Informational Conflict and Employment Fluctuations

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Abstract

Because it takes time for workers and employers to find each other, a successful match yields a surplus to be divided between them. This paper analyzes the possibility that conflict over the division of the surplus might break up the match, either temporarily or permanently. Private information regarding the size of the surplus provides a rational basis for such conflict. But even if match-specific information generates employment fluctuations at the micro level, one might expect that these fluctuations would not survive aggregation. One main finding of the paper is that changes in economic conditions affecting the size of the surplus in all matches can synchronize bargaining outcomes at the micro level, so that informational conflict does indeed lead to aggregate employment fluctuations. Informational conflict can lead to either a temporary disruption in employment, or to a permanent separation, depending on workers' ability to commit to punishment outcomes following rejection of a wage demand. This paper analyzes the case in which workers cannot commit to a permanent separation (from a jointly profitable match), but can only commit to a temporary suspension of employment, interpreted as a temporary layoff. The model gives a quantitatively reasonable account of temporary layoffs during a recession.

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1. Introduction

Because it takes time for workers and employers to find each other, a successful match yields a surplus to be divided between them. The implications of this observation have been extensively studied, following the seminal papers of Diamond (1982) and Mortensen (1982). This paper analyzes the possibility that conflict over the division of the surplus might break up the match, either temporarily or permanently. Private information regarding the size of the surplus provides a rational basis for such conflict: indeed, Myerson and Satterthwaite (1983) showed that it is generally impossible to ensure an *ex post* efficient outcome unless the size of the surplus is common knowledge[2]. But even if match-specific information generates employment fluctuations at the micro level, one might expect that these fluctuations would not survive aggregation. One main finding of the paper is that changes in economic conditions affecting the size of the surplus in all matches can synchronize bargaining outcomes at the micro level, so that informational conflict does indeed lead to aggregate employment fluctuations.

Persistent private information naturally leads to fluctuations in bargaining outcomes. Cyclic equilibria are analyzed in Kennan (2001): the main idea can be summarized as follows. A worker facing an employer who has private information about the value of the match has basically two choices: a pooling demand that ensures immediate agreement, or an aggressive demand that risks a conflict outcome. Only the aggressive demand reveals information, and persistence implies that information about current valuations will be valuable in future negotiations. This leads to cycles: a worker who is aggressive this time and loses will be pessimistic in subsequent negotiations, but the pooling demands induced by this pessimism do not reveal new information, and the pessimism wears off, so that after some time the worker becomes optimistic enough to make another aggressive demand, and so on.

Acemoglu (1995) modeled unemployment as the result of conflict over how to divide the match surplus in an environment where the employers have better information about the size of the surplus.[3] A major difference here is that employers' have private information only about the value of their own workers' labor, rather than the value of an aggregate shock, as in Acemoglu's model. The role of aggregate shocks in this paper is to ensure that fluctuations at the level of individual bargaining pairs do not disappear when averaged over the entire economy. The aggregate shocks do not directly cause employment fluctuations: if employers had no private information, there would be no conflict, regardless

[2]See Kennan and Wilson (1993) for an analysis of efficiency in private information bargaining.

[3]Hall (2003) also treats wage bargaining as a central element in employment fluctuations, but all separations in his model are efficient ex post – there is no private information. Hall focuses on the rate at which matches are made, rather than the rate at which they break up; he argues that the job creation rate is very sensitive to how much of the match surplus the employer expects to get.

of the aggregate state. But given that the employers do have private information, aggregate shocks cause aggregate employment fluctuations by synchronizing the workers' bargaining demands.

Informational conflict can lead to either a temporary disruption in employment, or to a permanent separation, depending on workers' ability to commit to punishment outcomes following rejection of a wage demand. This paper analyzes the case in which workers cannot commit to a permanent separation (from a jointly profitable match), but can only commit to a temporary suspension of employment, interpreted as a temporary layoff.

Both Mortensen and Pissarides (1994) and Cole and Rogerson (1999) analyze the extent to which the Mortensen-Pissarides model can match aggregate data on job flows in U.S. manufacturing, as described by Davis, Haltiwanger and Schuh (1996). A notable feature of the data is that the onset of a recession is associated with a burst of job destruction (meaning that establishments report unusually large decreases in the number of employees on the payroll, relative to the number of workers employed three months earlier). The Mortensen-Pissarides model explains this as being due to a change in the threshold at which job matches remain viable: a negative aggregate shock destroys those matches that generate a positive surplus only while the aggregate state is good. Here, the spike in job destruction at the start of a recession is explained instead as a burst of temporary layoffs, involving workers who were not optimistic enough to make tough bargaining demands while the aggregate state was good, but who become more aggressive when they have less to lose. The model gives a quantitatively reasonable account of temporary layoffs during a recession, but the dynamics of permanent separations follows the Mortensen-Pissarides model. In particular, the temporary layoff model does not resolve the unemployment persistence puzzle discussed by Shimer (2003) and Hall (2003). But an alternative version of the model, based on a stronger commitment assumption, is capable of generating highly persistent unemployment; this is discussed further in the Conclusion.

2. A Model of Repeated Negotiations with Private Information and Aggregate Shocks

The flow surplus from a successful job match is modeled as a stochastic process that has an idiosyncratic component and an "aggregate" component that is common to all jobs. The idiosyncratic component is observed privately by the employer, while the aggregate component is common knowledge. Each of these components is a Markov pure jump process with two states. The aggregate states are labeled "b" and "g" (meaning bad and good), and the idiosyncratic states are labeled "L" and "H" (low and high, also meaning bad and good). Let y_{bL} be the flow surplus when the economy is in the bad state, and the idiosyncratic component of this match is in the low state, and similarly for the other configurations. The exit hazards from the various states are labeled λ_L, λ_H, λ_b and λ_g.

Jobs are not permanent: there is a risk that the surplus from the match will disappear, in which case there is a permanent separation, and the worker searches for a new match. When the joint continuation value from a match falls below the joint opportunity cost, the match is destroyed. This is modeled as an additional (very low) state of the idiosyncratic component, which is reached with hazard rate δ_b or δ_g according to whether the aggregate state is bad or good. The exit hazard for a worker from the unmatched state is α_b or α_g. The environment is illustrated in Figure 1.

The rules of bargaining are as follows. Contracts break down sooner or later: there is a constant hazard rate λ_0 governing the probability of a breakdown. When a contract ends, the worker offers a new contract, and if this is rejected there is no trade for a period of length t_0, after which the worker makes a new offer. Thus the worker has full commitment power within the current contract, but no commitment power across contracts. These rules implicitly assume that long-term contracts are costly to enforce.

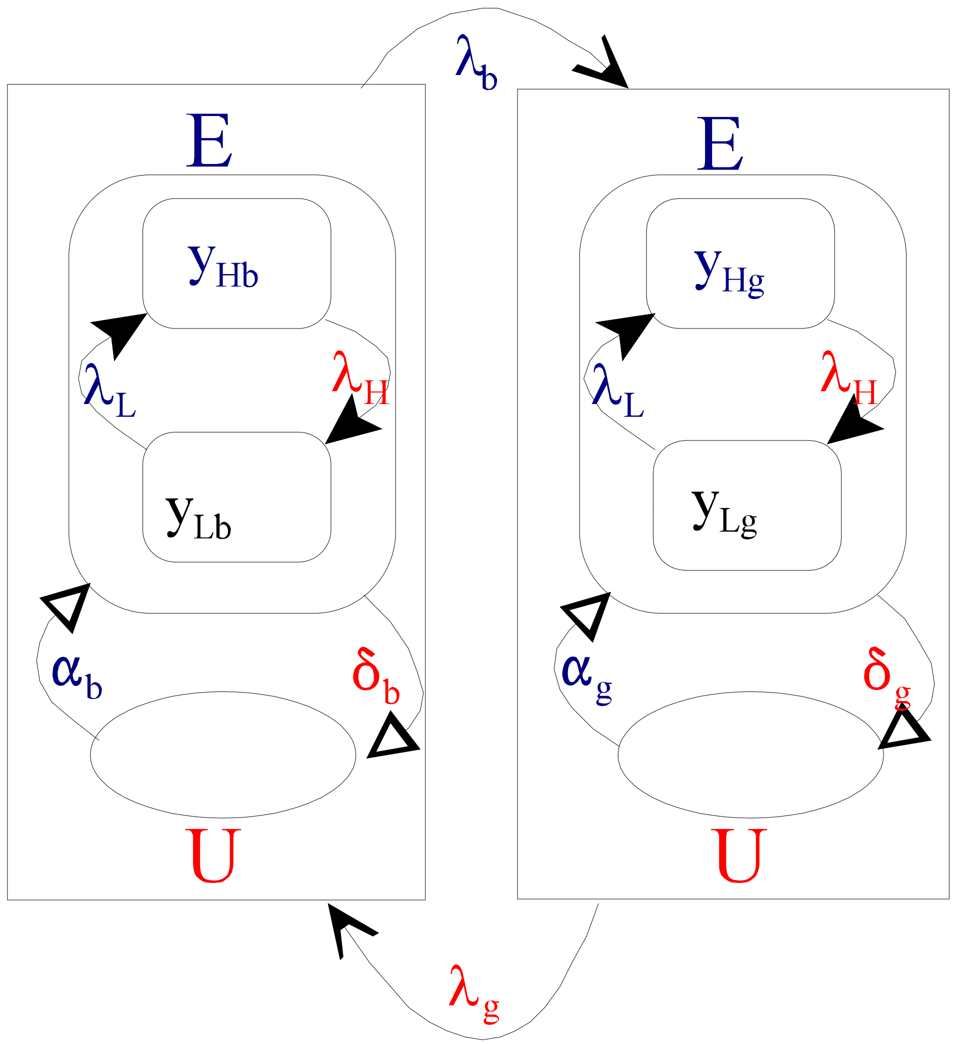

Figure 1: Model Parameters

In the absence of any historical information, the probability of the low idiosyncratic state is that implied by the invariant distribution of the Markov switching process, i.e.

$$\mu = \frac{\lambda_H}{\lambda_H + \lambda_L}$$

Let ψ(t) denote the probability that the employer's valuation is low at time t, given that it was low at t=0. Then

$$\psi(t) = \mu + (1-\mu)e^{-\Lambda t}$$

where $\Lambda = \lambda_L + \lambda_H$ governs the extent to which successive contract negotiations are linked. If Λ is infinite, information is completely transitory, so that any inference that the worker might draw from the current contract negotiation will be irrelevant by the time the next contract is negotiated. At the other extreme, if $\Lambda = 0$ the current information is entirely permanent.

The equilibrium solution used in this paper is based on a discrete-time version of the model, with no aggregate shocks, which is analyzed in Kennan (2001). The equilibrium is a renewal process based on the outcome of screening offers made by the worker. If the employer accepts an offer revealing that the private state is currently high, the continuation game is the same as it was the last time such a revelation was made, and similarly if a rejected offer convinces the worker that the state is currently low.

In each contract negotiation there are two possibilities from the worker's point of view. If information is sufficiently persistent and if the worker has inferred from a recent negotiation that the state was low, it will be optimal to make a pooling offer. Alternatively, if the worker believes that the high state is sufficiently likely, a screening offer will be worthwhile. Each offer leaves either the high or low employer type on the margin between acceptance and rejection. A screening offer is just acceptable to the high type, and unacceptable to the low type. A pooling offer is just acceptable to the low type, and more than acceptable to the high type.

If the employer accepts a screening offer, the worker will infer that the state is high, and so the worker will screen again when the next contract is negotiated (unless perpetual pooling is optimal). Of course the employer knows that acceptance of a screening offer weakens its bargaining position next time, so the offer must be sufficiently generous to compensate for this. If the employer rejects a screening offer, on the other hand, the worker infers that the state is currently low, and it may then be optimal to make a pooling offer next time, and perhaps again the time after that, and so on. Acceptance of these pooling offers reveals nothing about the state, and so the worker's belief decays toward μ. A key feature of the equilibrium is the length of time needed for the worker to become sufficiently optimistic to screen again, following rejection of a screening offer. This will depend on the aggregate state, so let K^b be the length of time during which the worker makes pooling offers even if the aggregate state is bad (so that the cost of screening is low), and let k be the additional time needed until the worker is optimistic enough to screen even if the public shock is good, with $K^g = K^b + k$. It is assumed that $t_0 < K^b$.

If the employer accepts an offer revealing a high valuation now, the worker screens again next time, and so on until a screening offer is rejected. The equilibrium cycle is sketched in Figure 3, which represents varying degrees of pessimism for the worker. At one extreme, immediately after an unsuccessful screening offer, the worker believes the employer's valuation is low now for sure. In this situation the worker pools now, and continues to pool (whenever a contract opportunity arises) until the probability of the low valuation has decayed past the screening threshold ζ_b^*. Beyond this point, the worker makes pooling offers if the aggregate state is good, and screening offers if the state is bad, until the probability of the low valuation has decayed past a second screening threshold ζ_g^*. At the other extreme, the worker is sure that the employer's valuation is high immediately after a screening offer is accepted, and (given that μ is below ζ_g^*) the worker remains sufficiently optimistic to make only screening offers until the employer rejects. The relationship between K and ζ^* is given by

$$\zeta_b^* = \mu + (1-\mu)e^{-\Lambda K^b}$$

$$\zeta_g^* = \mu + (1-\mu)e^{-\Lambda K^g}$$

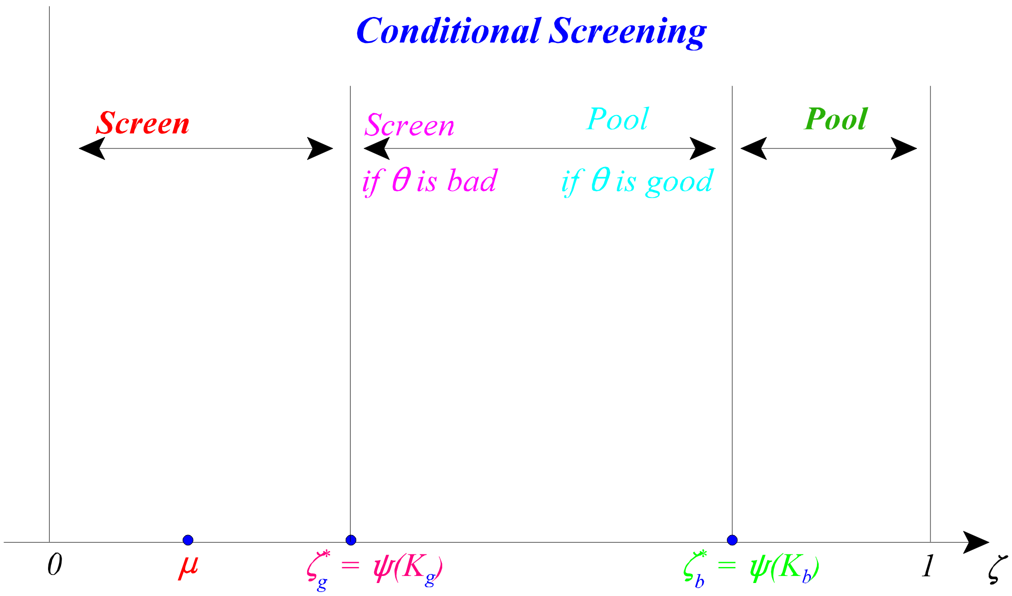

Figure 2: Pooling, Conditional Screening and Screening Regions

3. Value Functions

Let a denote the elapsed time since the last rejected offer. This indexes the seller's belief. If a contract expires before a reaches the screening region, there is a new pooling contract. If a contract expires in the screening region, there is a new screening contract if the employer's current valuation is high, or a temporary layoff if the valuation is low. Let $U_L^b(a)$ and $V_L^b(a)$ denote the worker's and the employer's continuation values if the employer's current valuation is low, the aggregate state is bad, and the age of the current contract is a, with similar notation for the other states.

The equilibrium is based on the "immediate signaling" and "stationary values" properties discussed in Kennan (2001). If *any* offer is rejected, the worker believes that the private valuation is low (for sure), and the employer's continuation value is then $V_L(0)$ or $V_H(0)$. In addition, it is assumed that the equilibrium satisfies a "tight pricing" property, meaning that the employer's value is the value of rejecting all screening offers, and accepting all pooling offers. Together, these properties fully determine the employer's continuation values: in particular, the employer's value function can be determined independently of the worker's continuation value in the unmatched state.

Since both sides are risk-neutral, with the same discount factor, the timing of wage payments is indeterminate: what matters is the expected present value of wage payments over the life of each contract. It is convenient to summarize these payments as a lump sum paid when the contract begins (with no flow payments). Define the screening prices P_H^b and P_H^g as the payments that make the high-valuation employer indifferent between accepting and rejecting the worker's contract offer, given that rejection would lead the worker to believe that the current valuation is low, while acceptance would reveal the high state. Then

$$P_H^b = V_H^b(K^g) - V_H^b(0)$$

$$P_H^g = V_H^g(K^g) - V_H^g(0)$$

Similarly, the pooling prices for a contract of age a are given by

$$P_L^b(a) = V_L^b(a) - V_L^b(0)$$

$$P_L^g(a) = V_L^g(a) - V_L^g(0)$$

Taking $V_L(0)$ and $V_H(0)$ as given, consider a contract with beliefs in the screening region (this might be either a screening contract that was accepted, or a pooling contract that has continued into the screening region). The continuation values are constant in this region, because the worker will make a screening offer at the next opportunity, regardless of how much additional time has elapsed. The employer's continuation values are determined by the asset pricing equations

$$\begin{aligned}
rV_L^b(K^g) &= y_L^b + \lambda_L\left[V_H^b(K^g) - V_L^b(K^g)\right] + \lambda_b\left[V_L^g(K^g) - V_L^b(K^g)\right] - \lambda_0\left[V_L^b(K^g) - V_L^b(0)\right] - \delta^b V_L^b(K^g) \\
rV_L^g(K^g) &= y_L^g + \lambda_L\left[V_H^g(K^g) - V_L^g(K^g)\right] - \lambda_g\left[V_L^g(K^g) - V_L^b(K^g)\right] - \lambda_0\left[V_L^g(K^g) - V_L^g(0)\right] - \delta^g V_L^g(K^g) \\
rV_H^b(K^g) &= y_H^b - \lambda_H\left[V_H^b(K^g) - V_L^b(K^g)\right] + \lambda_b\left[V_H^g(K^g) - V_H^b(K^g)\right] - \lambda_0\left[V_H^b(K^g) - V_H^b(0)\right] - \delta^b V_H^b(K^g) \\
rV_H^g(K^g) &= y_H^g - \lambda_H\left[V_H^g(K^g) - V_L^g(K^g)\right] - \lambda_g\left[V_H^g(K^g) - V_H^b(K^g)\right] - \lambda_0\left[V_H^g(K^g) - V_H^g(0)\right] - \delta^g V_H^g(K^g)
\end{aligned}$$

The worker's continuation values include the payments received when a screening offer is accepted, and the continuation value at the start of a temporary layoff if it is rejected. The workers' values are determined by the following equations

$$
\begin{aligned}
rU_L^b(K^g) &= \lambda_L\left[U_H^b(K^g) - U_L^b(K^g)\right] + \lambda_b\left[U_L^g(K^g) - U_L^b(K^g)\right] - \delta^b\left[U_L^b(K^g) - U_0^b\right] - \lambda_0\left[U_L^b(K^g) - U_L^b(0)\right] \\
rU_L^g(K^g) &= \lambda_L\left[U_H^g(K^g) - U_L^g(K^g)\right] - \lambda_g\left[U_L^g(K^g) - U_L^b(K^g)\right] - \delta^g\left[U_L^g(K^g) - U_0^g\right] - \lambda_0\left[U_L^g(K^g) - U_L^g(0)\right] \\
rU_H^b(K^g) &= -\lambda_H\left[U_H^b(K^g) - U_L^b(K^g)\right] + \lambda_b\left[U_H^g(K^g) - U_H^b(K^g)\right] - \delta^b\left[U_H^b(K^g) - U_0^b\right] + \lambda_0 P_H^b \\
rU_H^g(K^g) &= -\lambda_H\left[U_H^g(K^g) - U_L^g(K^g)\right] - \lambda_g\left[U_H^g(K^g) - U_H^b(K^g)\right] - \delta^g\left[U_H^g(K^g) - U_0^g\right] + \lambda_0 P_H^g
\end{aligned}
$$

where U_0 is the worker's value of search for a new match, contingent on the aggregate state.

One way to solve these equations is to solve first for $V(K^g)$, and then use the results (together with the screening price equations) to solve for $U(K^g)$. Alternatively, the continuation values can be stacked in one 8-dimensional vector V, and the equations can be written as:

$$\Omega_2 V(K^g) = Y_2$$

where

$$V(a)' = \left[V_L^b(a) \quad V_L^g(a) \quad V_H^b(a) \quad V_L^g(a) \quad U_L^b(a) \quad U_L^g(a) \quad U_H^b(a) \quad U_L^g(a)\right]$$

and the matrix Ω_2 and the vector Y_2 are given in the Appendix. Although Ω_2 is determined by the basic model parameters, Y_2 depends on the initial values V(0), and on the worker's separation values U_0. Taking these as given (for the moment), the solution is

$$V(K^g) = \Omega_2^{-1} Y_2$$

When the contract age lies between K^b and K^g, the worker makes a screening offer at contract expiration if the aggregate state is bad, and otherwise makes a pooling offer. The employer's continuation values in this conditional screening region are given by

$$
\begin{aligned}
rV_L^b(a) &= \dot{V}_L^b(a) + y_L^b + \lambda_L\left[V_H^b(a) - V_L^b(a)\right] + \lambda_b\left[V_L^g(a) - V_L^b(a)\right] - \lambda_0\left[V_L^b(a) - V_L^b(0)\right] - \delta^b V_L^b(a)\\
rV_L^g(a) &= \dot{V}_L^g(a) + y_L^g + \lambda_L\left[V_H^g(a) - V_L^g(a)\right] - \lambda_g\left[V_L^g(a) - V_L^b(a)\right] - \lambda_0\left[V_L^g(a) - V_L^g(0)\right] - \delta^g V_L^g(a)\\
rV_H^b(a) &= \dot{V}_H^b(a) + y_H^b - \lambda_H\left[V_H^b(a) - V_L^b(a)\right] + \lambda_b\left[V_H^g(a) - V_H^b(a)\right] - \lambda_0\left[V_H^b(a) - V_H^b(0)\right] - \delta^b V_H^b(a)\\
rV_H^g(a) &= \dot{V}_H^g(a) + y_H^g - \lambda_H\left[V_H^g(a) - V_L^g(a)\right] - \lambda_g\left[V_H^g(a) - V_H^b(a)\right] - \lambda_0\left[V_L^g(a) - V_L^g(0)\right] - \delta^g V_H^g(a)
\end{aligned}
$$

(where $\dot{V}$ denotes a time-derivative). These values differ from the corresponding values in the unconditional screening region in two ways. First, they are not constant. Second, when the aggregate state is good, the high-valuation employer's continuation value at contract expiration is the value of paying the pooling price and continuing with a new contract, rather than the value of rejecting the contract offer.

The worker's continuation values in the conditional screening region are given by

$$
\begin{aligned}
rU_L^b(a) &= \dot{U}_L^b(a) + \lambda_L\left[U_H^b(a) - U_L^b(a)\right] + \lambda_b\left[U_L^g(a) - U_L^b(a)\right] - \delta^b\left[U_L^b(a) - U_0^b\right] - \lambda_0\left[U_L^b(a) - U_L^b(0)\right]\\
rU_L^g(a) &= \dot{U}_L^g(a) + \lambda_L\left[U_H^g(a) - U_L^g(a)\right] - \lambda_g\left[U_L^g(a) - U_L^b(a)\right] - \delta^g\left[U_L^g(a) - U_0^g\right] + \lambda_0\left[V_L^g(a) - V_L^g(0)\right]\\
rU_H^b(a) &= \dot{U}_H^b(a) - \lambda_H\left[U_H^b(a) - U_L^b(a)\right] + \lambda_b\left[U_H^g(a) - U_H^b(a)\right] - \delta^b\left[U_H^b(a) - U_0^b\right] + \lambda_0\left[U_H^b(K^g) - U_H^b(a)\right] + \lambda_0 P_H^b\\
rU_H^g(a) &= \dot{U}_H^g(a) - \lambda_H\left[U_H^g(a) - U_L^g(a)\right] - \lambda_g\left[U_H^g(a) - U_H^b(a)\right] - \delta^g\left[U_H^g(a) - U_0^g\right] + \lambda_0\left[V_L^g(a) - V_L^g(0)\right]
\end{aligned}
$$

Note here that the contract age is reset to K^g following acceptance of a screening offer, with the interpretation that the worker's belief lies in the unconditional screening region following acceptance of a screening offer.

The equations for the employer's and the worker's continuation values in the conditional screening region can be written as

$$\dot{V}(a) = \Omega_1 V(a) - Y_1, \quad K^b \le a \le K^g$$

where Ω_1 and Y_1 are given in the Appendix. This is a system of linear differential equations, with terminal conditions given by the solution for $V(K^g)$ described above. The solution of the differential equation system can be written using matrix exponential notation as

$$V(a) = \Omega_1^{-1} Y_1 + e^{-\Omega_1(K^g - a)}\left[V(K^g) - \Omega_1^{-1} Y_1\right]$$

In particular, the continuation values at the start of the conditional screening region are given by

$$V(K^b) \;=\; \Omega_1^{-1}\,Y_1 + e^{-\Omega_1(K^g - K^b)}\Big[V(K^g) - \Omega_1^{-1}\,Y_1\Big]$$

When the contract age is less than K^b, the worker makes pooling offers at contract expiration regardless of the aggregate state. The continuation values in this pooling region are given by

$$\begin{aligned}
rV_L^b(a) &= \dot{V}_L^b(a) + y_L^b + \lambda_L\Big[V_H^b(a) - V_L^b(a)\Big] + \lambda_b\Big[V_L^g(a) - V_L^b(a)\Big] - \lambda_0\Big[V_L^b(a) - V_L^b(0)\Big] - \delta^b V_L^b(a)\\
rV_L^g(a) &= \dot{V}_L^g(a) + y_L^g + \lambda_L\Big[V_H^g(a) - V_L^g(a)\Big] - \lambda_g\Big[V_L^g(a) - V_L^b(a)\Big] - \lambda_0\Big[V_L^g(a) - V_L^g(0)\Big] - \delta^g V_L^g(a)\\
rV_H^b(a) &= \dot{V}_H^b(a) + y_H^b - \lambda_H\Big[V_H^b(a) - V_L^b(a)\Big] + \lambda_b\Big[V_H^g(a) - V_H^b(a)\Big] - \lambda_0\Big[V_L^b(a) - V_L^b(0)\Big] - \delta^b V_H^b(a)\\
rV_H^g(a) &= \dot{V}_H^g(a) + y_H^g - \lambda_H\Big[V_H^g(a) - V_L^g(a)\Big] - \lambda_g\Big[V_H^g(a) - V_H^b(a)\Big] - \lambda_0\Big[V_L^g(a) - V_L^g(0)\Big] - \delta^g V_H^g(a)
\end{aligned}$$

$$\begin{aligned}
rU_L^b(a) &= \dot{U}_L^b(a) + \lambda_L\Big[U_H^b(a) - U_L^b(a)\Big] + \lambda_b\Big[U_L^g(a) - U_L^b(a)\Big] - \delta^b\Big[U_L^b(a) - U_0^b\Big] + \lambda_0\Big[V_L^b(a) - V_L^b(0)\Big]\\
rU_L^g(a) &= \dot{U}_L^g(a) + \lambda_L\Big[U_H^g(a) - U_L^g(a)\Big] - \lambda_g\Big[U_L^g(a) - U_L^b(a)\Big] - \delta^g\Big[U_L^g(a) - U_0^g\Big] + \lambda_0\Big[V_L^g(a) - V_L^g(0)\Big]\\
rU_H^b(a) &= \dot{U}_H^b(a) - \lambda_H\Big[U_H^b(a) - U_L^b(a)\Big] + \lambda_b\Big[U_H^g(a) - U_H^b(a)\Big] - \delta^b\Big[U_H^b(a) - U_0^b\Big] + \lambda_0\Big[V_L^b(a) - V_L^b(0)\Big]\\
rU_H^g(a) &= \dot{U}_H^g(a) - \lambda_H\Big[U_H^g(a) - U_L^g(a)\Big] - \lambda_g\Big[U_H^g(a) - U_H^b(a)\Big] - \delta^g\Big[U_H^g(a) - U_0^g\Big] + \lambda_0\Big[V_L^g(a) - V_L^g(0)\Big]
\end{aligned}$$

This differential equation system can be written as

$$\dot{V}(a) \;=\; \Omega_0\,V(a) - Y_0\,, \quad t_0 \le a \le K^b$$

Using $V(K^b)$ as the terminal condition, the solution in this region is

$$V(a) \;=\; V_0^* + e^{-\Omega_0(K^b - a)}\Big[V(K^b) - V_0^*\Big]$$

At the end of a temporary layoff, there is a pooling offer, and the continuation values following acceptance of this offer are given by

$$V(t_0) = V_0^* + e^{-\Omega_0(K^b - t_0)}\left[V(K^b) - V_0^*\right]$$

During the temporary layoff, the continuation values are determined by the following system

$$\begin{aligned}
r V_L^b(a) &= \dot{V}_L^b(a) + \lambda_L\left[V_H^b(a) - V_L^b(a)\right] + \lambda_b\left[V_L^g(a) - V_L^b(a)\right] - \delta^b V_L^b(a) \\
r V_L^g(a) &= \dot{V}_L^g(a) + \lambda_L\left[V_H^g(a) - V_L^g(a)\right] - \lambda_g\left[V_L^g(a) - V_L^b(a)\right] - \delta^g V_L^g(a) \\
r V_H^b(a) &= \dot{V}_H^b(a) - \lambda_H\left[V_H^b(a) - V_L^b(a)\right] + \lambda_b\left[V_H^g(a) - V_H^b(a)\right] - \delta^b V_H^b(a) \\
r V_H^g(a) &= \dot{V}_H^g(a) - \lambda_H\left[V_H^g(a) - V_L^g(a)\right] - \lambda_g\left[V_H^g(a) - V_H^b(a)\right] - \delta^g V_H^g(a)
\end{aligned}$$

$$\begin{aligned}
r U_L^b(a) &= \dot{U}_L^b(a) + \lambda_L\left[U_H^b(a) - U_L^b(a)\right] + \lambda_b\left[U_L^g(a) - U_L^b(a)\right] - \delta^b\left[U_L^b(a) - U_0^b\right] \\
r U_L^g(a) &= \dot{U}_L^g(a) + \lambda_L\left[U_H^g(a) - U_L^g(a)\right] - \lambda_g\left[U_L^g(a) - U_L^b(a)\right] - \delta^g\left[U_L^g(a) - U_0^g\right] \\
r U_H^b(a) &= \dot{U}_H^b(a) - \lambda_H\left[U_H^b(a) - U_L^b(a)\right] + \lambda_b\left[U_H^g(a) - U_H^b(a)\right] - \delta^b\left[U_H^b(a) - U_0^b\right] \\
r U_H^g(a) &= \dot{U}_H^g(a) - \lambda_H\left[U_H^g(a) - U_L^g(a)\right] - \lambda_g\left[U_H^g(a) - U_H^b(a)\right] - \delta^g\left[U_H^g(a) - U_0^g\right]
\end{aligned}$$

Write this as

$$\dot{V}(a) = \Omega_{00} V(a) - Y_{00}, \quad 0 \le a < t_0$$

The solution for the values during a temporary layoff can then be written as

$$V(a) = e^{-\Omega_{00}(t_0 - a)}\left[V(t_0) - P(t_0)\right] + \left(I - e^{-\Omega_{00}(t_0 - a)}\right)\Omega_{00}^{-1} Y_{00}, \quad 0 \le a < t_0$$

where

$$P(t_0) = \left[P_L^b(t_0) \quad P_L^g(t_0) \quad P_L^b(t_0) \quad P_L^g(t_0) \quad -P_L^b(t_0) \quad -P_L^g(t_0) \quad -P_L^b(t_0) \quad -P_L^g(t_0)\right]'$$

Thus the continuation values jump at the end of the temporary layoff, by the amount of the relevant pooling offer; the employer’s values jump up once the pooling payment has been made, and the worker’s values jump down.

The continuation values following rejection of an offer are then given by

$$V(0) \;=\; e^{-\Omega_{00} t_0}\left[V(t_0) - P(t_0)\right] + \left(I - e^{-\Omega_{00} t_0}\right)\Omega_{00}^{-1} Y_{00}\,, \quad 0 \le a < t_0$$

The elements of the vector V(0) were taken as given earlier, so they enter both sides of the above equation, which must therefore be solved to determine the equilibrium values. Also, the worker’s separation values were taken as given. These are determined by

$$\begin{aligned}
(r+\alpha^b)\,U_0^b \;&=\; w_0 + \lambda^b\left[U_0^g - U_0^b\right] + \alpha^b \mu\, U_L^b(0) + \alpha^b(1-\mu)\left[V_H^b(K^g) - V_H^b(0) + U_H^b(K^g)\right] \\
(r+\alpha^g)\,U_0^g \;&=\; w_0 - \lambda^g\left[U_0^g - U_0^b\right] + \alpha^g \mu\, U_L^g(0) + \alpha^g(1-\mu)\left[V_H^g(K^g) - V_H^g(0) + U_H^g(K^g)\right]
\end{aligned}$$

where w_0 is the income flow for an unmatched worker (including unemployment benefits and the value of leisure). New matches are found at the rate α, and the worker immediately makes a screening offer (because the belief according to the invariant distribution is μ, and this lies in the screening region by assumption). If the new employer is in the high state, the screening offer is accepted, and otherwise it is rejected, and employment starts after a delay of length t_0.

4. Equilibrium

So far, it has been assumed that there are state-contingent thresholds ζ_b^* and ζ_g^* governing the worker's choice between screening and pooling offers. These thresholds determine K_b and K_g, giving the lengths of the pooling and conditional screening regions, and these in turn determine the continuation values for the employer and the worker. In particular, the worker's payoffs from screening and pooling are ultimately determined by the value of ζ_b^* and ζ_g^* used in the employer's and worker's strategies. So there must be a fixed point: using ζ_b^* and ζ_g^* to determine the strategies, and computing the worker's payoffs from screening and pooling as the belief ζ varies, it must be that screening and pooling yield the same continuation value for the worker when $\zeta = \zeta_b^*$ and $K = K_b$, if the aggregate state is good, and again when $\zeta = \zeta_g^*$ and $K = K_g$, if the aggregate state is bad.

When the aggregate state is good, the worker's expected payoffs from pooling and screening at the expiration of a contract of age K^g are given by

$$u[pool] \;=\; \zeta\, U_L^g(K^g) + (1-\zeta)\, U_H^g(K^g) + P_L^g(K^g)$$
$$u[screen] \;=\; \zeta\, U_L^g(0) + (1-\zeta)\left[U_H^g(K^g) + P_H^g\right]$$

where ζ is the worker's current belief (i.e. the probability that the employer's current valuation is low). This yields the following equation for the screening threshold:

$$P_L^g(K^g) + \zeta_g^*\left[U_L^g(K^g) - U_L^g(0)\right] \;=\; (1-\zeta_g^*)\,P_H^g$$

meaning that the worker is indifferent between pooling and screening if the aggregate state is good and the belief is ζ_g^*. On the other hand, the worker's belief when the contract age is K^g is given by

$$\zeta_g^* \;=\; \mu + (1-\mu)\,e^{-\Lambda K^g}$$

Eliminating ζ_g^* from these two equations yields

$$P_L^g(K^g) + \psi(K^g)\left(U_L^g(K^g) - U_L^g(0)\right) \;=\; \left(1 - \psi(K^g)\right)P_H^g$$

This equation implicitly involves K^b (as can be seen from the value function derivation in the previous section).

When the aggregate state is bad, the calculation of the screening threshold is slightly different, because in this case an accepted screening offer sets the state variable to $a = K_g$ (meaning that there will be a screening offer at the next opportunity, regardless of the aggregate state). Thus the belief that makes the worker indifferent between screening and pooling is given by

$$\zeta_b^*\left[U_L^b(K^b) - U_L^b(0)\right] + P_L^b(K^b) \;=\; (1-\zeta_b^*)\left[U_H^b(K^g) - U_H^b(K^b) + P_H^b\right]$$

After substituting for ζ^*_b,

$$P_L^b(K^b) + \psi(K^b)\left(U_L^b(K^b) - U_L^b(0)\right) = \left(1 - \psi(K^b)\right)\left[U_H^b(K^g) - U_H^b(K^b) + P_H^b\right]$$

This equation can be solved jointly with the above equation for K^g to obtain K^b and K^g in terms of the primitive parameters, thus completing the equilibrium calculation[4]. A numerical example is shown in Table 1.

[4]Whether this equilibrium is unique is an open question. In the special case where there are no aggregate shocks the equilibrium is unique (i.e. it is the only equilibrium satisfying the stationary value, immediate signaling and tight pricing properties).

There is an implicit assumption that one rejected offer should be enough to convince the worker that the employer's current valuation is low. This will not work if the high valuation is very persistent. In this case, the equilibrium must involve extended screening: the worker makes an offer above the screening price, and the employer randomizes in such a way that the worker makes another screening offer next time following rejection. This problem is analyzed in detail in a model with fixed-length contracts and no aggregate shocks in Kennan (2001), and the results indicate that the equilibrium construction used here will be valid if the opportunity cost of screening is sufficiently large.

Table 1: An Equilibrium Example

Parameters	Equilibrium
$\lambda_0 = 1$, $t_0 = .06$, $\delta_b = 2/5$, $\delta_g = 1/3$, $\alpha_b = 3$, $\alpha_g = 5$	$\zeta_b^* = .7258$, $\zeta_g^* = .6116$
$\lambda_L = 3/8$, $\lambda_H = 3/8$, $\lambda_b = 1$, $\lambda_g = 1/5$	$K^b = 1.06$, $K^g = 2$
$r = .05$, $y_L^b = .4150$, $y_H^b = 1+y_L^b$, $y_L^g = .7002$, $y_H^g = 1+y_L^g$, $w_0 = 0$	

		Continuation Values								Prices			
Age[a]	Beliefs	Employer				Worker				Pooling		Screening	
a	ζ	$V_L^b(a)$	$V_L^g(a)$	$V_H^b(a)$	$V_H^g(a)$	$U_L^b(a)$	$U_L^g(a)$	$U_H^b(a)$	$U_H^g(a)$	$P_L^b(a)$	$P_L^g(a)$	$P_H^b(a)$	$P_H^g(a)$
0	1	0.768	0.806	1.559	1.623	12.152	12.367	12.159	12.373				
K^b	.7258	1.139	1.299	1.968	2.166	11.795	11.909	11.830	11.926	0.3712	0.4924	0.4042	0.5229
K^g	.6116	1.138	1.296	1.963	2.146	11.793	11.898	11.834	11.944	0.3703	0.4900	0.4042	0.5229
Unmatched						U_0^b		U_0^g					
						12.067		12.285					

[a]Elapsed time since the last rejected screening offer

5. Employment Fluctuations

The model has two kinds of unemployment. Some workers are currently unmatched, following a permanent separation from their previous employers. Others are still matched with an employer, but unemployed because their contracts have recently broken down; such workers are described as being on temporary layoff.

Permanent Separations

The process governing job creation and destruction is not affected by temporary layoffs. Let U(t) be the proportion of unmatched workers. This is determined in the usual way by solving the piecewice-linear differential equation

$$\dot{U}(t) \;=\; \delta\left[1 - U(t)\right] - \alpha\, U(t)$$

where $(\alpha,\delta) = (\alpha^b,\delta^b)$ if the current aggregate state is bad, and otherwise $(\alpha,\delta) = (\alpha^g,\delta^g)$. If the aggregate state has been good during the interval $[T_1,t]$, then

$$U(t) \;=\; U_g^* + e^{-(\delta^g+\alpha^g)(t-T_1)}\left[U(T_1) - U_g^*\right]$$

where U_g^* is the steady-state level of permanent separations corresponding to the good aggregate state:

$$U_g^* \;=\; \frac{1}{1+\frac{\alpha^g}{\delta^g}}$$

Similarly, if the aggregate state has been bad during the interval $[T_0,t]$, then

$$U(t) \;=\; U_b^* + e^{-(\delta^b+\alpha^b)(t-T_0)}\left[U(T_0) - U_b^*\right]$$

where U_b^* is the steady-state level of permanent separations corresponding to the bad aggregate state. Thus the path of U(t) can be determined for any history of the Markov switching process determining the aggregate state, by stitching together the segments between switching points.

Survival Analysis

In order to determine the aggregate flow of temporary layoffs, it is necessary to keep track of the distribution of job matches over ages (where age refers to elapsed time since the last rejected offer, rather than the actual age of the match, which is irrelevant). Let $\ell(t,a)$ be the density of low-private-valuation matches aged a at time t, and let L(t,a) be the stock of low-private-valuation matches aged a or greater; also, let z(t,a) be the density of matches aged a at time t (including both low and high private valuations). The vector x is defined as

$$x(t,a) = \begin{bmatrix} \ell(t,a) \\ z(t,a) \end{bmatrix}$$

The cohort of matches in which offers were rejected at date t is $\ell(t,0) = z(t,0)$. This cohort includes the flow of temporary layoffs and the flow of new matches in the low state.

The size and composition of each cohort as it ages over the interval $[0,K^g]$ are determined by the following differential equation (with the time variable suppressed):

$$\dot{x}(a) = \begin{bmatrix} \dot{\ell}(a) \\ \dot{z}(a) \end{bmatrix} = \begin{bmatrix} -\Lambda-\delta & \lambda_H \\ 0 & -\delta \end{bmatrix} \begin{bmatrix} \ell(a) \\ z(a) \end{bmatrix}$$

For a cohort of age a, let a^g and a^b denote the amount of time spent in the good and bad aggregate states, with $a = a^g + a^b$. Recall that $\psi(a)$ is the probability that the employer's valuation is low at date t+a, given that the valuation was low at date t. Thus the size and composition of the cohort at age a are given by

$$\ell(a) = \psi(a)z(a)$$

$$z(a) = e^{-\delta^b a^b} e^{-\delta^g a^g} \ell(0)$$

Steady States

In the good aggregate state, the stock of contracts that have reached the screening age evolves according to the following system

$$\begin{bmatrix} \dot{L}(K^g) \\ \dot{Z}(K^g) \end{bmatrix} = \begin{bmatrix} -\Lambda - \delta^g - \lambda_0 & \lambda_H \\ -\lambda_0 & -\delta^g \end{bmatrix} \begin{bmatrix} L(K^g) \\ Z(K^g) \end{bmatrix} + \begin{bmatrix} \ell(K^g) \\ z(K^g) \end{bmatrix} + \begin{bmatrix} 0 \\ \alpha^g(1-\mu)U \end{bmatrix}$$

Thus in the good steady state,

$$0 = \begin{bmatrix} -\Lambda - \delta^g - \lambda_0 & \lambda_H \\ -\lambda_0 & -\delta^g \end{bmatrix} \begin{bmatrix} L(K^g) \\ Z(K^g) \end{bmatrix} + \begin{bmatrix} \ell(K^g) \\ z(K^g) \end{bmatrix} + \begin{bmatrix} 0 \\ \alpha^g(1-\mu)U \end{bmatrix}$$

This implies

$$L(K^g) = \frac{\left[\lambda_L + \left(\lambda_H + \delta^g \psi(K^g)\right) e^{-\delta^g K^g}\right] \mu \left(1 - U_g^*\right)}{\Lambda + \delta^g + \lambda_0 \left(1 - \psi(K^g)\, e^{-\delta^g K^g}\right) + \lambda_H \lambda_0 \dfrac{1 - e^{-\delta^g K^g}}{\delta^g}}$$

Recession Dynamics

This section considers the path of unemployment during and after a recession. It is assumed that the economy starts in the good steady state. At date T_0 the aggregate state switches from good to bad, and at date T_1 the state switches back. It is assumed that the duration of the recession is less than the length of the pooling phase in the bad aggregate state, but greater than the difference between this and the length of the pooling phase in the good state. That is,

$$K_g - K_b < T_1 - T_0 < K_b$$

The evolution of the age distribution is sketched in Figure 3. The diagonal flow in this diagram shows the increase in age over time.

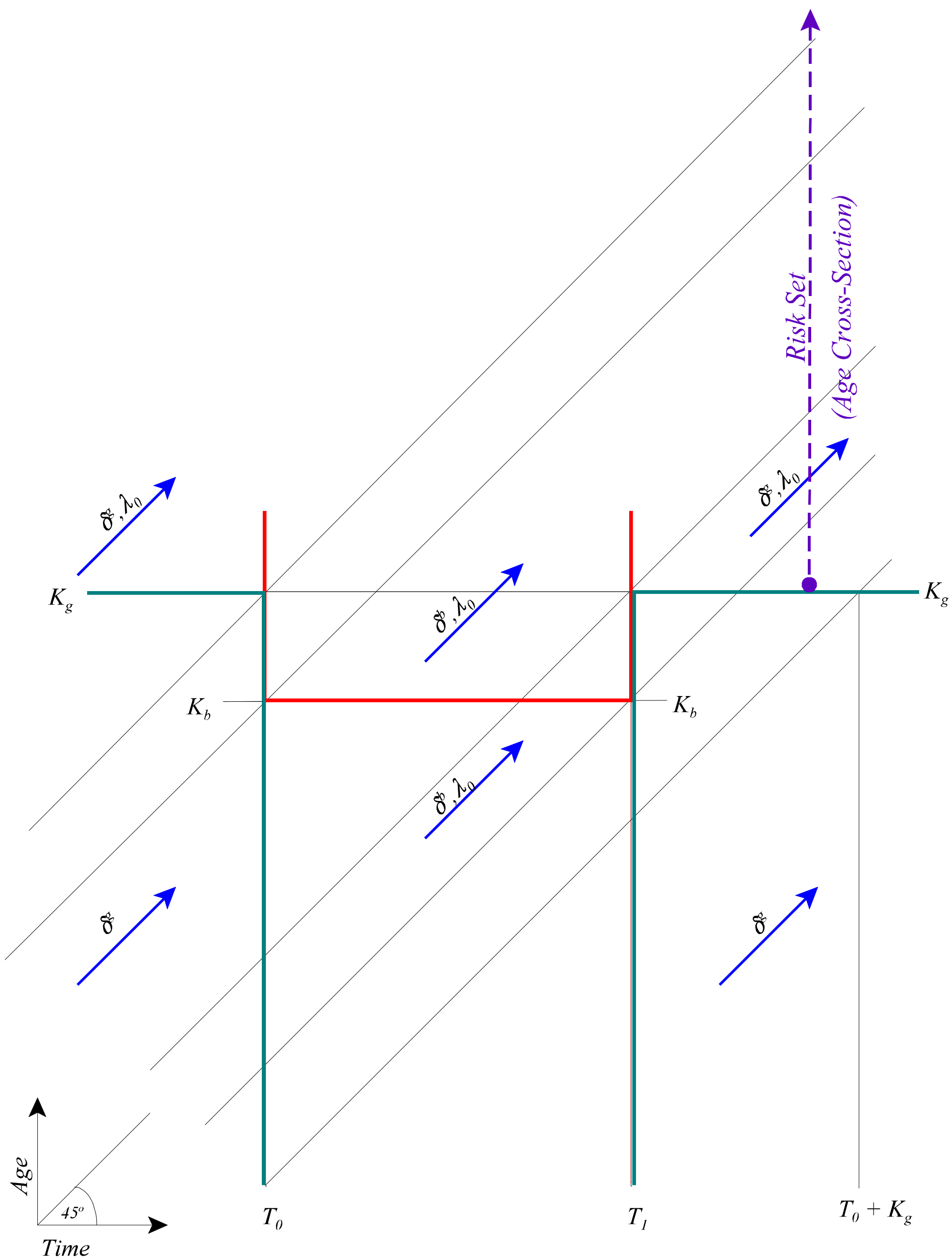

Figure 3: Survival analysis for cohorts born before the recession.

The Risk Set

Contracts are at risk of breakdown when the employer's current valuation is low, and when the contract is old enough to have reached the screening region. The set of such contracts is L(K): this will be called the risk set – meaning $L(K_b)$ during the recession, and $L(K_g)$ otherwise. During the recession, the risk set has two parts. Some contracts are at risk only because the aggregate state is bad. This "conditional" risk set is denoted by $L^c = L(K_g) - L(K_b)$, while the unconditional risk set is denoted by $L^u = L(K_g)$.

Expiration of a contract that has reached age K triggers a screening offer. This initiates a temporary layoff if the employer is currently in the low state, and the age counter is reset to zero in this case. On the other hand, if the employer is currently in the high state, the screening offer is accepted, and the age counter is set to K^g, meaning that there will be another screening offer when the new contract expires, regardless of the aggregate state.

The Conditional Risk Set

The conditional risk set is analyzed in Appendix B: the results are summarized here. For $t \in [T_0, T_0 + k]$, the stock of contracts of age $a \in [K^b, K^g]$ is

$$Z^c(t) = \left(\Upsilon(\lambda_0 + \delta^g, \tau) + e^{-(\lambda_0+\delta^g)\tau}\Upsilon(\delta^g, k-\tau)\right) e^{-\delta^g K_b} e^{-\Delta\tau} \ell_g^*(0)$$

where $\Delta = \delta^b - \delta^g$ and

$$\Upsilon(\theta, x) = \frac{1 - e^{-\theta x}}{\theta}$$

The conditional risk set is

$$L^c(t) = \mu Z^c(t) + (1-\mu)\left(\Upsilon(\lambda_0 + \delta^g + \Lambda, \tau) + e^{-(\lambda_0+\delta^g+\Lambda)\tau}\Upsilon(\delta^g + \Lambda, k-\tau)\right) e^{-(\delta^g+\Lambda)K^b} e^{-\Delta\tau} \ell_g^*(0)$$

So

$$H^c(t) = (1-\mu)\left[Z^c(t) - \left(\Upsilon(\lambda_0 + \delta^g + \Lambda, \tau) + e^{-(\lambda_0+\delta^g+\Lambda)\tau}\Upsilon(\delta^g + \Lambda, k-\tau)\right) e^{-(\delta^g+\Lambda)K^b} e^{-\Delta\tau} \ell_g^*(0)\right]$$

where $H^c(t)$ is the set of high-valuation contracts that are in the conditional screening region.

For $t \in [T_0 + k, T_1]$,

$$X^c(t) \; = \; e^{-\Delta(\tau-k)} X^c(T_0+k)$$

The Unconditional Risk Set

During the recession, the set of contracts in the unconditional screening region evolves according to

$$\dot{X}^u(t) \; = \; \begin{bmatrix} -\Lambda-\delta^b-\lambda_0 & \lambda_H \\ -\lambda_0 & -\delta^b \end{bmatrix} X^u(t) + x(t,K^g) + \begin{bmatrix} 0 \\ (1-\mu)\alpha^b U(t) \end{bmatrix} + \lambda_0 \begin{bmatrix} 0 \\ H^c(t) \end{bmatrix}$$

The coefficient matrix in this system can be written as A - δ^b I. Suppose -ρ_1 and -ρ_2 are the roots of A (the roots are negative, so ρ_1 and ρ_2 are positive). The solution can be written as

$$\left(\rho_2 - \rho_1\right) X^u(t) \; = \; \left(A + \rho_2 I\right) X_1(t) \; - \; \left(A + \rho_1 I\right) X_2(t)$$

where

$$X_i(t) \; = \; e^{-(\rho_i+\delta^b)\tau_0} \left(X^u(T_0) + \int_0^{\tau_0} e^{(\rho_i+\delta^b)s} b(T_0+s)\, ds \right) \; , \; i = 1,2$$

with τ_0 = t - T_0, and

$$b(t) \; = \; x(t,K^g) + \begin{bmatrix} 0 \\ (1-\mu)\alpha^b U(t) \end{bmatrix} + \lambda_0 \begin{bmatrix} 0 \\ H^c(t) \end{bmatrix}$$

At date T_0 + k, the formula for H^c changes, as described above, and $X_i(t)$ is given by

$$X_i(t) \; = \; e^{-(\rho_i+\delta^b)\tau_1} \left(X^u(T_0+k) + \int_0^{\tau_1} e^{(\rho_i+\delta^b)s} b(T_0+k+s)\, ds \right) \; , \; i = 1,2$$

where τ_1 = t - T_1. After the recession ends, the conditional risk set is no longer relevant, and the job creation and destruction rates revert to α^g and δ^g. Moreover, after date T_0 + K^g, the initial cohort size is no longer constant. The solution for the risk set is obtained in segments: the first four segments are the intervals $[T_0, T_0+k]$, $[T_0+k, T_1]$, $[T_1, T_1+k]$, $[T_1+k, T_0+K^g]$, and the next four are obtained by shifting these forward by K^g, and this pattern is repeated *ad infinitum.* The details of this construction are given in Appendix C.

Quantitative Implications

In this section the model is used to describe a recession and the subsequent recovery, using realistic parameter values. The main focus is on the extent to which cyclical variations in worker flows are influenced by the dynamics of temporary layoffs.

The standard way to judge the empirical relevance of a model of employment fluctuations is to ask whether it can match selected moments of the data, using reasonable parameter values, as in Mortensen and Pissarides (1994), Cole and Rogerson (1999) and Merz (1999). The question addressed here is more narrowly focused: what does a recession look like in the model, relative to the data? This question is interesting in part because it leads to a more concrete analysis of what actually happens in the model. In addition, the moments usually considered in the standard method miss an important feature of the data: a recession is best described as an unusual and short-lived aberration from the normal state of the economy. This feature is well captured by the Markov jump process used here (when λ_b is substantially larger than λ_g), but it is obscured by the standard statistics used in the real business cycle literature.

Empirical Measurements of Worker Flows

Only about half of the stock of workers in the unemployment pool in the U.S. in an average month are there because they have been laid off (the rest being quits, new entrants, and a residual that includes re-entrants). Thus the model in this paper (like the MP model) cannot be expected to reproduce the aggregate unemployment rate, mainly because the model does not explain labor force transitions.
[but modeling temporary layoffs gives a more realistic description of flows within the labor force].
There is a big gap between the job destruction flow in the Mortensen-Pissarides model and the empirical counterpart in the Davis-Haltiwanger-Schuh (1996) data. This is illustrated in Figure 4, using CPS gross flow data taken from Bleakley, Ferris and Fuhrer (1999).[5]

[5]The worker flow data (which can be found at http://www.bos.frb.org/economic/neer/neer1999/neer499c.htm) are seasonally adjusted quarterly averages of CPS matched monthly observations.

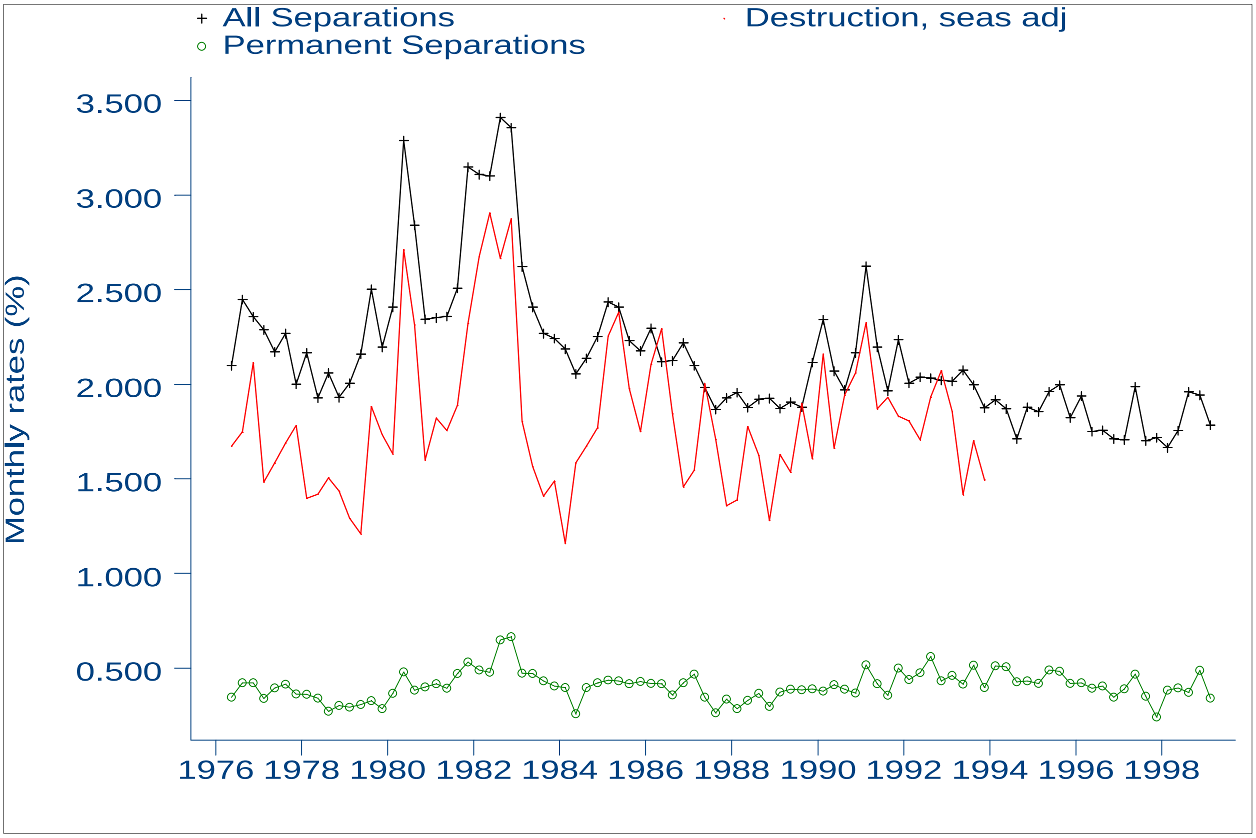

Figure 4: Worker Separations and Job Destruction in Manufacturing

The series in the middle of the figure is the DHS job destruction measure (seasonally adjusted), and the series at the top is the total worker separation flow, including permanent and temporary layoffs, quits and labor force exits. The similarity between these two series is impressive, given that one is based on a household survey, and the other is based on an establishment survey. In contrast, the series at the bottom of the figure measures the permanent layoff flow from employment to unemployment (excluding workers who left the labor force following a permanent separation). These separations coincide with job destruction in the MP model, but in fact they are only a small part of the job destruction process in manufacturing. Moreover, Figure 5 shows that cyclical fluctuations in the job destruction series are similar to the fluctuations in the worker separation series when the permanent layoff flow from employment to unemployment is *excluded*.[6] Thus any model that tries to explain the job destruction data in terms of permanent separations is largely beside the point. A broader interpretation of worker separations in the MP model might include quits and labor force exits, but given the rules of the

[6]NBER business cycle peaks are indicated by vertical lines in Figure 5.

Unemployment Insurance system there is a big difference between quits and layoffs for workers who are firmly attached to the labor force (which is true of all of the workers in the MP model), and the MP model has nothing to say about workers who move in and out of the labor force.

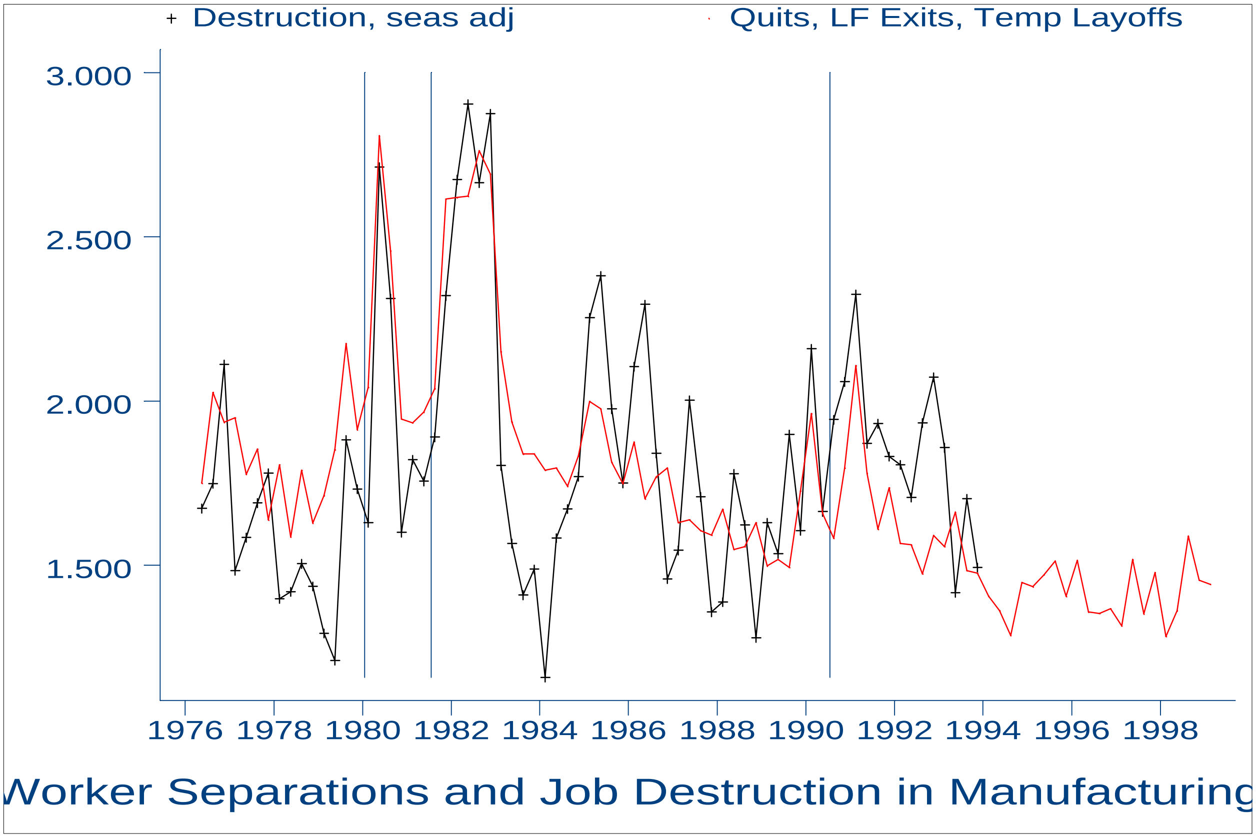

Figure 5

This paper bridges part of the gap between the MP model and the DHS data by explicitly modeling temporary layoffs. In this respect the paper follows Merz (1999), although the economic interpretation is quite different: in Merz's model, temporary layoffs are caused by a temporary decline in productivity, such that the expected cost of an unemployment spell is less than the cost of recruiting a new worker when productivity recovers. Figure 6 uses CPS data on unemployment by reason to show movements in the stocks of temporary and permanent layoffs. About 30% of the stock of workers unemployed due to layoffs in a typical month are on temporary layoff. There is no indication that the relative importance of temporary layoffs has declined over time (for example, the proportion on temporary layoff in 2000 was 33%), although the volatility of temporary layoffs does seem to have decreased.

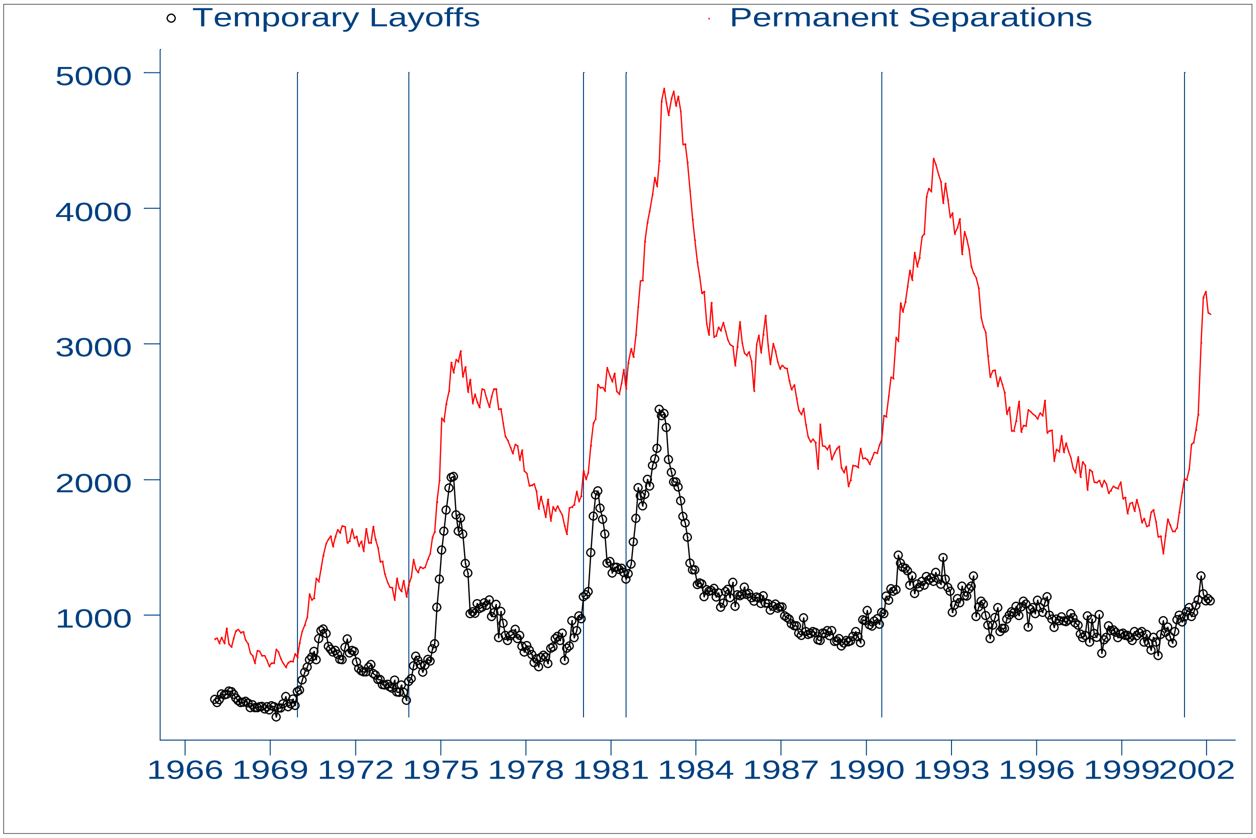

Figure 6: Workers on Permanent and Temporary Layoff (thousands, seasonally adjusted)

A notable feature of the data in Figure 6 is that the stock of temporary layoffs increases rapidly at the beginning of a recession (i.e., during the period immediately after a business cycle peak), and then starts to decline, while the stock of workers on permanent layoff continues to rise. As will be seen, the informational conflict model of temporary layoffs can match this feature quite well.

The relative magnitudes of the temporary and permanent layoffs flows are shown in Figure 7, again using the Bleakley, Ferris and Fuhrer data.[7] These flows are of roughly equal importance on average, and the cyclical fluctuations in temporary separations are more important than the cyclical fluctuations in permanent separations.

[7]The data in this Figure are centered moving averages.

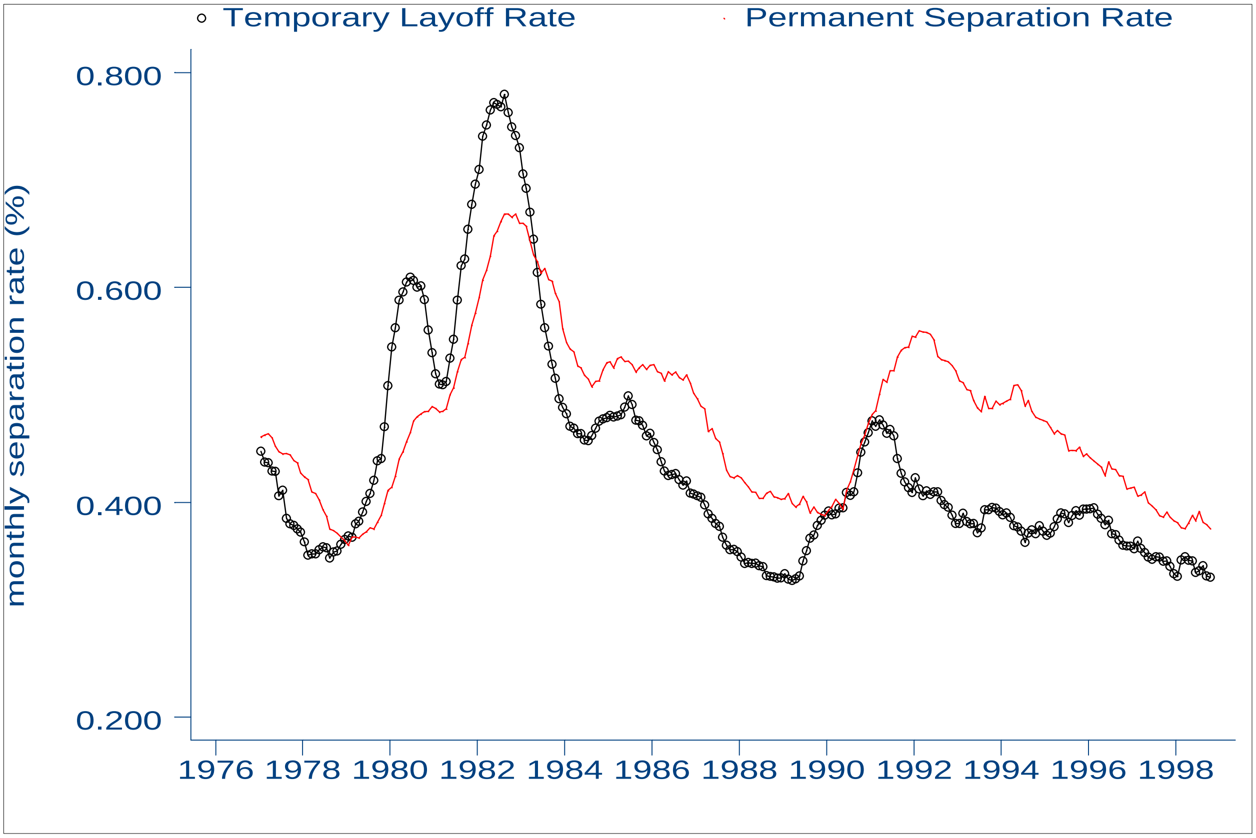

Figure 7: Temporary and Permanent Separation Flows

Figure 6 shows that temporary layoffs are a relatively small part of the unemployment stock, while Figure 7 shows that they are a relatively big part of the inflow. Figure 8 reconciles these two observations, using unemployment duration data for spells that are immediately followed by employment, rather than labor force exit. Temporary layoff spells last about 3 weeks on average, and there is not much variation in this over the cycle. Unemployment spells following permanent separations last much longer, with big cyclical fluctuations.

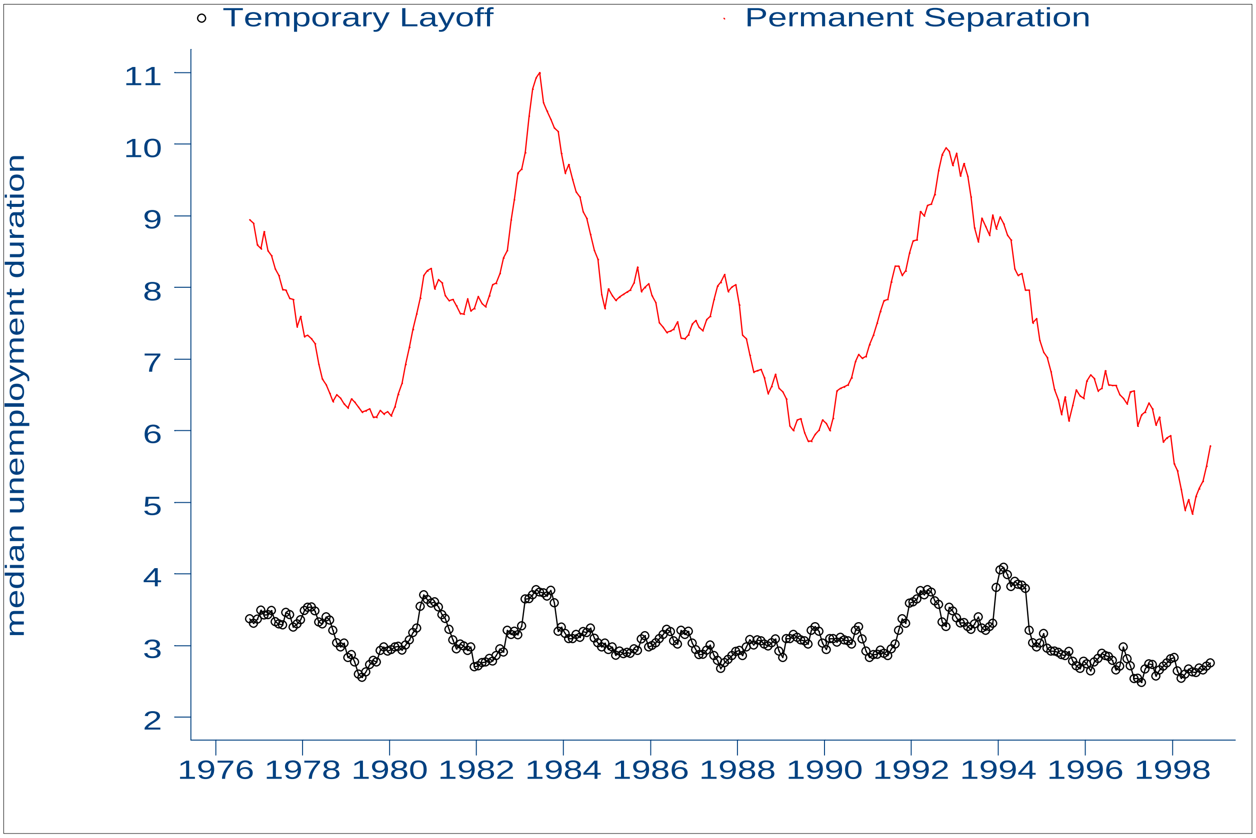

Figure 8: Unemployment Duration

Parameter Values

The model has three basic parameters (r, λ_0, t_0), five state-contingent productivity levels $(w_0, y_L^b, y_L^g, y_H^b, y_H^g)$, and eight state transition rates $(\lambda_L, \lambda_H, \lambda_b, \lambda_g, \alpha_b, \alpha_g, \delta_b, \delta_g)$. If the aggregate state is usually good (and if the system is not too persistent), a recession can reasonably be approximated by starting from the good steady state, with a transition to the bad aggregate state at some date T_0, followed by a reversion to the good state at date T_1. Given that the average duration of (postwar) recessions is about a year, T_1 is set to 1, with $T_0 = 0$. Although the productivity levels and the aggregate state transition rates (λ_b, λ_g) affect the equilibrium values of K_b and K_g, nothing is lost by ignoring the details of this relationship and choosing K_b and K_g directly.

Some of the parameter values are roughly pinned down by the data, while others are more speculative. The parameter list is ($t_0 = .06$, $\delta_b = 2/5$, $\delta_g = 1/3$, $\alpha_b = 3$, $\alpha_g = 5$, $\lambda_0 = 1$, $\lambda_L = 3/8$, $\lambda_H = 3/8$, $K_b = 1.06$, $K_g = 2$). The time unit is a year.

- In the CPS data, the median duration of temporary layoff unemployment spells is about 3 weeks, or about .06 years, and as Figure 8 shows, there in not much cyclical variation in this. This gives $t_0 = .06$.
- For the 5-year period 1994-1998, Bleakley et al measured the average outflow from the stock of permanently separated workers as 2.8+1.9 (new jobs + labor force exits); the inflow was 3.1, and the stock was 11.3. This gives an average flow of 3.9/11.3, implying $\alpha_g = 5.08$. The lowest value of the escape rate from unemployment was about 60% of the highest value (over the period 1977-1998), suggesting that if α_g is set to 5, α_b should be 3. Taking the extremes in this way exaggerates the cyclical variability of the flow from permanent separations to new jobs, but this ignores labor force exits, and there is more cyclical variability in the duration of unemployment spells followed by labor force exit than there is in the duration of unemployment spells that end with new jobs.
- According to Davis, Haltiwanger and Schuh (1996), the job destruction rate in manufacturing is 5.5% per quarter (an annual rate of 0.22), and this is used by Cole and Rogerson (1999) as the permanent separation rate. In the Bleakley et al data for manufacturing the corresponding figure for worker flows is .2615 per annum. But this includes all outflows from employment – quits, labor force exits and "re-entrants" (the residual category) along with permanent and temporary layoffs. If the duration of temporary layoffs is less than a month (as the data suggest), then the DHS measure should miss most of them, since their data are measured quarterly. When permanent separations are measured as the proportion of workers employed last month who are unemployed this month because of a permanent layoff, the separation rate is only .057. In light of these ambiguities, $\delta_g = ⅓$ is simply chosen so as to match the ratio of the temporary layoff and permanent separation flows[8], which is approximately 1.2. Then δ_b is set slightly above δ_g.
- The remaining parameters were chosen with little guidance from the data. Setting $\lambda_0 = 1$ means that the expected duration of a labor contract is one year, which seems like a natural choice given that many wages are adjusted annually. Setting $K_g = 2$ means that it normally takes two years before workers become optimistic enough to make tough demands following a previous conflict; $K_b = T_0 + t_0$ is chosen to give a sharp contrast between the chances of informational conflict in the good and the bad state (while avoiding some tedious calculations needed if a contract that begins during the recession can reach the screening region before the recession ends). The process driving the

[8]Using a temporary layoff duration of 3 weeks, it is assumed that one quarter of all temporary layoffs escape notice in the CPS, so the observed flow is scaled up by 4/3.

idiosyncratic revenue component is assumed to be symmetric ($\lambda_L = \lambda_H$), with less than unit persistence ($\lambda_L + \lambda_H = ¾$).

Implications

The path of the risk set for this numerical example is shown in Figure 9. When the recession begins, there is a jump in the risk set because contracts older than K_b and younger than K_g are suddenly at risk. When the recession ends, this jump is reversed, but the magnitude of the jump is different.[9] At date $T_0 + K_g$, the risk set starts increasing rapidly, because there is a relatively large flow of contracts that restarted soon after the recession began, and these are now reaching the screening region.

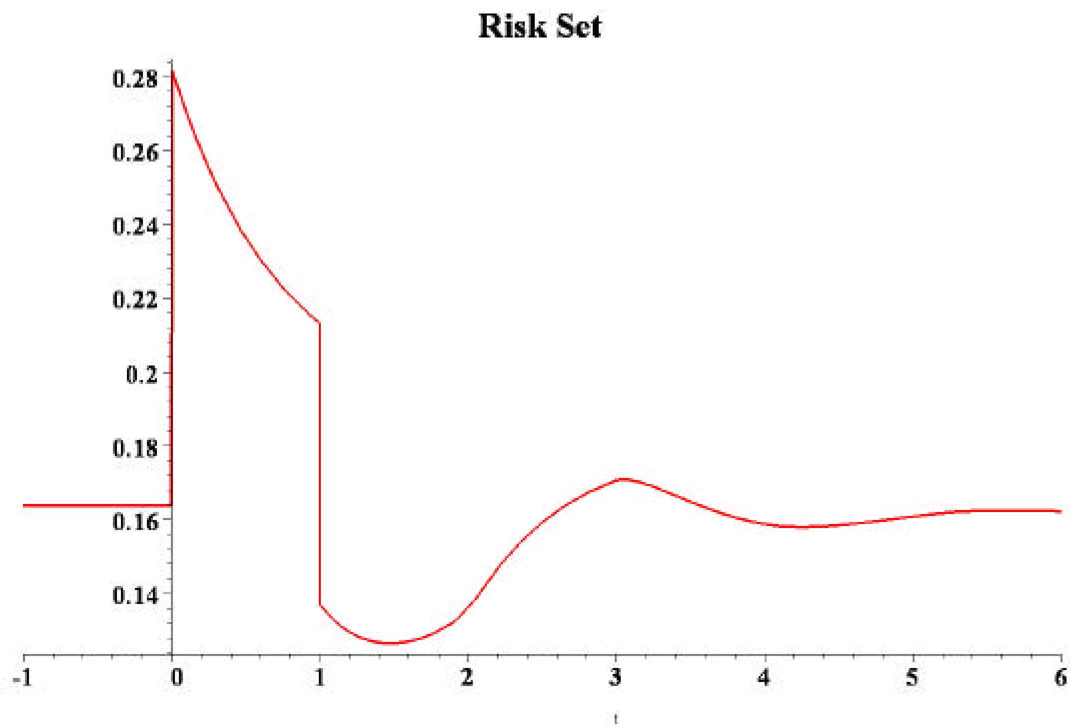

Figure 9: The Risk Set

The unemployment stocks are shown in Figure 10. The temporary layoff stock (the lower series in the figure) is basically proportional to the integral of the risk set over the interval ($t-t_0$,t), but it is adjusted for permanent separations that occur during a temporary layoff, and it excludes layoffs that occur at the beginning of new matches (on the grounds that these would not be classified as temporary layoffs in the

[9]This asymmetry in the size of the jumps occurs for several reasons: (1) the system is no longer in the steady state; (2) the survival probability to age K_b is lower during the recession than it was before the recession began; (3) contracts older than K_b have been exposed to the risk of a temporary layoff during the recession.

data). There is a sharp spike in temporary layoffs when the recession begins, and a smaller drop when the recession ends. The stock of permanent separations builds up more slowly during the recession, and returns to the good steady state about a year after the recession ends. Thus the model (as parameterized in this example) has the property that temporary layoff unemployment declines long before the recession ends, while permanent layoff unemployment continues to rise.[10]

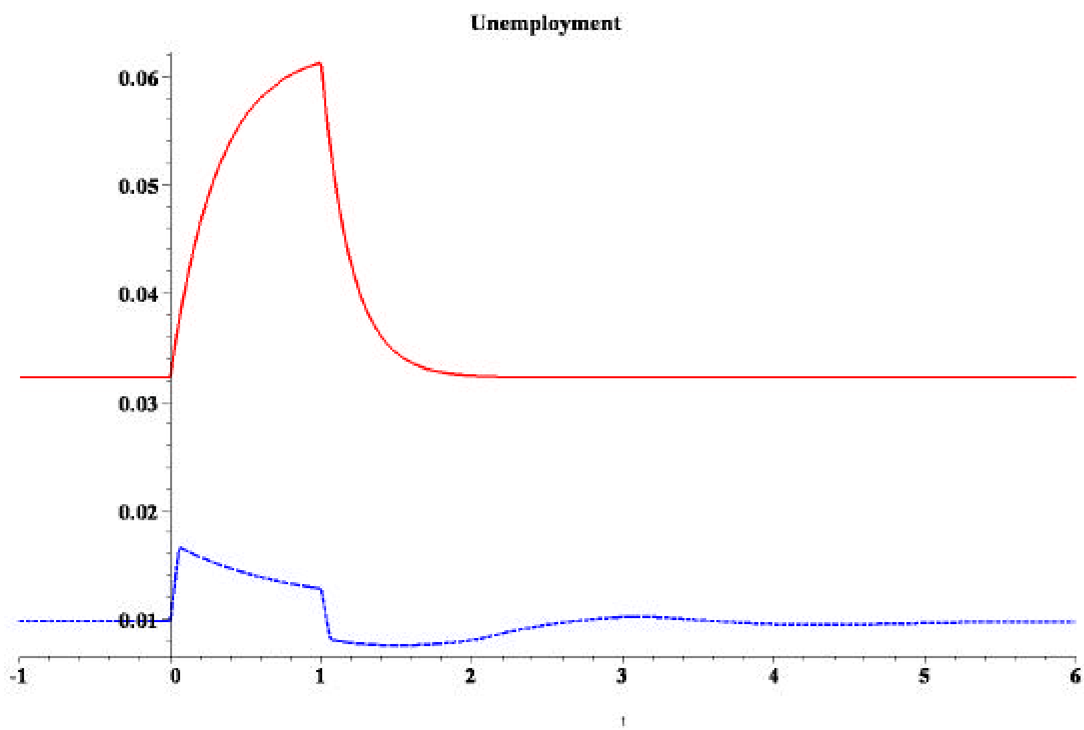

Figure 10: Permanent and Temporary Layoff Stocks

The layoff flows are shown in Figure 11. The temporary layoff flow (the dashed line in the figure) is just the risk set (since $\lambda_0 = 1$). In contrast to the stock measures, the flow of temporary layoffs is bigger and more volatile than the flow of permanent separations, as is the case in the data. In particular, the temporary layoff flow takes a long time to return to normal after the end of the recession. This is because the recession tends to synchronize the timing of the screening cycle across job matches; the synchronization is ultimately dissipated by random realizations of the idiosyncratic productivity process, and by match destruction, but this takes time.

[10]For some parameter values, the recession generates two separate peaks in the unemployment rate. Note that this can't happen in the Mortensen-Pissarides model. When the aggregate state switches from good to bad in that model, there is a discrete jump in the unemployment level (because some jobs were viable only as long as the aggregate state was good), and this is followed by a monotonic adjustment toward the bad steady state.

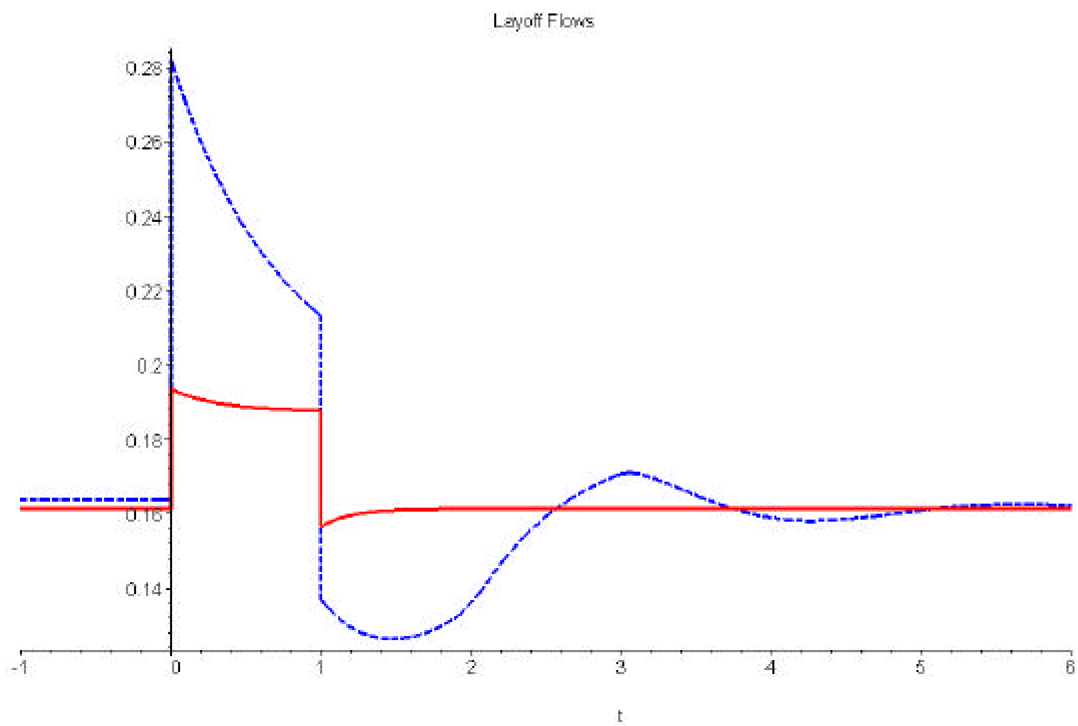

Figure 11: Permanent and Temporary Layoff Flows

Conclusion

The paper presents a new interpretation of temporary layoffs: they are caused by informational friction between workers and employers. The model can generate worker flow data that look like what happens in U.S. data during recessions. In the model, the spike in job destruction that occurs at the beginning of a recession is generated to a large extent by temporary layoffs. This matches the data, and it improves on the Mortensen-Pissarides model.

It is difficult to tell from the job flows data whether spikes in job destruction are caused by temporary layoffs (one can ask whether establishments showing big employment losses at the onset of a recession have offsetting employment gains in subsequent quarters, but given that there are only three recessions in the basic data set, with large seasonal employment changes getting in the way, there is not much hope of getting a reliable answer to this question). Meanwhile, as Katz and Meyer (1990) point out, most workers who claim unemployment insurance indicate that they expect to be recalled by their previous employer, so that the Mortensen-Pissarides model may be missing the point by treating all unemployed workers as permanently separated from their jobs. This paper goes to the other extreme, attributing job destruction bursts entirely to temporary layoffs.[11]

If workers can commit to leave this match and search for a new one whenever a wage demand is rejected, there is no employment cycle at the micro level. On the other hand, this may lead to more realistic unemployment dynamics in the aggregate. The most interesting case is when μ lies in the conditional screening region. Then when a new match is made, there is a screening offer if the aggregate state is bad, and a pooling offer if the aggregate state is good. Following acceptance of a screening offer, the worker is optimistic enough to screen again if the contract expires soon. But after some time the belief reaches the unconditional screening region, and stays there. On the other hand, rejection of a screening offer breaks up the match, so the worker's belief is never more pessimistic than μ. At the start of the recession, all matches enter the risk set, so there is a jump in the separation rate. When the recession ends, matches of age greater than K immediately leave the risk set (where age is redefined as elapsed time since the last *accepted* screening offer). The main point of this version of the model is that informational conflict continues to generate permanent separations for some time after the recession ends, because some workers made successful screening demands during the recession, and they remain optimistic enough to make aggressive demands for some time after the recession ends.

Appendices

See http://www.ssc.wisc.edu/~jkennan/research/index.htm.

[11]Of course there is a range of less extreme cases. When productivity is low, the firm could lay off a worker permanently, and then search for a new worker if productivity recovers; alternatively, the worker can be laid off temporarily, and recalled if productivity recovers. Merz (1999) analyzes the socially efficient allocation in such an economy, assuming complete information, and asks whether such an allocation might exhibit employment fluctuations matching those seen in the data. The results in this paper suggest that these fluctuations might instead be explained by private information.

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