value of a, that S is indeed increasing in a, and that θ is continuous in a. Since the worker and the firm have equal bargaining power they each realize their disagreement payoff plus half the gains from trade. Thus the worker, who receives a transfer t from the firm, obtains

$$
\begin{aligned}
W^e + t &= U + \frac{1}{2}\left[J^e + W^e - S\right] \\
&= U + \frac{1}{2}\left[-x + \int_0^{\tilde{\gamma}} \left(\frac{p-\gamma}{r+\delta} - S + x\right) dG(\gamma)\right].
\end{aligned}
\tag{23}
$$

and the firm, that pays the worker a transfer t, obtains

$$
\begin{aligned}
J^e - t &= V + \frac{1}{2}\left[J^e + W^e - S\right] \\
&= V + \frac{1}{2}\left[-x + \int_0^{\tilde{\gamma}} \left(\frac{p-\gamma}{r+\delta} - S + x\right) dG(\gamma)\right]
\end{aligned}
\tag{24}
$$

To solve for the equilibrium values of U, V and θ, we can proceed exactly as in the previous section. In particular, we can again derive an expression for the expected utility of an unemployed worker and an expression for the expected utility of a firm with a vacancy. These expressions are now given by

$$
(r + \delta)U = b + a\theta q(\theta)[W^e + t - U]
\tag{25}
$$

and

$$
(r + \delta)V = -c + aq(\theta)[J^e - t - V],
\tag{26}
$$

respectively. As in the previous section, we can use the free entry condition $V = 0$ to represent the problem graphically in (U, θ) space. Given $V = 0$, equation (23) implies that $W^e + t - U$ is continuous and decreasing in $S = U$.[15] Using this fact

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[15]The fact that $(W^e + t - U)$ is continuous in $S = U$ can be seen from the first line of (23): when S reaches $\tilde{S}$ we have that x changes discontinuously but $(J^e + W^e)$ is continuous at $\tilde{S}$, which implies that $(W^e + t - U)$ is also continuous. An analogous reasoning applies to $(J^e - t - V)$ in equation (24).

in (25) provides a continuous and increasing relationship between U and θ which is represented by the AA curve in Figure 2. Analogously, equation (24) implies that $(J^e - t - V)$ is decreasing in $S = U$. Using this fact in (26) provides a continuous and decreasing relationship between U and θ which is represented by the JJ curve in Figure 2. As in Section 4, the existence and uniqueness of the equilibrium and the fact that $\mathrm{d}S/\mathrm{d}a > 0$ are then again established in a straightforward manner by inspection of Figures 2 and 3. What is important to note is that θ is continuous in a, so that when $\tilde{\gamma}$ drops discretely as a consequence of the increase in a, there is a one off increase in unemployment, as already stated in result 4. The evolution of the endogenous variables of the model following changes in a are visually summarized in Figure 5.

6 Robustness

The model introduced in Section 2 provides a very simple framework to analyze inefficient wage bargaining in a decentralized labor market. A potential problem with this simple framework, however, is that the inefficiency is not robust and depends crucially on the assumed bargaining game.[16] To address this issue we now allow for two-sided asymmetric information between the worker and the firm. It is well known that in the presence of two-sided asymmetric information, under fairly mild assumptions, voluntary bargaining is inefficient for *any* bargaining game (see Myerson and Satterthwaite (1983)). Thus, if both the worker and the firm have some private information, and either can opt out of the wage bargaining process, there must be inefficient separations whatever form the wage bargaining game takes. The bargaining inefficiency that is central to our analysis is therefore robust to changes in the bargaining game once we allow for two-sided asymmetric information.

Before turning to the general situation in which both the worker and the firm have some bargaining power and both of them possess some private information, it proves useful to start analyzing the situation in which the firm still has all the bargaining power in an environment with two-sided private information. We show below that all the main results described until now continue to hold in this generalized set up.

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[16]For instance, in our main model there would be no bargaining inefficiency if the worker made a take-it-or-leave-it offer to the firm.

In Section 6.2 we briefly discuss what happens if the firm and the worker play the most efficient bargaining game that maximizes their joint expected surplus (subject to their interim participation constraints). There we refer to Matouschek (2004) and conjecture that the main results described above hold.

6.1 Monopsony with Two-Sided Private Information

In this section we allow both firms and workers to have some private information. In particular, we assume that, upon being matched, the firm learns the price $p \in [\underline{p}, \overline{p}]$ of the good that it can produce at the same time at which the worker learns her disutility $\gamma \in [\underline{\gamma}, \overline{\gamma}]$. It is convenient, but not crucial for the results, to assume that the supports are infinite, i.e. $\underline{p}, \underline{\gamma} \rightarrow -\infty$ and $\overline{p}, \overline{\gamma} \rightarrow -\infty$. The worker's disutility and the price of the firm's good are independently drawn from distributions with respective cumulative density functions $G(\gamma)$ and $F(p)$. We continue to denote the inverse of the worker's hazard rate by $H(\gamma) \equiv G(\gamma)/g(\gamma)$ and denote the inverse of the firm's hazard rate by $K(p) \equiv [1 - F(p)]/f(p)$. We assume that the density functions are continuous and strictly positive and that the distributions satisfy the monotone hazard rate conditions $H'(\gamma) \geq 0$ for all γ and $K'(p) \leq 0$ for all p.

As in the model of Section 2, we continue to assume that at the ex post bargaining stage the firm has all the bargaining power. In particular, we assume that the bargaining game that the firm and the worker play to determine the wage maximizes the firm's expected surplus subject to the 'interim participation constraint' that the worker and the firm, after having learned their private information, prefer to participate in the bargaining game to searching for an alternative trading partner.[17]

The Revelation Principle (see, for example, Myerson (1991)) allows us to restrict the analysis, without loss of generality, to Bayesian incentive compatible direct mechanisms. Suppose then that, after having learned p and γ, the firm and the worker make announcements $\widehat{p}$ and $\widehat{\gamma}$. A direct mechanism specifies the probability of trade $q(\widehat{\gamma}, \widehat{p})$ and expected wage payment $w(\widehat{\gamma}, \widehat{p})$ as a function of these announcements. The wage bargaining game maximizes the firm's expected surplus subject to the worker's participation constraint. Thus, it is described by the solution to

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[17] In the absence of private information the corresponding bargaining game would have the firm make a take-it-or-leave-it wage offer to the worker.

$$\max_{q(\cdot),\, w(\cdot)} V + E_{\gamma,p}\left[\left(\frac{p}{r+\delta} - V\right) q(\gamma,p)\right] - E_{\gamma,p}[w(\gamma,p)] \qquad (27)$$

subject to the interim participation and incentive compatibility constraints.[18] The following lemma follows immediately from Williams (1987) and describes the optimal trading rule that solves the maximization problem (27).

Lemma 1 *The optimal trading rule that solves maximization problem (27) is given by*

$$q(\gamma,p,S) = \begin{cases} 1 & \text{if } \gamma + H(\gamma) \leq p - (r+\delta)S \\ 0 & \text{otherwise.} \end{cases}$$

Proof: This lemma follows immediately from Theorem 5 in Williams (1987) and we refer to his analysis. Besides the obvious notational differences, note that he refers to the seller's reservation price as v_1 which, in our notation, is given by $\gamma/(r+\delta) + U$. Also, he refers to the buyer's reservation price as v_2 which, in our notation, is given by $p/(r+\delta) - V$. ∎

Note that the optimal trading rule implies that wage bargaining is inefficient. Thus, just as in the main model, a firm and a worker sometimes separate although it would be efficient for them to stay together. Also, it is again the case that an increase in the aggregate disagreement payoff has an ambiguous effect on the joint expected surplus of a firm-worker match

$$J^e + W^e = S + E_{\gamma,p}\left[\left(\frac{p-\gamma}{r+\delta} - S\right) q(\gamma,p,S)\right].$$

On the one hand it increases the payoff that the firm and the worker realize whenever they separate but, on the other hand, it also increases the probability of separation. To see when either effect dominates, note that $\widetilde{\gamma}$ is still implicitly defined by

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[18]The incentive compatibility constraints ensure that each manager finds it optimal to make truthful announcements of his or her type and the interim individual rationality constraints ensure that, after learning their type, the managers prefer participating in the bargaining game to realizing the disagreement payoffs.

(11) and trade still takes place if and only if $\gamma \le \widetilde{\gamma}$. Differentiating $J^e + W^e$ with respect to S then gives

$$\frac{d(J^e + W^e)}{dS} = \left[1 - \int_{-\infty}^{\infty} G(\widetilde{\gamma}) f(p) dp\right] - \left[\int_{-\infty}^{\infty} G(\widetilde{\gamma}) \frac{1}{1 + H'(\widetilde{\gamma})} f(p) dp\right].$$

The first term on the right hand side is equal to the probability $1 - E_{\gamma,p}[q(\gamma, p, S)]$ that trade does not take place. Thus it represents the positive effect of an increase in S, namely that the firm and the worker get a higher payoff whenever they disagree. The second term on the right hand side represents the negative effect of an increase in S that is due to the reduction in the probability of trade. For *arbitrarily* small S the first term on the right hand side goes to zero so an increase in S reduces the expected joint surplus while for *arbitrarily* large S the second term goes to zero so that an increase in S increases the expected joint surplus. Differentiating again with respect to S shows that $J^e + W^e$ is convex in S as long as $H''(\gamma)$ is not too positive. This is the case, for instance, for uniform and exponential distributions. Recall that the simple bargaining game in the model of Section 2 had exactly the same implications. For the general equilibrium analysis it is also useful to establish the following lemma.

Lemma 2 *The expected gains from trade for a worker $W^e - U$ and the expected gains from trade for a firm $J^e - V$ depend on the aggregate disagreement payoff S and not on the distribution of the individual disagreement payoffs U and V. Furthermore,*

$$\frac{d(W^e - U)}{dS} \le 0 \ \text{and} \ \frac{d(J^e - V)}{dS} \le 0.$$

Proof: In Appendix B.   ∎

To solve the model we now need to determine the equilibrium values of U, V, and θ. Once again free entry ensure that $V = 0$ so that the Bellman equations for the value of search for workers and firms (4) and (7) can again be solved for the unique U and θ. To see this note that, because of Lemma 2, the right hand side of the two Bellman equations are decreasing in U, just as they were in the main model. Thus, (4) implies a negative relationship between U and θ and (7) a positive one so that the two equations can be solved for the unique equilibrium values of U and θ. The

two equations also imply that an increase in a leads to an increase in U and has an ambiguous effect on θ.

All the main results in the previous sections are driven by two features of the basic model. First, $J^e + W^e$ is decreasing in S for small S and increasing for large S and it is convex in S as long as the $H''(\gamma)$ is not 'too positive.' Second, an improvement in the matching technology increases S in equilibrium. Since this extended model with two-sided asymmetric information has exactly the same features all the results that we derived in the main model also hold in the current set up. We therefore conclude that the results of the main model are robust to the introduction of two-sided asymmetric information as long as the firm continues to be a monopsonist.

6.2   Optimal Bargaining with Two-Sided Private Information

Throughout the analysis we have assumed that the wage bargaining game is exogenously given and that the firm has all the bargaining power. In other words, we have assumed that the firm is a monopsonist. We have made this assumption because we believe that it is a useful benchmark which is relevant in many settings.[19] However, it is an interesting question to ask what would happen in our set up if the firm and the worker could in advance contract over the wage bargaining game. In particular, it would be interesting to know whether, in this case, an improvement in the outside option could still be harmful to the worker and the firm and whether they would still have an incentive to impose rigidities on their own relationship.

Reconsider then the model presented in the previous section but suppose that the firm and the worker can contract over the wage bargaining game before any private information is revealed. Since they are both risk neutral and liquidity unconstrained they choose the bargaining game that maximizes their joint expected surplus subject to the interim participation constraint. In other words they agree to play the Myerson-Satterthwaite (1983) bargaining game. In a recent paper Matouschek (2004) shows that in this bargaining game an increase in the sum of the players' disagreement payoffs has an ambiguous effect on their expected joint surplus since it increases the payoff they get in case of disagreement but also reduces the probability of agreement, just as in the

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[19]Note that once one allows for private information monopsony power by the firms does not imply that they can extract all the rents and push the workers down to their reservation utilities. Essentially, private information partially protects the workers from the firms' monopsony power. Note also that all our results hold if we assume that the worker has all the bargaining power.

model above. Moreover, he shows that for certain common distributions, in particular the standard uniform, standard normal and standard exponential distribution, the expected joint surplus is quasi-convex in the sum of the disagreement payoffs. Since it is the quasi-convexity of the expected joint surplus that drives the results described in this paper we conjecture that these results would also hold in a specification of the model in which the wage bargaining game is endogenized.

7 Conclusions

In this paper we have shown that if wage negotiations between firms and workers are hampered by the presence of private information a reduction in labor market frictions leads to a costly increase in job insecurity. This adverse insecurity effect of a fall in labor market frictions can be so large that firms and workers who are in an employment relationship can be made worse off by it. In contrast, unemployed workers are always made better off by such a fall in labor market frictions. We then endogenize the organizational structure of the employment relationship and show that a fall in labor market frictions induces a one off reorganization in which firms and workers switch from a very rigid employment relationship to a very flexible one. This reorganization leads to a large, one off increase in job insecurity and unemployment.

Throughout our analysis we maintain one simplifying assumption, namely that all uncertainty is match specific. This assumption is realistic if workers' firm specific skills are very important. We believe that it would be interesting to investigate if our results continues to hold in a model in which firm and worker types are correlated across matches and leave this analysis for future work.

Appendix A

Fixed number of firms in the short-run

In this section we briefly discuss how some of the results of the model with free entry of firms considered in the main text would change if the number of firms were exogenously given. We anticipate that the only qualitatively new result is that, differently from what happened in the free entry model, in this section matched workers can be made worse off and matched firms can be made better off by an increase in a. In the free entry case, in which $V = 0$, an increase in a necessarily improved the bargaining position of matched workers vis-à-vis firms and thus redistributed surplus towards them. However, with a fixed number of firms, V is also increasing in a and the relative bargaining positions of workers and firms are affected in a much less clear-cut way. It is therefore possible that W^e decreases and J^e increases in a. Except for this difference, the rest of the qualitative results obtained in the main text continues to hold also with a fixed number of firms.

Assume that there is an exogenously given inflow of firms per unit time. To simplify things assume that this inflow is equal to x and is therefore the same as that of workers. This implies that, since workers also leave unemployment and firms fill vacancies at the same rate, the steady state number of unemployed workers and vacancies is the same and thus $\theta = 1$. Normalizing $q(1) = 1$ workers and firms face therefore the same exogenously given matching rate a.[20]

The equilibrium of the model is now given by equations (11), (4), (7), (12), and (13) with $\theta = q(\theta) = 1$.[21] Adding (12) and (13) one obtains

$$W^e + J^e - S = \int_0^{\tilde{\gamma}} \left(\frac{p - \gamma}{r + \delta} - S \right) dG(\gamma). \tag{28}$$

Adding (4) and (7) (computed at $\theta = 1$) one also obtains

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[20]If the inflow of firms were exogenously given but not equal to that of workers, than θ would be endogenous and determined by the dynamics of the number of unemployed workers and vacancies. Enodgenizing θ would, however, considerably complicate the analysys without adding much insight, and here we limit ourselves to the equal inflows case.

[21]In what follows we always refer to the equations in the main text evaluated at $\theta = q(\theta) = 1$, even though we do not mention this explicitly every time.

$$(r + \delta)S = b - c + a(W^e + J^e - S). \tag{29}$$

Combining (28) and (29) we have

$$(r + \delta)S = b - c + a \int_0^{\tilde{\gamma}} \left(\frac{p - \gamma}{r + \delta} - S \right) dG(\gamma). \tag{30}$$

Since the left hand side of (30) is increasing in S and, given the negative relationship between $\tilde{\gamma}$ and S implied by (11), the right hand side is decreasing in S, there exists a unique equilibrium value of S. Inspection of (30) also reveals that an increase in a determines an increase in S and, by (11), a decrease in $\tilde{\gamma}$. These results are qualitatively identical to those obtained in the main text with free entry of firms. So is the qualitative behavior of $(W^e + J^e)$, once we substitute $S = U + V$ for U in (14) and (15). However, the effects of changes in a on the expected utility of a matched worker, W^e, and of a matched firm, J^e, can be different in this model from those in the free entry model considered in the main text. Differentiating (12) and (13) we obtain

$$\frac{dW^e}{da} = \frac{dU}{da} - \frac{G(\tilde{\gamma})}{1 + H'(\tilde{\gamma})} \frac{dS}{da}. \tag{31}$$

and

$$\frac{dJ^e}{da} = \frac{dV}{da} - G(\tilde{\gamma}) \frac{dS}{da}. \tag{32}$$

To make progress we therefore need to find dU/da and dV/da, since dS/da is simply the sum of the two.

$$(r + \delta)\frac{dU}{da} = W^e - U - a \frac{G(\tilde{\gamma})}{1 + H'(\tilde{\gamma})} \frac{W^e + J^e - S}{r + \delta + z}. \tag{33}$$

and

$$(r + \delta)\frac{dV}{da} = J^e - V - aG(\tilde{\gamma}) \frac{W^e + J^e - S}{r + \delta + z}. \tag{34}$$

where $z \equiv aG(\tilde{\gamma}^*) \left(1 + \frac{1}{1 + H'(\tilde{\gamma}^*)} \right)$. Using (33) and (34) in (31) and (32) we obtain

$$(r + \delta)\frac{\mathrm{d}W^e}{\mathrm{d}a} = W^e - U - \frac{G(\widetilde{\gamma})}{1 + H'(\widetilde{\gamma})}\frac{(r + \delta + a)(W^e + J^e - S)}{r + \delta + z}, \qquad (35)$$

and

$$(r + \delta)\frac{\mathrm{d}J^e}{\mathrm{d}a} = J^e - V - G(\widetilde{\gamma})\frac{(r + \delta + a)(W^e + J^e - S)}{r + \delta + z}. \qquad (36)$$

We therefore have that $dW^e/da > 0$ if and only if

$$\frac{W^e - U}{W^e + J^e - S} > \frac{G(\widetilde{\gamma})}{1 + H'(\widetilde{\gamma})}\frac{r + \delta + a}{r + \delta + z} \qquad (37)$$

and $dJ^e/da > 0$ if and only if

$$\frac{J^e - V}{W^e + J^e - S} > G(\widetilde{\gamma})\frac{r + \delta + a}{r + \delta + z} \qquad (38)$$

Note that although (37) and (38) do not yet give conditions only in terms of exogenous parameters, they are nevertheless very useful to understand intuitively when agents are more likely to loose or gain from improvements in the matching technology. Condition (37) implies that a matched worker is likely to gain from an increase in a if $(W^e - U)/(W^e + J^e - S)$ is large. This is the case if the worker has a strong bargaining position, i.e. if he is able to appropriate a large share of the surplus generated by the match with the firm. If instead the worker is in a weak bargaining position, then an increase in a can actually make him worse off. An analogous interpretation applies to the condition for firms given in (38).

Appendix B

Robustness

Definition: For the lemmas below it is useful to introduce the following definitions:

$$\overline{q}_w(\gamma) \equiv E_p[q(\gamma, p)], \qquad \overline{q}_f(p) \equiv E_\gamma[q(\gamma, p)],$$

$$\overline{w}_w(\gamma) \equiv E_p[t(\gamma, p)], \qquad \overline{w}_f(p) \equiv E_\gamma[t(\gamma, p)],$$

Lemma 3 *A mechanism $(q(\cdot), w(\cdot))$ is Bayesian incentive compatible if and only if $\overline{q}_w(\gamma)$ is non-increasing, $\overline{q}_f(p)$ is non-decreasing,*

$$W^e(\gamma) = W^e(\overline{\gamma}) + \int_{\gamma}^{\overline{\gamma}} \overline{q}_w(t)dt,$$

and

$$J^e(p) = J^e(\underline{p}) + \int_{\underline{p}}^{p} \overline{q}_f(t)dt.$$

Proof: Since the proof is well known we omit it to save space. ∎

Lemma 4 *A Bayesian incentive compatible mechanism $(q(\cdot), w(\cdot))$ satisfies*

$$W^e(\overline{\gamma}) + J^e(\underline{p}) - S = E_{\gamma,p}[(p - \gamma - S - K(p) - H(\gamma))q(\gamma, p)].$$

Proof: Since the proof is well known we omit it to save space. ∎

Lemma 5 *The optimal trading rule $q(\gamma, p, S)$ satisfies*

$$E_{\gamma,p}[(p - \gamma - S - K(p) - H(\gamma))q(\gamma, p, S)] = 0.$$

Proof: Since the proof is well known we omit it to save space. ∎

Proof of Lemma 2 in the text:
Lemmas 3 - 5, imply that

$$W^e(\gamma) = U + \int_{\gamma}^{\infty} \overline{q}_w(t)dt,$$

and

$$J^e(p) = V + \int_{-\infty}^{p} \overline{q}_f(t)dt.$$

Taking expectations and rearranging then gives

$$W^e - U = \int_{-\infty}^{\infty} \int_{\gamma}^{\infty} \overline{q}_w(t)f(\gamma)dtd\gamma$$

and

$$J^e - V = \int_{-\infty}^{\infty} \int_{-\infty}^{p} \overline{q}_f(t)f_f(p)dtdp.$$

From Lemma 1 it follows that right hand side of each equation depends on S and not on the distribution of U and V. Furthermore, it follows from the same lemma that the right hand side of each equation is decreasing in S. ∎

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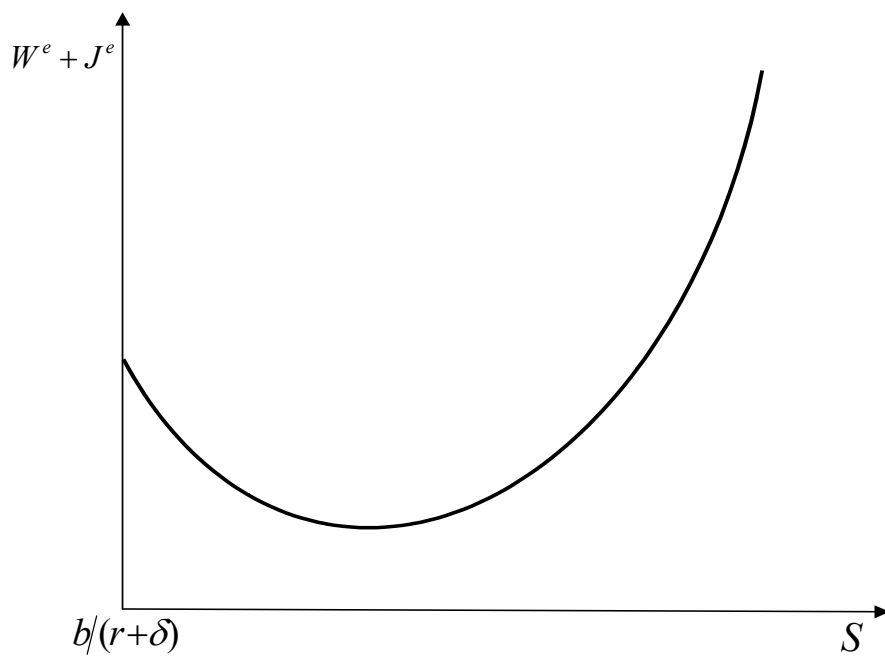
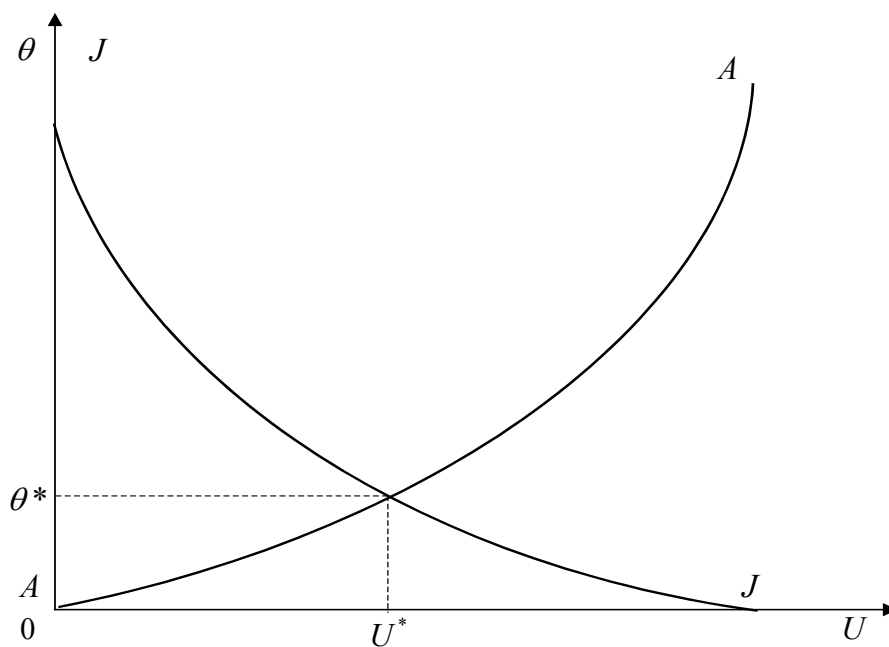Figure 1: Expected joint utility of a worker-firm pair.

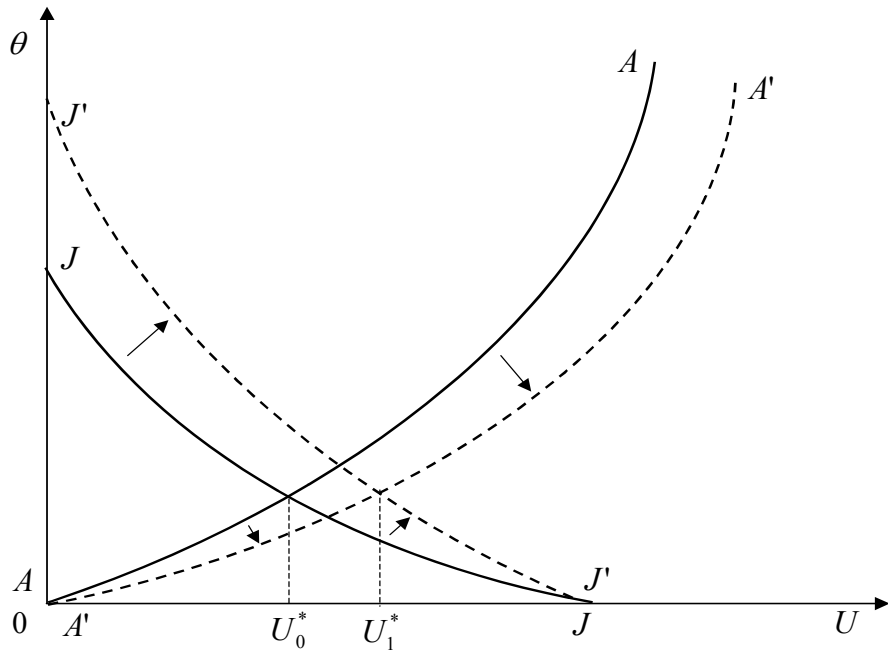Figure 2: Existence and uniqueness of equilibrium.
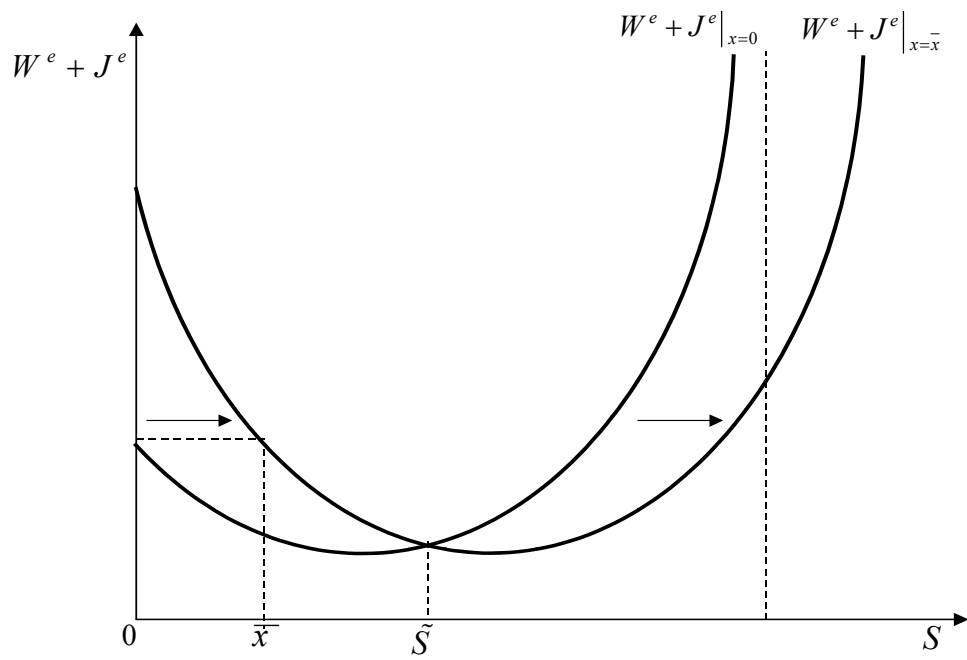
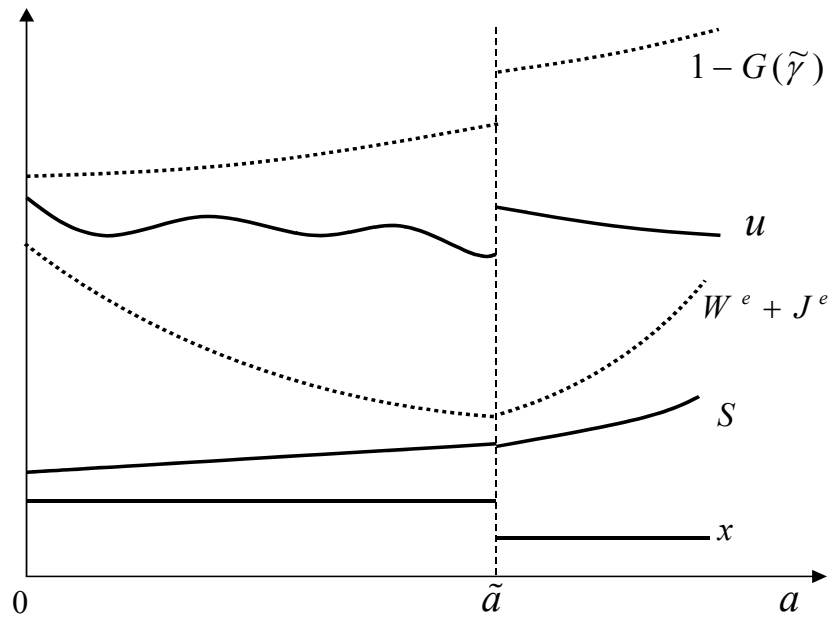Figure 3: Relationship between $S = U$ and a.

Figure 4: Optimal choice of x.

Figure 5: Evolution of endogenous variables following changes in a.