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Abstract

We investigate the effect of employer-provided health insurance on job mobility rates and economic welfare. In particular, we develop and estimate an equilibrium model of wage and health insurance determination that yields implications that are empirically observed. Namely, not all jobs provide health insurance and jobs with insurance pay higher wages than those without insurance. Using data from the 1990 to 1993 panels of the Survey of Income and Program Participation, we find that jobs that do provide health insurance last almost five times longer than jobs that do not. While this implies that the mobility rate for jobs without insurance is significantly higher than the mobility rate for jobs with insurance, this difference is welfare enhancing since jobs with health insurance are more productive jobs. Furthermore, simulations reveal that decreasing the health insurance premium paid by employers increases the steady state health insurance coverage rate, decreases the unemployment rate, but may or may not lead to productivity gains in the economy.

1 Introduction

Health insurance is most often received through one's employer in the United States. According to U.S. Census Bureau statistics, almost 85% of Americans with private health insurance gain their coverage through the labor market. The connection between employment decisions and health insurance coverage has generated a substantial amount of interest, among labor and health economists, in the possible explanations for and impacts of this linkage. One branch of the literature has investigated the relationship between employer-provided health insurance and job mobility. In spite of a substantial amount of research on the issue, the relationship between health insurance coverage and mobility rates has not as yet been satisfactorially explained. Basing their arguments largely on anecdotal evidence, many proponents of healthcare reform, including President Clinton, claim that the present employment-based system causes some workers to remain in jobs they would rather leave since they are "locked in" to their source of health insurance. While it is true that individuals with employer-provided health insurance are less likely to change jobs than other individuals (Mitchell, 1982; Cooper and Manheit, 1993), the claim that health insurance is the cause of this result has not been established. Madrian (1994) estimates that health insurance leads to a 25 percent reduction in worker mobility, while Holtz-Eakin (1994) finds no effect, even though they use the identical methodology. Building on their approach, Buchmueller and Valletta (1996) and Anderson (1997) arrive at a reduction in worker mobility slightly larger than Madrian's estimate, while Kapur (1998) concludes there is no distortion due to health insurance. The most recent and only paper in this literature that attempts to explicitly model worker decisions, Gilleskie and Lutz (1999), finds that employment-based health insurance leads to no reduction in mobility for married males and a relatively small (10 percent) reduction in mobility for single males. Using statewide variation in continuation of coverage mandates, Gruber and Madrian (1994) find that an additional year of coverage significantly increases mobility which they claim establishes that health insurance does indeed cause reductions in mobility. It must be noted that while this literature has extensively examined how the employment-based system affects mobility, the more pressing welfare implications have largely been ignored (Gruber and Madrian, 1997; Gruber and Hanratty, 1995 are notable exceptions).

If health insurance coverage is perceived as strictly a nonpecuniary characteristic of the job, like a corner office or reserved parking space, the theory of compensating differentials would predict a negative relationship between the cost (or provision) of health insurance and wages. Somewhat surprisingly, Monheit et al. (1985) estimates a positive relationship. Subsequent research attempted to exploit exogenous variation from a variety of sources in order to accurately identify the "effect" of health insurance on wages. Gruber (1994) uses statewide variation in mandated maternity benefits, Gruber and Krueger (1990) employ industry and state variation in the cost of worker's compensation insurance, and Eberts and Stone (1985) rely on school district variation in health insurance costs to estimate the manner in which wages are affected. All three conclude that most (more than 80%) of the cost of the benefit is reflected in lower wages. In addition, Miller (1995) estimates significant wage decreases for individuals moving from a job without insurance to a job with insurance. Hence, the research that examines to what extent health insurance costs are passed on to employees finds that a majority of the costs are borne by employees in the form of lower wages.

These results from the two branches of the literature seem inconsistent on the face of it. If individuals are bearing the cost of the health insurance being provided to them by their employer, why are they apparently less likely to leave these jobs? In addition, the absence of a conceptual framework that is consistent with many of the empirical findings on job lock and the indirect costs of health insurance to workers means that few policy implications can be drawn from the empirical results that have been obtained.

In this paper we attempt to provide such a framework by developing and estimating an equilibrium model of employer-provided health insurance and wage determination. The model is based on a continuous-time stationary search model in which unemployed and employed agents stochastically uncover employment opportunities characterized in terms of idiosyncratic match values. Firms and searchers then engage in Nash bargaining to divide the surpluses from each potential employment match. In contrast to traditional matching-bargaining models (e.g., Flinn and Heckman, 1982; Diamond, 1982; and Pissarides, 1985), we allow employee compensation to vary over both wages and health insurance coverage. In our framework, health insurance coverage is not viewed as a form of nonpecuniary compensation, but rather as an endogenously-determined property of an employment contract that has a direct impact on the value of the match to both workers and firms. Since an employment contract may terminate due to the poor health of the employee, we view health insurance coverage as reducing the rate of "exogenous" terminations from this source. Starting from this premise, we are able to derive a number of implications from the model that coincide with both anecdotal and empirical evidence. Most basically, the model implies that not all jobs will provide health insurance, workers "pay" for health insurance in the form of lower wages, and jobs with health insurance coverage tend to last longer than those without (both unconditionally and conditionally on wage rates).

Using data from the 1990 to 1993 panels of the Survey of Income and Program Participation (SIPP), we find broad conformity with the implications of the model. In particular, the average duration of jobs that provide health insurance is five times greater than for jobs that do not. Estimates of the model imply a steady-state health insurance coverage rate of 58 percent and a steady-state coverage rate among workers of 70 percent. These rates are similar to estimates published by the Census bureau that are based on the same dataset.

The remainder of the paper proceeds as follows. In Section 2 we present three versions of a search-theoretic model of the labor market with matching and bargaining. To set ideas, we begin by outlining the standard model in which firms only make wage offers to all searchers and there is no on-the-job (OTJ) search. We then extend the model to allow for the provision of health insurance. In the first extension, we do not allow workers to meet new employers and hence job-to-job transitions are ruled out; the second extension is to allow on-the-job search. In this case we can explicitly analyze the phenomenon of "job lock" and determine whether it implies inefficiency in the labor market. Section 3 contains a discussion of the data used to estimate the equilibrium model, while section 4 develops the econometric methodology. Section 5 presents the empirical results and policy simulations associated with changing the health insurance premium. In section 6 we conclude and discuss extensions to the model that would be particularly valuable for performing more sophisticated policy analyses than are possible within the present framework.

2 A Model of Health Insurance Provision and Wage Determination

In this section we describe the behavioral model of labor market search with matching and bargaining. The model is formulated in continuous time and assumes stationarity of the labor market environment. In the first subsection, we derive the decision rules for terminating search (by accepting employment) and for dividing the match value between worker and firm when health insurance is not an option. In the second subsection, we describe the manner in which we introduce health insurance options into the model and derive the appropriate decision rules for this case.

Throughout we assume that there exists an invariant, technologically-determined distribution of worker-firm productivity levels which is given by $G(\theta)$. All individuals begin their lives in the nonemployment state, and we assume that it is optimal for them to search. The instantaneous utility flow in the nonemployment state is b, which can be positive or negative. When an unemployed searcher and a firm meet, which happens at rate λ, the productive value of the match (θ) is immediately observed by both the applicant and the firm. At this point a division of the match value is proposed using a Nash bargaining framework. In the first two versions of the model considered we do not allow for on-the-job search, without this phenomenon the basic structure of the model is clearer and comparative statics results are more easily derived. However, these models cannot be used to investigate the phenomenon of job lock and are clearly counterfactual, since a high proportion of jobs end with immediate entry into employment with a new firm. When we do allow for on-the-job search, we assume that employed individuals meet potential new employers at the constant rate λ_e.

Given the nature of the data available to us (from the supply side of the market), firms are treated as relatively passive agents throughout. In particular, we assume that the only factor of production is labor, and that total output of the firm is simply the sum of the productivity levels of all of its employees. Then if the firm "passes" on the applicant – that is, does not make an employment offer – its "disagreement" outcome is 0 [it earns no revenue but makes no wage payment]. With the additional assumption that there are no fixed costs of employment to firms, the implication is that employment contracts are negotiated between workers and firms on an individualistic basis, that is, without reference to the composition of the firm's current workforce.

2.1 Labor Market Decisions without Health Insurance

The model considered in this section assumes that there is no on-the-job search and that health insurance is either offered to no employees (or all of them). The potential employee's disagreement value is the value of continued search, which we denote V_n. For any given value of V_n there exists a corresponding critical match value $\theta^* = \rho V_n$, which has the property that all matches with values greater than θ^* will result in employment while all those matches of lower value will not. For any $\theta \geq \theta^*$, the wage offer is given by

$$w(\theta, V_n) = \arg\max_w \{V_e(w) - V_n\}^\alpha \left\{\frac{\theta - w}{\rho + \eta}\right\}^{1-\alpha}, \tag{1}$$

where without loss of generality it has been assumed that the firm shares the employee's effective rate of discount, $\rho + \eta$.

The value of employment at a wage of w is easily determined. Consider an infinitesimally small period of time Δt. Over this "period," either the individual will continue to be employed at wage w or s/he will lose their job. Job loss occurs at rate η. Then

$$V_e(w) = \frac{w\Delta t}{1 + \rho\Delta t} + \frac{1}{1 + \rho\Delta t}\left[\eta\Delta t\, V_n + (1 - \eta\Delta t)\, V_e(w)\right] + \frac{o(\Delta t)}{1 + \rho\Delta t}, \tag{2}$$

where the term $(1 + \rho\Delta t)^{-1}$is an "infinitesimal" discount factor associated with the small interval Δt, $\eta\Delta t$ is the approximate probability of being terminated from one's current employment by the end of Δt, V_n is the value of being nonemployed, and $o(\Delta t)$ is a term which has the property that $\lim_{\Delta t \to 0}(o(\Delta t)/\Delta t) = 0$. Note that the first term on the right hand side of [2] is the value of the wage payment over the interval, which is the total payment $w\Delta t$ multiplied by the "instantaneous" discount factor [think of the payment as being received at the end of the interval Δt]. After collecting terms and taking the limit of [2] as $\Delta t \to 0$, we have

$$V_e(w) = \frac{w + \eta V_n}{\rho + \eta}. \tag{3}$$

We now substitute [3] into [1] so as to simplify the problem as follows:

$$\begin{aligned} V_e(w) - V_n &= \frac{w + \eta V_n}{\rho + \eta} - V_n \\ &= \frac{w - \rho V_n}{\rho + \eta}, \end{aligned}$$

so that

$$\begin{aligned} w(\theta, V_n) &= \arg\max_w \, [w - \rho V_n]^\alpha [\theta - w]^{1-\alpha} \\ &= \alpha\theta + (1-\alpha)\rho V_n. \end{aligned} \tag{4}$$

We can now move onto computing the value of nonemployment. Using the same setup as above for defining the value of employment, we begin with the $\Delta t-$period formulation which is

$$\begin{aligned} & V_n = \frac{b\Delta t}{1+\rho\Delta t} + \frac{1}{1+\rho\Delta t}\{\lambda\Delta t \int \max[V_n, V_e(w(\theta, V_n))] \, dG(\theta) \\ & + (1-\lambda\Delta t)\, V_n\} + o(\Delta t), \end{aligned} \tag{5}$$

where $\lambda\Delta t$ is the approximate probability of encountering one potential employer over the interval. Rearranging and taking limits, we have

$$\rho V_n = b + \lambda \int_{\rho V_n} [V_e(w(\theta, V_n)) - V_n] \, dG(\theta).$$

Since

$$\begin{aligned} V_e(w(\theta, V_n)) &= \frac{\alpha\theta + (1-\alpha)\rho V_n + \eta V_n}{\rho + \eta} \\ &= \frac{\alpha\theta - \alpha\rho V_n}{\rho + \eta} + V_n, \end{aligned}$$

we have

$$V_e(w(\theta, V_n)) - V_n = \frac{\alpha\theta - \alpha\rho V_n}{\rho + \eta}.$$

Then the final (implicit) expression for the value of search is

$$\rho V_n = b + \frac{\alpha\lambda}{\rho + \eta} \int_{\rho V_n} [\theta - \rho V_n] \, dG(\theta). \tag{6}$$

Note that this expression is identical to the expression for the reservation value in a model with no bargaining when θ is the payment to the individual except for the presence of the factor α. This is not unexpected, since when $\alpha = 1$, the entire match value is transferred to the worker and search over θ is the same as search over w.

Now we can summarize the important properties of the model. The critical "match" value θ^* is equal to ρV_n, which is defined by [6]. Since at this match value the wage payment is equal to $w^* = w(\theta^*, V_n) = \alpha\theta^* + (1-\alpha)\theta^* = \theta^*$, the reservation wage is identical to the reservation match value. The probability that a random encounter generates an acceptable match is given by $\tilde{G}(\theta^*)$, where $\tilde{G}$ denotes the survivor function. The rate of leaving unemployment is $\lambda\tilde{G}(\theta^*)$. As we can see from [6], since θ^* is a decreasing function of α, rates of unemployment are higher when searchers have more bargaining power.

The observed wage density is a simple mapping from the matching density. Since

$$\begin{aligned} w(\theta, V_n) &= \alpha\theta + (1-\alpha)\theta^* \\ \Rightarrow \tilde{\theta}(w, V_n) &= \frac{w - (1-\alpha)\theta^*}{\alpha}, \end{aligned} \tag{7}$$

then the density function of observed wages is given by

$$h(w) = \begin{cases} \frac{\alpha^{-1} g\left(\tilde{\theta}(w, V_n)\right)}{\tilde{G}(\theta^*)} & w \geq \theta^* \\ 0 & w < \theta^*. \end{cases} \tag{8}$$

2.2 Bargaining with Health Insurance (No OTJ Search)

There are many reasons that individuals and families positively value employer-provided health insurance. We abstract from virtually all of them and use a modeling framework that provides a rationale for both firms and workers to simultaneously make health insurance provision choices. In particular, our model posits cooperative behavior between workers and firms in which an efficient choice of whether or not to purchase health insurance is made conditional on the value of the match. The model described above took the rate of termination of matches to be exogenous; we now allow the worker-firm pair to alter this dissolution rate through the purchase of health insurance for the worker. We take the rate of dissolution of the match to partially be determined by the health status of the worker; health insurance increases the worker's utilization rate of medical services and increases her general health status. The instantaneous health insurance premium is equal to ϕ. If purchased, the match dissolution rate decreases from η_0, the rate without insurance, to η_1. Thus matches with health insurance are, on average, longer than matches without health insurance. Due to the stationary environment, if health insurance is purchased to cover a particular match at any instant in time it will always be purchased. Therefore the exogenous rate of dissolution will be constant over the course of a particular employment match and take values in the set $\{\eta_0, \eta_1\}$.

The value of the Nash bargaining objective function is given by

$$S(w, d; \theta, V_n) = \{V_e(w, d) - V_n\}^\alpha \left\{\frac{\theta - w - d\phi}{\rho + d\eta_1 + (1-d)\eta_0}\right\}^{1-\alpha}, \tag{9}$$

given any wage w and health insurance provision choice d, where d is equal to 1 when health insurance is purchased and otherwise is equal to 0. Then the solution to the problem is given by the mapping

$$(w^*, d^*)(\theta, V_n) = \arg\max_{w,d} S(w, d; \theta, V_n).$$

Solving for the equilibrium contract value is most easily accomplished by first solving for an optimal w given a θ, V_n, and health insurance status d, for both cases $d = 0$ and $d = 1$. That is, let

$$\hat{w}(\delta, \theta, V_n) = \arg\max_{w} S(w, d = \delta; \theta, V_n), \ \delta = 0, 1,$$

and

$$\hat{S}(\delta, \theta, V_n) = S(\hat{w}(\delta, \theta, V_n), \delta; \theta, V_n),$$

so that $\hat{w}(\delta, \theta, V_n)$ is the optimal wage offer given health insurance status δ and $\hat{S}(\delta, \theta, V_n)$ is the maximum value of the Nash bargaining problem given health insurance status δ. Define the difference between the optimal value of the problem given health insurance insurance and the optimal value when it is not by

$$Q(\theta, V_n) = \hat{S}(1, \theta, V_n) - \hat{S}(0, \theta, V_n)$$

The optimal contract is then given by

$$(w^*, d^*)(\theta, V_n) = \begin{cases} (\hat{w}(0, \theta, V_n), 0) & \Leftrightarrow \quad Q(\theta, \rho V_n) < 0 \\ (\hat{w}(1, \theta, V_n), 1) & \Leftrightarrow \quad Q(\theta, \rho V_n) \geq 0 \end{cases}.$$

The solution to the problem is both relatively easy to derive and intuitive. Conditioning on θ, V_n, and a health insurance status of $d = 0$, we have

$$\hat{w}(0, \theta, V_n) = \alpha\theta + (1 - \alpha)\rho V_n, \tag{10}$$

so that

$$\begin{aligned} \hat{S}(0, \theta, V_n) &= \left(\frac{\alpha\theta + (1-\alpha)\rho V_n - \rho V_n}{\rho + \eta_0}\right)^{\alpha} \left(\frac{\theta - \alpha\theta - (1-\alpha)\rho V_n}{\rho + \eta_0}\right)^{1-\alpha} \\ &= \left(\frac{\alpha(\theta - \rho V_n)}{\rho + \eta_0}\right)^{\alpha} \left(\frac{(1-\alpha)(\theta - \rho V_n)}{\rho + \eta_0}\right)^{1-\alpha} \\ &= \frac{\alpha^{\alpha}(1-\alpha)^{1-\alpha}}{\rho + \eta_0}(\theta - \rho V_n). \end{aligned}$$

Similarly, with health insurance with an instantaneous premium of ϕ, we have

$$\hat{w}(1, \theta, V_n) = \alpha(\theta - \phi) + (1 - \alpha)\rho V_n \tag{11}$$

so that

$$\begin{aligned} \hat{S}(1, \theta, V_n) &= \left(\frac{\alpha(\theta - \phi) + (1-\alpha)\rho V_n - \rho V_n}{\rho + \eta_1}\right)^{\alpha} \times \\ &\quad \left(\frac{\theta - \alpha(\theta - \phi) - (1-\alpha)\rho V_n - \phi}{\rho + \eta_1}\right)^{1-\alpha} \\ &= \left(\frac{\alpha(\theta - \phi - \rho V_n)}{\rho + \eta_1}\right)^{\alpha} \left(\frac{(1-\alpha)(\theta - \phi - \rho V_n)}{\rho + \eta_1}\right)^{1-\alpha} \\ &= \frac{\alpha^{\alpha}(1-\alpha)^{1-\alpha}}{\rho + \eta_1}(\theta - \phi - \rho V_n). \end{aligned}$$

Now note that

$$\begin{aligned} Q(\theta, V_n) &= \alpha^{\alpha}(1-\alpha)^{1-\alpha}\left(\frac{(\theta-\phi-\rho V_n)}{\rho+\eta_1}-\frac{(\theta-\rho V_n)}{\rho+\eta_0}\right) \\ &= \frac{\alpha^{\alpha}(1-\alpha)^{1-\alpha}}{(\rho+\eta_1)(\rho+\eta_0)}\left[(\eta_0-\eta_1)(\theta-\rho V_n)-(\rho+\eta_0)\phi\right]. \end{aligned}$$

Since $\eta_0 - \eta_1 > 0$, $\partial Q(\theta, V_n)/\partial\theta > 0$. Therefore there exists a unique critical value θ^{**} such that

$$\begin{aligned} 0 &= Q(\theta^{**}, V_n) \\ \Rightarrow \theta^{**} &= \rho V_n + \frac{\rho+\eta_0}{\eta_0-\eta_1}\phi \\ &= \theta^* + \frac{\rho+\eta_0}{\eta_0-\eta_1}\phi \\ &> \theta^*. \end{aligned} \tag{12}$$

To summarize, given a value of V_n any match value of $\theta \geq \theta^*$ will be acceptable. An acceptable match value $\theta \in [\theta^*, \theta^{**})$ will result in a job without health insurance while a job with $\theta \in [\theta^{**}, \infty)$ will carry health insurance.

The final task is to characterize the value of search V_n. After a bit of manipulation, we can write the steady state value of nonemployment in this case as

$$\begin{aligned} \rho V_n &= b + \alpha\lambda\{(\rho+\eta_0)^{-1}\int_{\rho V_n}^{\rho V_n + \frac{\rho+\eta_0}{\eta_0-\eta_1}\phi}(\theta-\rho V_n)\, dG(\theta) \\ &\quad + (\rho+\eta_1)^{-1}\int_{\rho V_n + \frac{\rho+\eta_0}{\eta_0-\eta_1}\phi}^{\infty}(\theta-\phi-\rho V_n)\, dG(\theta)\}. \end{aligned}$$

With this value of V_n, the specification of the health insurance problem is complete.

The distribution of accepted wage-health insurance pairs is defined as follows. Given that $\theta \geq \theta^{**}$, the wage density is

$$m(w|d=1) = \begin{cases} \frac{\alpha^{-1} g\left(\frac{w-(1-\alpha)\theta^*}{\alpha}+\phi\right)}{\tilde{G}(\theta^{**})} & w \geq w_1^{\min} \\ 0 & w < w_1^{\min} \end{cases} \tag{13}$$

where $w_1^{\min} = \theta^* + \alpha\left(\frac{\rho+\eta_1}{\eta_0-\eta_1}\right)\phi$ represents the smallest possible wage for a job that provides health insurance. The conditional density of wages given no health insurance is

$$m(w|d=0) = \begin{cases} \frac{\alpha^{-1} g\left(\frac{w-(1-\alpha)\theta^*}{\alpha}\right)}{\tilde{G}(\theta^*)-\tilde{G}(\theta^{**})} & w \in [w_0^{\min}, w_0^{\max}] \\ 0 & w \notin \left[w_0^{\min}, w_0^{\max}\right] \end{cases} \tag{14}$$

where $w_0^{\min} = \theta^*$ and $w_0^{\max} = \theta^* + \alpha\left(\frac{\rho+\eta_0}{\eta_0-\eta_1}\right)\phi$. The wage $w_0^{\min}$ is the minimum paid at jobs without health insurance, while $w_0^{\max}$ represents the maximum possible wage at an uninsured job. Since the probability of having health insurance given an acceptable match value is

$$p(d=1) = \frac{\tilde{G}(\theta^{**})}{\tilde{G}(\theta^*)}, \tag{15}$$

the unconditional (w,d) distribution is

$$m\left(w,d\right)=\begin{cases}\frac{\alpha^{-1}}{\tilde{G}(\theta^*)}g\left(\frac{w-(1-\alpha)\theta^*}{\alpha}\right) & w\in[w_0^{\min},w_1^{\min})\ ,d=0\\ \frac{\alpha^{-1}}{\tilde{G}(\theta^*)}g\left(\frac{w-(1-\alpha)\theta^*}{\alpha}\right)^{(1-d)}g\left(\frac{w-(1-\alpha)\theta^*}{\alpha}+\phi\right)^{d} & w\in[w_1^{\min},w_0^{\max})\\ \frac{\alpha^{-1}}{\tilde{G}(\theta^*)}g\left(\frac{w-(1-\alpha)\theta^*}{\alpha}+\phi\right) & w\in[w_0^{\max},\infty),\ d=1\\ 0 & otherwise\end{cases}$$

Since $\eta_0-\eta_1>0$, then $w_0^{\max}>w_1^{\min}$ and there exits an interval of wages that both jobs with and without health insurance will pay even though there is perfect separation in θ space between match values that result in health insurance provision and those that don't. The size of this interval of overlap in wage space is most directly related to the size of the insurance premium and the bargaining power of searchers (α).

The marginal wage density is then

$$m\left(w\right)=\begin{cases}\frac{\alpha^{-1}}{\tilde{G}(\theta^*)}g\left(\frac{w-(1-\alpha)\theta^*}{\alpha}\right) & w\in[w_0^{\min},w_1^{\min})\\ \frac{\alpha^{-1}}{\tilde{G}(\theta^*)}\left(g\left(\frac{w-(1-\alpha)\theta^*}{\alpha}\right)+g\left(\frac{w-(1-\alpha)\theta^*}{\alpha}+\phi\right)\right) & w\in[w_1^{\min},w_0^{\max})\\ \frac{\alpha^{-1}}{\tilde{G}(\theta^*)}g\left(\frac{w-(1-\alpha)\theta^*}{\alpha}+\phi\right) & w\in[w_0^{\max},\infty)\\ 0 & otherwise\end{cases}$$

Figures 1 through 4 represent some of the features of the model in a graphical and easily understood form. The model parameters used to prepare the graphs are based on estimates of the equilibrium model obtained when using SIPP data.[1]

Figure 1 plots an estimated productivity p.d.f. which is assumed to belong to the log normal family of distributions. The lower dotted line represents the critical match value for leaving unemployment, θ^*, which is estimated to be approximately 4.91. The dotted line to the right represents θ^{**}, which is the critical match value for the match to provide health insurance coverage (its estimated value is 14.80). The likelihood that an unemployed searcher who encounters a potential employer will accept a job is the area to the right of θ^*. The likelihood that an unemployed searcher accepts a job that doesn't provide health insurance is then given by the probability mass in the area between the two critical values divided by the probability of finding an acceptable match, which in this case is about 70 percent.

In Figure 2 we plot the equilibrium mapping from match values into (w,d) pairs. The mapping begins at the match value θ^* and is increasing in θ up to the value θ^{**}. At this value there is a downword shift due to the cost of health insurance provision, with the mapping resuming its monotonicity in θ for all values greater than θ^{**}.

The wage densities conditional on health insurance status are displayed in Figure 3. We can clearly discern the area of overlap between these two densities. Since both these p.d.f.s are derived from slightly different mappings of the same p.d.f. $g(\theta)$, it is not surprising that they share general features in terms of shape. Note that the wage density conditional on not having health insurance

[1] The estimates are taken from the specification of the model in which employed agents are allowed to meet new potential employers. Therefore the wage functions and hazard rates out of jobs conditional on health insurance status refer to the first jobs accepted after an unemployment spell. We will discuss how the phenomenon of on-the-job search impacts the mapping between match values and wages for currently employed searchers in the next section.

is always defined on a closed interval $[w_0^{\min}, w_0^{\max}]$, while the range of wages conditional on having health insurance is unbounded so long as G has unbounded support.

In Figure 4 we plot the marginal wage density. The interval of overlap in the wage distribution adds a "bulge" to a density that otherwise resembles the parent log normal density. Recall that wages in the interval of the bulge are the only ones that can be *either* associated with health insurance or not. Wages in the right tail are always associated with jobs that provide health insurance while those to the left of the bulge are associated with jobs that do not provide health insurance.

We conclude this subsection by deriving some comparative static results for a number of important characteristics of the labor market. The characteristics in which we are particularly interested are the probability that a job includes health insurance, $p(d=1)$, the steady state unemployment rate, denoted u, and the steady state health insurance coverage rate, denoted h. We have shown that it is possible to characterize the equilibrium of the model in terms of the two critical values θ^* and θ^{**}. Our first result establishes the relationship between these values and the cost of providing health insurance, ϕ. We focus on the relationship between the equilibrium wage-health insurance distribution and the cost of providing health insurance since any policy aimed at increasing the incidence of health insurance coverage will attempt to change the cost of health insurance coverage.

Proposition 1. $\frac{\partial \theta^*}{\partial \phi} < 0$ and $\frac{\partial \theta^{**}}{\partial \phi} > 0$.

Proof. Define the implicit function

$$T(\theta^*, \phi) = R(\theta^*, \phi) - \theta^* = 0$$

where

$$\begin{aligned} R(\theta^*, \phi) &= b + \alpha\lambda\{(\rho+\eta_0)^{-1} \int_{\theta^*}^{\theta^* + \frac{\rho+\eta_0}{\eta_0-\eta_1}\phi} (\theta - \theta^*)\, dG(\theta) \\ &\quad + (\rho+\eta_1)^{-1} \int_{\theta^* + \frac{\rho+\eta_0}{\eta_0-\eta_1}\phi}^{\infty} (\theta - \phi - \theta^*)\, dG(\theta)\} \end{aligned}$$

By the implicit function theorem, the partial derivative of θ^* with respect to ϕ equals

$$\frac{\partial \theta^*}{\partial \phi} = -\frac{\frac{\partial T(\theta^*,\phi)}{\partial \phi}}{\frac{\partial T(\theta^*,\phi)}{\partial \theta^*}} = -\frac{T_\phi}{T_{\theta^*}}. \tag{16}$$

Applying Leibniz' rule, it is easy to show that

$$\begin{aligned} \frac{\partial R}{\partial \theta^*} &= -\alpha\lambda \left\{ \frac{G\left(\theta^* + \frac{\rho+\eta_0}{\eta_0-\eta_1}\phi\right) - G(\theta^*)}{\rho+\eta_0} + \frac{1 - G\left(\theta^* + \frac{\rho+\eta_0}{\eta_0-\eta_1}\phi\right)}{\rho+\eta_1} \right\} \\ &\Rightarrow \quad T_{\theta^*} < 0 \end{aligned}$$

By applying Liebniz' rule, the derivative of T with respect to ϕ is

$$T_\phi = -\alpha\lambda \left\{ \frac{1 - G\left(\theta^* + \frac{\rho+\eta_0}{\eta_0-\eta_1}\phi\right)}{\rho+\eta_1} \right\} < 0$$

By equation [16], we find that $\frac{\partial\theta^*}{\partial\phi} < 0$. Next, we know that the critical productivity levels are linked according to the equation

$$\theta^{**} = \theta^* + \frac{\rho + \eta_0}{\eta_0 - \eta_1}\phi.$$

Hence, we have

$$\frac{\partial\theta^{**}}{\partial\phi} = \frac{\partial\theta^*}{\partial\phi} + \frac{\rho + \eta_0}{\eta_0 - \eta_1}$$

Since $\frac{\partial\theta^*}{\partial\phi} \in (-1, 0)$ and $\frac{\rho+\eta_0}{\eta_0-\eta_1} \geq 1$, then $\frac{\partial\theta^{**}}{\partial\phi} > 0$.■

As the health insurance premium decreases the critical productivity level that results in a job match increases, which implies that the probability that an encounter between a searcher and a potential employer results in a job match, $\widetilde{G}(\theta^*)$, also decreases. As a result, the mean time spent in unemployment will increase as the health insurance premium decreases.

We can now derive the effect of health insurance premiums on the probability that a new job will be offer health insurance coverage, $p(d = 1)$. In addition, the next proposition shows how changes in the health insurance premium affect the steady state unemployment and health insurance coverage rates. These rates are defined as

$$\begin{aligned} u &= \frac{\frac{1}{\lambda\widetilde{G}(\theta^*)}}{\frac{1}{\lambda\widetilde{G}(\theta^*)} + \frac{p(d=1)}{\eta_1} + \frac{1-p(d=1)}{\eta_0}} \\ h &= \frac{\frac{p(d=1)}{\eta_1}}{\frac{1}{\lambda\widetilde{G}(\theta^*)} + \frac{p(d=1)}{\eta_1} + \frac{1-p(d=1)}{\eta_0}}. \end{aligned}$$

Then u can be interpreted as the proportion of the labor market career an individual spends in the unemployment state (for sufficiently long careers) and h can be thought of as the proportion of one's labor market career in which they are covered by health insurance.

Proposition 2. The economic indicators are related to the health insurance premium as follows: (a) $\frac{\partial p(d=1)}{\partial\phi} < 0$, (b) $\frac{\partial u}{\partial\phi}$ cannot be unambiguously signed and (c) $\frac{\partial h}{\partial\phi} < 0$.

Proof. Given the equation, $p(d = 1) = \frac{\widetilde{G}(\theta^{**})}{\widetilde{G}(\theta^*)}$, we have

$$\frac{\partial p(d = 1)}{\partial\phi} = \frac{1}{\widetilde{G}(\theta^*)}\left\{\frac{\widetilde{G}(\theta^{**})}{\widetilde{G}(\theta^*)}g(\theta^*)\frac{\partial\theta^*}{\partial\phi} - g(\theta^{**})\frac{\partial\theta^{**}}{\partial\phi}\right\}.$$

Since $\frac{\partial\theta^*}{\partial\phi} < 0$ and $\frac{\partial\theta^{**}}{\partial\phi} > 0$, we know $\frac{\partial p(d=1)}{\partial\phi} < 0$.

Next, rewrite u as

$$u = \left(1 + \frac{\lambda\widetilde{G}(\theta^{**})}{\eta_1} + \frac{\lambda\left[\widetilde{G}(\theta^*) - \widetilde{G}(\theta^{**})\right]}{\eta_0}\right)^{-1}$$

Differentiating with respect to ϕ yields

$$\begin{aligned}\frac{\partial u}{\partial \phi} &= -\left(1+\frac{\lambda \widetilde{G}(\theta^{**})}{\eta_1}+\frac{\lambda\left[\widetilde{G}(\theta^{*})-\widetilde{G}(\theta^{**})\right]}{\eta_0}\right)^{-2} \times \\ &\left(\left(\frac{\lambda}{\eta_0}-\frac{\lambda}{\eta_1}\right) g(\theta^{**}) \frac{\partial \theta^{**}}{\partial \phi}-\frac{\lambda}{\eta_0} g(\theta^{*}) \frac{\partial \theta^{*}}{\partial \phi}\right)\end{aligned}$$

Since $\eta_0 > \eta_1$, we know $\left(\frac{\lambda}{\eta_0}-\frac{\lambda}{\eta_1}\right) < 0$. Since $\frac{\partial \theta^{**}}{\partial \phi} > 0$ and $\frac{\partial \theta^{*}}{\partial \phi} < 0$, the sign of $\frac{\partial u}{\partial \phi}$ depends on all of the parameters of the model (as they effect both θ^{*} and θ^{**}) and the productivity density function, $g(\theta)$.

In terms of the steady state health insurance coverage rate, we can rewrite h as

$$h=\left(\frac{\eta_0-\eta_1}{\eta_0}+\frac{\eta_1}{\lambda \widetilde{G}(\theta^{**})}+\frac{\eta_1 \widetilde{G}(\theta^{*})}{\eta_0 \widetilde{G}(\theta^{**})}\right)^{-1}$$

Differentiating h with respect to ϕ gives us

$$\begin{aligned}\frac{\partial h}{\partial \phi} &= -\left(\frac{\eta_0-\eta_1}{\eta_0}+\frac{\eta_1}{\lambda \widetilde{G}(\theta^{**})}+\frac{\eta_1 \widetilde{G}(\theta^{*})}{\eta_0 \widetilde{G}(\theta^{**})}\right)^{-2} \times \\ &\left(\frac{\eta_1 g(\theta^{**})}{\lambda\left(\widetilde{G}(\theta^{**})\right)^2} \frac{\partial \theta^{**}}{\partial \phi}+\frac{\eta_1 \widetilde{G}(\theta^{*}) g(\theta^{**})}{\eta_0\left(\widetilde{G}(\theta^{**})\right)^2} \frac{\partial \theta^{**}}{\partial \phi}-\frac{\eta_1 g(\theta^{*})}{\eta_0 \widetilde{G}(\theta^{**})} \frac{\partial \theta^{*}}{\partial \phi}\right)\end{aligned}$$

Since $\frac{\partial \theta^{**}}{\partial \phi} > 0$ and $\frac{\partial \theta^{*}}{\partial \phi} < 0$, the second expression in parentheses is always positive. Hence, $\frac{\partial h}{\partial \phi} < 0.\blacksquare$

Proposition 2 establishes the fact that as the health insurance premium decreases, the probability that a worker-firm match that results in a job that provides health insurance coverage increases. In addition, this proposition highlights the fact that while a decrease in the health insurance premium faced by employers unambiguously increases the steady state health insurance coverage rate, the unemployment rate may increase or decrease. We shall consider these impacts again using the estimated model parameters in Section 5.

2.2.1 Bargaining with Health Insurance (with OTJ Search)

In the previous subsection we assumed that there was no contact between employed individuals and new potential employers. Given the large number of job to job transitions in our data, such an assumption is clearly counterfactual. In this subsection we generalize the model to allow for such meetings, which are assumed to occur at the exogenously-determined rate λ_e. By fixing the rate of arrival of meetings, we have made the rate independent of the individual's current match value and their current contract as characterized by their wage and health insurance coverage status. For simplicity, we assume that on-the-job search is costless.

As was assumed in the case of nonemployed search, when a currently-employed individual meets a new potential employer, both sides immediately observe the value of the (new) potential match θ'. Whether or not the individual leaves the old firm for the new one and the nature of the new employment contract given that there is one depend critically on the information sets of the old and new firm and the nature of the bargaining process. We assume that (1) the individual knows the value of θ and θ'; (2) the current employer knows θ but not θ'; and (3) the potential employer knows θ' but not θ. Each firm is assumed to make a series of credible and binding wage and health insurance provision offers to the employee that can be communicated to the other firm. The bargaining process ends when one firm drops out of the bidding, which will occur when the rents from employing the worker to that firm reach zero. As long as the offers made through the bargaining process are unique mappings from the match value at the current firm and the best offer currently on the table from its competitor, then in the end of the process the match values of each firm will be revealed. The sequential bargaining process and gradual revelation of information serves to ensure that the firm with the "dominated" match value doesn't drop out of the competition too quickly.

Let us introduce a bit of notation before proceeding. For an employed agent, we denote their current labor market state by (θ, w, d) and any potential new state by (θ', w', d'). When an individual is unemployed, for purposes of defining the equilibrium wage and health insurance provision functions we will say that their current match value is θ^*, which is that value of θ required for an unemployed searcher and a firm to initiate an employment contract. We start by considering the rent division problem facing a currently employed agent who encounters a new potential employer.

Say that a currently-employed agent with current contract given by (θ, w, d), $\theta \geq \theta^*$, meets a new potential employment match with value θ'. We assume that the potential match will only be reported to the current employer if the employee has an incentive to do so. One situation in which this will clearly be the case is when $\theta' > \theta$. When this occurs, we assume that the bargaining process is characterized by a sequence of bids, by the current and potential employer, for the individual's services. The bidding stops when the surplus value of the match to one of the firms reaches 0 [this is clearly the current employer when $\theta' > \theta$]. How are the bids determined? Let the maximal value of the match θ to the worker be given by $Q(\theta)$. Then the solution to the Nash bargaining problem when $\theta' > \theta$ is given by

$$\begin{aligned} S(\theta', w', d', \theta) &= \{V_e(\theta', w', d') - Q(\theta)\}^{\alpha} \\ &\quad \times V_f(\theta', w', d')^{1-\alpha}, \end{aligned}$$

where $V_f(\theta', w', d')$ denotes the new firm's value of the problem [recall that each firm's threat point is assumed to be zero]. For the moment, we will simply posit the existence of a employment contract outcome that is a function of the highest and the next best match value; if these values are θ and $\tilde{\theta}$, respectively, then the wage function is $w(\theta, \tilde{\theta})$ and the health insurance provision function is $d(\theta, \tilde{\theta})$. Then the firm's value of the current match situation is defined as follows:

$$\begin{aligned} V_f(\theta, w, d) &= \frac{(\theta - w - d\phi)\Delta t}{1 + \rho\Delta t} + \frac{\eta(d)\Delta t}{1 + \rho\Delta t} \times 0 \\ &\quad + \frac{\lambda_e \Delta t}{1 + \rho\Delta t} \int_{\hat{\theta}(w,d)}^{\theta} V_f(\theta, w(\theta, \tilde{\theta}), d(\theta, \tilde{\theta}))\, dG(\tilde{\theta}) \\ &\quad + \frac{\lambda_e \Delta t G(\hat{\theta}\,(w, d))}{1 + \rho\Delta t} V_f(\theta, w, d) \\ &\quad + \frac{(1 - \lambda_e \Delta t - \eta(d)\Delta t)}{1 + \rho\Delta t} V_f(\theta, w, d) + \frac{o(\Delta t)}{1 + \rho\Delta t}, \end{aligned}$$

where $\hat{\theta}(w,d)$ is defined as the maximum value of θ for which the contract (w,d) would leave the firm with no profit. Any encounter with a potential firm in which the match value is less than $\hat{\theta}(w,d)$ will not be reported by the employee. After rearranging terms and taking limits, we have

$$\begin{aligned} V_f(\theta,w,d) &= [\rho+\eta(d)+\lambda_e\tilde{G}(\hat{\theta}(w,d))]^{-1} \\ &\quad \times\{\theta-w-d\phi+\lambda_e\int_{\hat{\theta}(w,d)}^{\theta} V_f(\theta,w(\theta,\tilde{\theta}),d(\theta,\tilde{\theta}))\,dG(\tilde{\theta})\}. \end{aligned}$$

For the employee, the value of employment at a current match value θ and wage and health insurance provision status (w,d) is given by

$$\begin{aligned} V_e(\theta,w,d) &= \frac{w\Delta t}{1+\rho\Delta t}+\frac{\eta(d)\Delta t}{1+\rho\Delta t}V_n \\ &\quad +\frac{\lambda_e\Delta t}{1+\rho\Delta t}\int_{\hat{\theta}(w,d)}^{\theta} V_e(\theta,w(\theta,\tilde{\theta}),d(\theta,\tilde{\theta}))\,dG(\tilde{\theta}) \\ &\quad +\frac{\lambda_e\Delta t}{1+\rho\Delta t}\int_{\theta} V_e(\tilde{\theta},w(\tilde{\theta},\theta),d(\tilde{\theta},\theta))\,dG(\tilde{\theta}) \\ &\quad +\frac{\lambda_e\Delta t G(\hat{\theta}(w,d))}{1+\rho\Delta t}V_e(\theta,w,d) \\ &\quad +\frac{(1-\lambda_e\Delta t-\eta(d)\Delta t)}{1+\rho\Delta t}V_e(\theta,w,d)+\frac{o(\Delta t)}{1+\rho\Delta t}. \end{aligned}$$

Note that when an employee encounters a firm with a new match value lower than his current one but that is capable of being used to increase the value of his current employment contract [i.e., $\theta>\tilde{\theta}>\hat{\theta}(w,d)$], her new value of employment at the current firm becomes $V_e(\theta,w(\theta,\tilde{\theta}),d(\theta,\tilde{\theta}))$. Instead, when the match value at the newly-contacted firm exceeds that of the current firm, mobility results. The value of employment at the new firm is given by $V_e(\tilde{\theta},w(\tilde{\theta},\theta),d(\tilde{\theta},\theta))$ – that is, the match value at the current firm becomes the determinant of the "threat point" faced by the new firm and plays a role in the determination of the new wage. Finally, when the match value at the new firm is less than $\hat{\theta}(w,d)$, the contact is not reported to the current firm since it would not result in any improvement in the current contract. Because of this selective reporting, the value of employment contracts must be monotonically increasing both within and across consecutive job spells. Declines can only be observed following a transition into the unemployment state.

After rearranging terms and taking limits, we have

$$\begin{aligned} V_e(\theta,w,d) &= [\rho+\eta(d)+\lambda_e\tilde{G}(\hat{\theta}(w,d))]^{-1} \\ &\quad \times\{w+\eta(d)V_n+\lambda_e\int_{\hat{\theta}(w,d)}^{\theta} V_e(\theta,w(\theta,\tilde{\theta}),d(\theta,\tilde{\theta}))\,dG(\tilde{\theta}) \\ &\quad +\lambda_e\int_{\theta} V_e(\tilde{\theta},w(\tilde{\theta},\theta),d(\tilde{\theta},\theta))\,dG(\tilde{\theta})\}. \end{aligned}$$

With a new match value of $\theta'>\theta$, the surplus attained by the individual at the new match with respect to the value she could attain at the old match after extracting all of the surplus associated with it is

$$V_e(\theta',w',d')-Q(\theta),$$

where

$$Q(\theta) = V_e(\theta, w^*(\theta), d^*(\theta)),$$

with $(w^*, d^*)(\theta)$ denoting the value of the wage and health insurance if the agent receives all the rents from the match θ. Note that $w^*(\theta) \equiv w(\theta, \theta)$ and $d^*(\theta) \equiv d(\theta, \theta)$. Therefore

$$\begin{aligned} Q(\theta) &= [\rho + \eta(d^*(\theta)) + \lambda_e \tilde{G}(\theta)]^{-1} \\ &\quad \times \{w^*(\theta) + \eta(d^*(\theta))V_n + \lambda_e \int_\theta V_e(\tilde{\theta}, w(\tilde{\theta}, \theta), d(\tilde{\theta}, \theta))\, dG(\tilde{\theta})\}, \end{aligned}$$

where we have used the fact that $\hat{\theta}(w^*(\theta), d^*(\theta)) = \theta$.

The model is closed after specifying the value of nonemployment. Passing directly to the steady state representation of this function, we have

$$\begin{aligned} V_n &= [\rho + \lambda_n \tilde{G}(\theta^*)]^{-1} \\ &\quad \times \{b + \lambda_n \int_{\theta^*} V_e(\tilde{\theta}, w(\tilde{\theta}, \theta^*), d(\tilde{\theta}, \theta^*))\, dG(\tilde{\theta})\}, \end{aligned}$$

where θ^* is the critical match value associated with the decision to initiate an employment contract.

When an employed agent meets a new potential employer, the solution to the Nash bargaining problem is given by

$$(w, d)(\theta', \theta) = \arg\max_{w,d} S(\theta', w, d, \theta),$$

and as we have noted above, $(w^*, d^*)(\theta) = (w, d)(\theta, \theta)$. When an unemployed agent meets an acceptable firm, we write the bargaining problem as

$$(w, d)(\theta, \theta^*) = \arg\max_{w,d} S_n(\theta, w, d, \theta^*),$$

where $S_n(\theta, w, d, \theta^*) = (V_e(\theta, w, d) - V_n)^\alpha V_f(\theta, w, d)^{1-\alpha}$.

We note that an important characteristic of our model is efficient bargaining, that is, when confronted with a choice between two employers with associated match values θ and θ', the individual always takes employment with the employer associated with the higher match value. This property is an attractive one for an equilibrium model to have, and also aids in reducing the complexity of solving the model. We begin by positing a few characteristics of the equilibrium functions (w, d) which we will later confirm to hold in equilibrium.

Conjecture 1 $d(\theta', \theta) = 1 \Leftrightarrow \theta' \geq \theta^{**}$.

In words, the decision to provide health insurance is only a function of the current best match value and not of the next-best option. There exists a critical value, here called θ^{**}, which fully characterizes the health insurance provision outcome exactly as was true in the model without OTJ search. The reason for this result is related to the fact that the payoffs for the firm and worker from buying health insurance given current match value θ' are both positive when $\theta' \geq \theta^{**}$, and are both negative when this is not the case.

Given this result, the complete characterization of the equilibrium is considerably simplified. Given knowledge (or a guess) of the critical values θ^* and θ^{**}, we can define the "conditional" Nash bargaining problem by

$$w(\theta', \theta; \theta^*, \theta^{**}) = \arg\max_w S(\theta', w, \chi[\theta' \geq \theta^{**}], \theta)$$

for the case of a currently employed searcher and

$$w(\theta', \theta^*; \theta^*, \theta^{**}) = \arg\max_w S_n(\theta', w, \chi[\theta' \geq \theta^{**}], \theta^*)$$

for the case of an unemployed searcher. The "boundary condition" associated with the equilibrium wage offer function is

$$w^*(\theta; \theta^*, \theta^{**}) = w(\theta, \theta; \theta^*, \theta^{**})$$

To solve the equilibrium requires that we search over scalars θ^* and θ^{**} and functions $w(\theta', \theta; \theta^*, \theta^{**})$ to solve the fixed point equations implicitly defined by the value functions V_e, V_n, and V_f.

The model is sufficiently complex that comparative statics results are hard to come by. Instead, we will concern ourselves with displaying some of the implications of the model, particularly those that differ from the earlier version without on-the-job search.

The current version of the model more closely corresponds with the types of events seen in the SIPP data, and moreover is the only one that can be used to look at the issue of job lock. In the model without OTJ search, the exit rate from jobs with health insurance was tautologically lower than from jobs with health insurance, and in both cases the rates were independent of job duration. With OTJ search these implications are changed.

Though the model with OTJ search continues to tautologically imply higher *nonvoluntary* exits from jobs without health insurance, there are now two possible routes by which a job spell may end. Given efficient separations, we know that *voluntary* exits from a job spell occur whenever a job with a higher match value is located (independent of whether the current job provides health insurance or not). The instantaneous exit rate of a job with match value θ ($\theta \geq \theta^*$) is given by

$$r(\theta) = \eta_0 \chi[\theta^* \leq \theta < \theta^{**}] + \eta_1 \chi[\theta \geq \theta^{**}] + \lambda_e \tilde{G}(\theta),$$

so that the duration of time that individuals spend in a job spell conditional on the current match value is

$$f_e(t_e|\theta) = r(\theta) \exp(-r(\theta) t_e), \ t_e > 0.$$

Then the density of durations in a given job spell conditional upon health insurance status is

$$f_e(t_e|d) = \int f_e(t_e|\theta)\, dG(\theta|d).$$

The corresponding conditional hazard, $h_e(t_e|d) = f_e(t_e|d)/\tilde{F}_e(t_e|d)$, exhibits negative duration dependence for both $d = 0$ and $d = 1$. However, because $\eta_0 > \eta_1$ and because the lowest value of θ for $d = 1$ exceeds the greatest value of θ for $d = 0$, the hazard out of jobs covered by health insurance exceeds the hazard out of jobs with health insurance at any value of t_e. Note that the limiting value (as $t_e \to \infty$) for the hazard in jobs without health insurance is $\lim_{t \to \infty} h_e(t_e|d = 0) = \eta_0 + \lambda_e \tilde{G}(\theta^{**})$, while the corresponding limiting value for jobs with health insurance is $\lim_{t \to \infty} h_e(t_e|d = 1) = \eta_1$.

Using estimates of the OTJ search model, we have plotted the hazard functions and they appear in Figure 5. Note that within each regime (defined in terms of d), negative duration dependence is implied through the operation of the well-known composition effect (i.e., selection in terms of θ). We also see that our model estimates imply substantial differences in the levels of the hazard rates between jobs with health insurance and those without. These estimated differences of course stem from the large differences observed in the data. Within our model, these differences do not indicate that health insurance status distorts decision-making regarding job mobility as is often claimed in the "job lock" literature.

3 Data

Data from the 1990 to 1993 annual panels of the Survey of Income and Program Participation (SIPP) are used to estimate the model. The SIPP interviews individuals every four months for up to nine times, so that at the maximum an individual will have been interviewed relatively frequently over a three year period. The SIPP collects detailed monthly information regarding individuals' demographic characteristics and labor force activity, including earnings, number of weeks worked, average hours worked, as well as whether the individual changed jobs during the month. In addition, at each interview date the SIPP gathers data for a variety of health insurance variables including whether an individual's private health insurance is employer-provided.[2] The model developed in this paper assumes a homogeneous population, though it would not in principle be difficult to allow primitive parameters to depend on observable individual characteristics. Instead of doing so, we have attempted to define a sample that is relatively homogeneous with respect to a number of demographic characteristics. In particular, only whites between the ages of 22-39 with at least a high school education have been selected. In addition, any individual who reports attendance in school, self-employment, military service, or participation in any government welfare program (i.e., AFDC, WIC, or Food Stamps) over the sample period is excluded.[3] Although the format of the SIPP data makes the task of defining job changes fairly difficult, in other respects the survey information is well-suited to the requirements of this analysis since it follows individuals for up to three years and includes data on both wages and health insurance at the current job.

In the empirical work reported below we estimate both the OTJ and no-OTJ search versions of the model. Since the specification without OTJ search cannot account for direct movements from job to job, we only use information regarding the duration of time spent in the initial unemployment spell, the duration of time spent in the first job spell after unemployment, and the wage and health insurance status of that first job spell after unemployment. It is assumed, albeit incorrectly, that the first job terminates with an exit into unemployment. In contrast, when estimating the OTJ search version of the model we use the same information except that we distinguish the manner by which the first job spell after unemployment was left. That is, for cases in which the end of the first job spell is observed, an indicator variable which takes the value one if the job was quit and

[2] There are several issues involved in constructing a meaningful employer-provided health insurance variable. First, there is a timing problem since the insurance variable can change values only at the interview month, while a job change can occur any time. Second, there are job spells in which the individual reports employer-provided coverage for some part of the spell and no coverage for the remainder of the spell. Since these spells do not represent more than 20% of the entire sample (of spells) and any other solution is admittedly ad hoc, we eliminate them. At present we are investigating the sensitiity of our results to alternative treatments of this problem.

[3] Some individuals, about 3 percent of the sample, had missing data at some point during the panel. Since estimation depends critically on having complete labor market histories we have excluded these cases.

zero if the individual transited into unemployment is added to the other 4 dependent variables: the duration of the unemployment spell, the duration of the first job spell, and the wage rate and health insurance status of the first job spell.

Since there is no time invariant unobserved heterogeneity in the model (since θ draws are i.i.d.), we construct labor market "cycles" in a manner similar to Wolpin (1992) and Flinn (1999). A cycle begins with an unemployment spell, which could be right-censored, and ends with a right-censored or complete first job spell after unemployment. Information from job spells beyond the first job is not used.

Table 1 contains some descriptive statistics from the sample of spells used in all of the empirical analysis. Notice that by far the largest proportion of unemployment spells end with a transition into a job that does not provide health insurance coverage. It is also clear that jobs with health insurance tend to last longer on average than jobs without health insurance. However, the most striking difference is in the average wages of jobs conditional on health insurance provision. Jobs with health insurance have a mean wage about 54 percent larger than do jobs without health insurance. The model constructed above is, on the face of it, consistent with all of these descriptive statistics, and in the following section we describe our attempt to recover the primitive parameters of the model from these data.

4 Econometric Specification

We now turn our attention to the development of the econometric specification used to estimate the parameters of the stationary search model developed above. Throughout we will make parametric assumptions concerning the matching distribution and will estimate the parameters of the model using relatively standard maximum likelihood methods. The complexity of the model structure requires us to spend some time developing the likelihood function and discussing identification issues, particularly since it it widely appreciated that the identification of bargaining models is challenging given the types of data to which we have access.

The building blocks of the likelihood function are labor market "cycles," where a cycle is defined as a sequence of labor market states beginning with an unemployment spell and ending with the last job prior to the following unemployment spell for a given individual. As discussed above, due to the complexity of the likelihood function and data limitations, cycles are truncated after the first job spell in an employment spell. The reason for this has to do with an "aliasing" problem that exists with respect to wage observations. Since our model of on-the-job search allows for wage increases during a job spell in response to meeting potential employers with associated match values high enough to improve the employee's compensation at her current firm but not so high as to induce turnover, in order to estimate the model using all job spell information requires access to a complete, continuously-observed wage history. While the SIPP data contains wage information collected on a monthly basis, it is not continuous and on inspection seems so variable as to raise questions concerning its accuracy. As a result, in estimating the model we use information only on the duration of the unemployment spell, the first job spell, the wage rate and health insurance status on the first job in the employment spell, and the reason that the first job spell ends. After making an assumption regarding the value of the bargaining power parameter α and an assumption regarding the functional form of G, this information will be sufficient to identify all the parameters of the model. Given these estimates, later in the paper we will simulate some wage-health insurance paths to assess the degree to which the model is capable of generating "realistic" labor market histories in terms of wage and health insurance coverage patterns.

In addition, for the econometric model to be consistent with the data, it is necessary for us to introduce measurement error both in wage rates and health insurance status. The measurement error processes are assumed to be independent of one another. In terms of wages, we assume that measured wages, $\widetilde{w}$, are related to true wages by

$$\widetilde{w} = w\varepsilon,$$

where ε is independently and identically distributed on the positive real line with distribution function F and density f. In terms of health insurance status, we assume that reported status $\widetilde{d}$ is equal to the true status d with probability q; note that this is restrictive since we assume that the probability of mismeasuring health insurance status is independent of the true state.

We now consider the specification of all of the "types" of likelihood contributions which can be observed given the data to which we limit our attention.[4] The types are:

1. A right-censored unemployment spell
2. A completed unemployment spell followed by a right-censored one-job employment spell
3. A completed unemployment spell followed by a one-job employment spell in which the job ends in termination
4. A completed unemployment spell followed by a first job spell which is immediately followed by a second job.

We consider each of these cases in turn:

Case 1: If the cycle consists only of a right-censored unemployment spell of duration t_u, then the likelihood contribution is given by

$$\begin{aligned} L_1(t_u) &= p(T_u > t_u) \\ &= \exp\left(-\lambda\widetilde{G}(\theta^*)\, t_u\right). \end{aligned}$$

Case 2: The dependent variables in this case are (t_u, t_1, w_1, d_1), but since w_1 and d_1 are measured with error, the likelihood contribution is defined in terms of $\left(t_u, t_1, \widetilde{w}_1, \widetilde{d}_1\right)$. The likelihood of a completed unemployment duration of t_u is just $f_u(t_u) = \lambda\widetilde{G}(\theta^*)\exp\left(-\lambda\widetilde{G}(\theta^*)\, t_u\right)$. The likelihood of an observed wage and health insurance pair (w_1, d_1) and a right-censored first job spell of duration t_1 is derived as follows.

When an unemployed agent takes a job with health insurance status d, we know that the wage is given by $w_d(\theta, \theta^*)$ where w_d is the equilibrium wage function for a job with health insurance status, d.[5] Recognizing that the mapping $(w, d) = n(\theta, \theta^*)$ is 1-1, we can define a function

[4] For the model without OTJ search, we assume that all transitions from employment are into the unemployment state. In terms of the likelihood contributions derived below, this assumption implies that cases 3 and 4 are identical.

[5] The estimation procedure requires that we solve for the equilibrium wage functions, $w_d(\theta, \theta^*)$ and the critical matches, θ^* and θ^{**}. Since the computational burden of the Nash bargaining problem with OTJ search is substantial, we simplify the analysis by approximating the system of value functions and solve for the equilibrium of the model using our approximations. See Appendix for details. For the model without OTJ search, the equilibrium of the model has a closed form. That is, we know the equilibrium wage functions, the fixed point equation to solve for the critical match out of unemployment, and the relationship between the critical match for the provision of health insurance and the parameters of the model.

$\widetilde{\theta}(w,d,\theta^*) = w_d^{-1}(w,\theta^*)$ for all (w,d) pairs. Therefore, the distribution of wages and health insurance status for individuals entering the current job from the unemployment state is given by

$$\begin{aligned} m(w,d \mid \theta^*) &= m(w \mid d,\theta^*) \times p(d \mid \theta^*) \\ &= \frac{\partial\widetilde{\theta}(w,d,\theta^*)}{\partial w} \frac{g\left(\widetilde{\theta}(w,d,\theta^*)\right)}{\widetilde{G}(\theta^{**})^d \left[\widetilde{G}(\theta^*) - \widetilde{G}(\theta^{**})\right]^{1-d}} \times \frac{\widetilde{G}(\theta^{**})^d \left[\widetilde{G}(\theta^*) - \widetilde{G}(\theta^{**})\right]^{1-d}}{\widetilde{G}(\theta^*)} \\ &= \frac{\partial\widetilde{\theta}(w,d,\theta^*)}{\partial w} \frac{g\left(\widetilde{\theta}(w,d,\theta^*)\right)}{\widetilde{G}(\theta^*)}, d = 0,1. \end{aligned}$$

In terms of the measured job status of an individual immediately after unemployment, we have

$$\begin{aligned} \widetilde{m}\left(\widetilde{w},\widetilde{d} \mid \theta^*\right) &= \sum_d \int \widetilde{m}\left(\widetilde{w},\widetilde{d} \mid w,d,\theta^*\right) m(w,d \mid \theta^*) \\ &= \{q \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) m(w,d=1)\,dw + (1-q) \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) m(w,d=0)\,dw\}^{\widetilde{d}} \\ &\quad \times \{q \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) m(w,d=0)\,dw + (1-q) \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) m(w,d=1)\,dw\}^{1-\widetilde{d}} \end{aligned}$$

The probability density $\widetilde{m}$ is only defined with respect to measured information concerning the compensation package on the first job after unemployment, and not the duration of that job. Since we know the mapping $\widetilde{\theta}(w,d,\theta^*)$ for all (w,d) pairs, we know the rate of leaving the first job after unemployment for an individual paid a wage w with health insurance status d is given by

$$h_e(w,d,\theta^*) = d\eta_1 + (1-d)\eta_0 + \lambda_e \widetilde{G}\left(\widetilde{\theta}(w,d,\theta^*)\right).$$

Then we can define the joint density

$$\begin{aligned} &\widetilde{m}_2\left(\widetilde{w},\widetilde{d},t_1 \mid \theta^*\right) = \\ &\qquad \{q \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) \exp\left(-h_e(w,1,\theta^*)\,t_1\right) m(w,d=1)\,dw \\ &\qquad + (1-q) \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) \exp\left(-h_e(w,0,\theta^*)\,t_1\right) m(w,d=0)\,dw\}^{\widetilde{d}} \\ &\qquad \{q \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) \exp\left(-h_e(w,0,\theta^*)\,t_1\right) m(w,d=0)\,dw \\ &\qquad + (1-q) \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) \exp\left(-h_e(w,1,\theta^*)\,t_1\right) m(w,d=1)\,dw\}^{1-\widetilde{d}}. \end{aligned}$$

Multiplying the above density by the likelihood of the completed unemployment spell duration, we get

$$L_2\left(\widetilde{w}_1,\widetilde{d}_1,t_u,t_1\right) = \widetilde{m}_2\left(\widetilde{w}_1,\widetilde{d}_1,t_1 \mid \theta^*\right) \times f_u(t_u).$$

Case 3: If an unemployment spell ends with a job and the individual is terminated at the end of the first job [which then initiates another employment cycle since a new unemployment spell is begun], then the likelihood contribution is defined with respect to the dependent variables $\left(\widetilde{w}_1, \widetilde{d}_1, t_1, t_u\right)$. Given the true value of the match in the first job, θ_1, the likelihood that the job ends in unemployment is given by

$$p(u \mid \theta_1) = \frac{\eta(\theta_1)}{\eta(\theta_1) + \lambda_e \widetilde{G}(\theta_1)},$$

where $\eta(\theta) = \chi[\theta \leq \theta^{**}]\,\eta_1 + \chi[\theta^* \leq \theta < \theta^{**}]\,\eta_0$. Since the conditional [on θ] density of time to termination given that the individual is terminated is

$$\begin{aligned} f(t_1 \mid \theta_1, u) &= \frac{\eta(\theta_1)\exp(-\eta(\theta_1)\,t_1)}{p(u \mid \theta_1)} \\ &= \left(\eta(\theta_1) + \lambda_e \widetilde{G}(\theta_1)\right)\exp(-\eta(\theta_1)\,t_1), \end{aligned}$$

we have

$$\begin{aligned} f(t_1, u \mid \theta_1) &= f(t_1 \mid \theta_1, u) \times p(u \mid \theta_1) \\ &= \eta(\theta_1)\exp(-\eta(\theta_1)\,t_1). \end{aligned}$$

Then in this case we have

$$\begin{aligned} \widetilde{m}_3\left(\widetilde{w}, \widetilde{d}, t_1 \mid \theta^*\right) = \; & \{q \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) f\left(t_1, u \mid \widetilde{\theta}(w, d, \theta^*)\right) m(w, d=1)\,dw \\ & + (1-q) \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) f\left(t_1, u \mid \widetilde{\theta}(w, d, \theta^*)\right) m(w, d=0)\,dw\}^{\widetilde{d}} \\ & \{q \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) f\left(t_1, u \mid \widetilde{\theta}(w, d, \theta^*)\right) m(w, d=0)\,dw \\ & + (1-q) \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) f\left(t_1, u \mid \widetilde{\theta}(w, d, \theta^*)\right) m(w, d=1)\,dw\}^{1-\widetilde{d}}, \end{aligned}$$

so that

$$L_3\left(\widetilde{w}_1, \widetilde{d}_1, t_u, t_1\right) = \widetilde{m}_3\left(\widetilde{w}_1, \widetilde{d}_1, t_1 \mid \theta^*\right) \times f_u(t_u).$$

Case 4: This is very similar to Case 3. The likelihood of exiting from the first job in the spell directly into another job is a function only of the time invariant match value on the first job, θ_1, and is

$$p(e \mid \theta_1) = \frac{\lambda_e \widetilde{G}(\theta_1)}{\eta(\theta_1) + \lambda_e \widetilde{G}(\theta_1)},$$

while the conditional density of first job duration given exit directly into another one is

$$f(t_1 \mid \theta_1, e) = \frac{\lambda_e \widetilde{G}(\theta_1)\exp\left(-\lambda_e \widetilde{G}(\theta_1)\,t_1\right)}{p(e \mid \theta_1)},$$

so that

$$
\begin{aligned}
f\left(t_1, e \mid \theta_1\right) &= f\left(t_1 \mid \theta_1, e\right) \times p\left(e \mid \theta_1\right) \\
&= \lambda_e \widetilde{G}\left(\theta_1\right) \exp\left(-\lambda_e \widetilde{G}\left(\theta_1\right) t_1\right).
\end{aligned}
$$

Then

$$
\begin{aligned}
\widetilde{m}_4\left(\widetilde{w}, \widetilde{d}, t_1 \mid \theta^*\right) =& \{q \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) f\left(t_1, e \mid \widetilde{\theta}\left(w, d, \theta^*\right)\right) m\left(w, d=1\right) dw \\
&+ (1-q) \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) f\left(t_1, e \mid \widetilde{\theta}\left(w, d, \theta^*\right)\right) m\left(w, d=0\right) dw\}^{\widetilde{d}} \\
&\{q \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) f\left(t_1, e \mid \widetilde{\theta}\left(w, d, \theta^*\right)\right) m\left(w, d=0\right) dw \\
&+ (1-q) \int w^{-1} f\left(\frac{\widetilde{w}}{w}\right) f\left(t_1, e \mid \widetilde{\theta}\left(w, d, \theta^*\right)\right) m\left(w, d=1\right) dw\}^{1-\widetilde{d}},
\end{aligned}
$$

and

$$
L_4\left(\widetilde{w}_1, \widetilde{d}_1, t_u, t_1\right) = \widetilde{m}_4\left(\widetilde{w}_1, \widetilde{d}_1, t_1 \mid \theta^*\right) \times f_u\left(t_u\right).
$$

Then the log likelihood function is simply given by

$$
\ln L = \sum_{j=1}^{4} \sum_{s \in S_j} \ln L_j,
$$

where S_j is the set of all "cycles" of type j in the sample. Note that sample members contribute different numbers of cycles of different types, but under our i.i.d. assumptions all are simply pooled in forming the log likelihood function. Thus the consistency of our estimator relies on there being no unobserved heterogeneity at the individual level, for example.

It is well-known that it is difficult to identify the bargaining power parameter α with access to data such as ours. Since the value of the bargaining power parameter is not of central concern to this analysis, we assume symmetry and set $\alpha = 0.5$. The estimates of other parameters will not be invariant to our assumption regarding the value of α, and the reader should bear this in mind when interpreting our estimates.

We should also point out that we estimate the unemployment utility flow, b, and the health insurance premium, ϕ. In computing the likelihood, it is necessary to solve for the equilibrium wage functions, the critical match for transitions out of nonemployment, θ^*, and the critical match for the provision of health insurance, θ^{**}. Our strategy is to estimate the critical matches as free parameters and to use the theoretical implications of the model to back out estimates of the unemployment utility flow and the health insurance premium.

Our final caveat in concluding this section. For our estimator to be consistent, it is necessary that the first job wage rate be the one initially paid at the time the job was taken. This is because the likelihood specification is predicated on the "threat point" value of θ being the reservation value θ^*. If several contacts have been made [all with match values less than θ_1], the wage will be higher than the original wage rate on the job which was defined with respect to θ^*. Since we have monthly observations on wage rates, we believe that the first month's wage on the new job after unemployment is the one defined with respect to θ^*.

5 Results and Simulations

This section presents the estimation results based on the econometric model discussed in the previous section. Although our interest naturally centers on the results obtained from the model which allows for OTJ search, we also present estimates of the model in which we assume that $\lambda_e = 0$ for purposes of comparison and a loose form of sensitivity analysis. It is well-known that with the type of data available to us identification of primitive parameters requires that parametric assumptions be made regarding the distribution G (Flinn and Heckman, 1982). We assume that the productivity distribution $G(\theta)$ is log normal with parameters μ_θ and σ_θ. Furthermore, we assume a log normal distribution for the measurement error distribution with parameters μ_ε and σ_ε.[6] It is exceedingly difficult to identify the bargaining power parameter α, even after making functional form assumptions regarding G. In light of this, we assume symmetry in bargaining power and accordingly set $\alpha = 0.5$. Rather than estimate the discount rate (ρ) freely, we fix it at .08 (annualized).

In the first subsection we report and discuss model estimates for the no OTJ and the OTJ search specifications. Since it is somewhat difficult to interpret the estimates of some of the primitive paramaters, we also compute estimates of population moments that serve to usefully characterize the stationary equilibrium. In the following subsection we describe the results of a policy experiment in which health insurance premiums are systematically reduced from their estimated levels.

5.1 Model Estimates

Table 2 presents the maximum likelihood estimates for the model without OTJ search. The first thing to note is that our estimates support the premise of our model that $\eta_0 > \eta_1$.[7] In particular, our estimates reveal that a job that provides insurance is almost three times less likely to (exogenously) dissolve than a job without health insurance. Durations are measured in weeks, so the point estimate of λ implies that the mean wait between contacts (when unemployed) is about 6 months. The unemployment utility flow parameter is large and negative, and the estimated cost of health insurance seems on the high side at 6.753 an hour. As we shall see shortly, these values will change greatly and assume more reasonable values when we allow for OTJ search.

As was discussed in the previous section, for the model to fit the data required that measurement error be incorporated. In some sense, the degree of measurement error required to provide an acceptable degree of fit of the equilibrium model to the data can be considered an index of the degree of model misspecification. The degree of measurement eror in log wage rates, σ_ε, takes a value (.423) similar to that found in most similar studies. More interesting perhaps is the estimated amount of error in the measurement of health insurance coverage. The estimate of q is found to be about .95, so that, in conjunction with the measurement error assumed to be present in wage rates, only 5 percent of the reports of health insurance coverage are assumed to be incorrect.

In Table 3 we present estimates of the model that allows for OTJ search. Not surprisingly, there are some large differences between the estimates of the equilibrium in the model without OTJ search and with it. Since the models are equivalent for the case in which $\lambda_e = 0$, it is interesting to note that the point estimate of this parameter implies that a contact between a new potential employer and a currently employed individual about every 2 years. The standard error of the estimate of λ_e

[6] We assume that $\mu_\varepsilon = -.5\sigma_\varepsilon^2$ to ensure that the observed wage equals the true wage in expectation.

[7] In our parameterization of the model, the log likelihood would still be well-defined even if the ordering of the estimated exogenous separation rates was not consistent with our assumption. The incongruity, if you will, would be seen in an estimated value of the cost of insurance that was negative.

is sufficiently small that it is safe to say that employed search is an important part of job turnover, and that the model estimated without OTJ search is seriously misspecified.

Allowing for OTJ search results in more reasonable estimates of the utility flow from the unemployment state and the health insurance premium (although it still seems on the high side at 4.35 an hour). The estimate of the rate of encountering job offers in the unemployed state implies an average duration between contacts of 35 weeks, and the "exogenous" rate of exit from a job without health insurance is now estimated to be over 5 times higher that of a job with health insurance. The estimated value of the equilibrium quantities θ^* and θ^{**} are only slightly affected by the restriction that $\lambda_e = 0$.

The primitive parameters are often difficult to interpret, so in Table 4 we compute some more easily interpreted statistics computed under the estimated equilibria of the two specifications. A number of characteristics of the equilibrium don't seem to be terribly sensitive to the restriction that $\lambda_e = 0$. As we would expect, however, some are, such as the average duration of jobs by health insurance status. With no OTJ search, the average length of jobs without health insurance is 117 weeks while those with health insurance last on average 216 weeks. However, we know that the exit process is misspecified under the assumption of $\lambda_e = 0$. Allowing for the "correct" process (i.e., $\lambda_e > 0$), the average duration of of jobs without health insurance declines to 85 weeks while jobs with health insurance last 445 weeks on average. Thus, allowing for OTJ search greatly increases the disparity between the average durations of jobs by health insurance status. This type of differential is often loosely interpreted as being evidence of job lock, though we have shown that turnover decisions are efficient.

The implied values for the mean and variance of wages are relatively insensitive to the assumption that $\lambda_e = 0$, though some caution is required in interpreting the implications of these estimates. In the model without OTJ search, the wage distributions that are generated when unemployed agents accept a wage and health insurance pair offered by an employer are the same that would be observed in the cross-section at any moment in time. This is not true in the model in which employed individuals can move up the job ladder without intervening spells of unemployment. In this case, each conditional (on health insurance status) steady state distribution of wages will stochastically dominate the corresponding conditional distribution of wages for individuals entering jobs from the unemployment state. Therefore, the conditional steady state wage distributions are quite different in the no OTJ and OTJ search specifications.

Given the radical change in the dynamic structure of the equilibrium produced by relaxing the $\lambda_e = 0$ restriction, we find large differences in the steady state rates of health insurance coverage in the general and the employed population. The model with OTJ search implies that in the steady state 58 percent of the general population is covered by health insurance, while almost 70 percent of employees have health insurance. The corresponding percentages for the no OTJ search specification are 37 and 46 percent. The OTJ search specification does a much better job of fitting the SIPP data and in generating reasonable forecasts of the impacts of policy interventions, as we shall see in the next subsection.

5.2 Simulations

While the partial equilibrium model we develop and estimate is undeniably highly stylized, we have attempted to show that it is able to capture many features of the data at our disposal. While no policy makers explicitly appear in our model, the parameter that we view as being most amenable to manipulation is the cost of health insurance.[8] We might view changes in the private cost of providing health insurance cost to be impacted by government programs, but since we do not model the government revenue-generating process or its objective function, we prefer to think of reductions in the private cost of health insurance coverage as reflecting improvements in delivering health services.

In Table 5 we present statistics tracing the impact of reductions of varying degrees in ϕ on the properties of labor market equilibrium. Estimates from the OTJ search specification are used to perform the experiment.

By looking across the rows of the Table, we can see that changes in ϕ have quite subtle and somewhat surprising effects on the equilibrium. In the row presenting the results for θ^* we see evidence of some nonmonotonicity as the cost of health insurance declines. The variation in this decision rule parameter is minor compared to the size of the systematic declines observed in the critical value θ^{**}; which are to be expected. The manifestation of these effects can be seen in the third row of the data, which contains information on the probability that a job obtained by an unemployed searcher will be covered by health insurance. At the model estimates, this probability is only .3. By the time the health insurance premium is reduced by 80 percent, this probability has increased to .81. Not unexpectedly, significant reductions in the cost of health insurance have enormous impacts on the likelihood that a new job will offer health insurance; in the limit, as the cost goes to zero, our model predicts that all jobs would provide health insurance.

We find that the steady state unemployment rate is increasing in the cost of health insurance. The reason seems to be that lower costs of insurance makes lower match value jobs relatively more attractive while having a small indirect effect on the value of high match value jobs. The impact on unemployment is small but noticeable.

Even if all jobs provide health insurance, not all individuals would be covered since the benefits only accrue to the employed. The health insurance coverage rate captures both the impact of lowered costs on increased coverage of the employed population and on the steady state unemployment rate. We see significant increases in this coverage rate as the cost of health insurance declines. The next line reports steady state coverage among the employed population only, and this closely tracks the coverage patterns for the total population.

High costs of health insurance imply that a relatively small number of new jobs provide insurance coverage. Since the jobs that provide insurance last a significantly greater amount of time than do those that don't, and since they are high productivity jobs in equilibrium, this selection mechanism can result in high average productivity levels of jobs in the steady state. As the health insurance premium is reduced this selection effect becomes less strong, until in the limit (i.e., $\phi \rightarrow 0$) it disappears altogether. Therefore, while reduced health care costs increase coverage rates they may have negative effects on average steady state productivity levels. We see some indication of this in the last line of Table 5. While the effects are not large in absolute magnitude, we see that after an initial gain in average productivity (when costs are reduced by 20 percent), average productivity declines with further reductions in ϕ.

We exhibit the tradeoffs between steady state coverage rates and mean productivity levels in Figure 6. From the productivity profile we can see that there exists a unique cost of health insurance that maximizes the average productivity level in the population, and that the health

[8] Through changes in the costs of search, it may be possible to manipulate the utility flow in the unemployment state, b, as well. Since changes in b will only have indirect effects on the health insurance coverage decision, we ignore this possible policy instrument in what follows.

insurance premium that maximizes mean productivity is high. This analysis makes clear some of the potential tradeoffs, in this case between enrollment rates and productivity, that a policy maker manipulating the value of ϕ may face.

6 Conclusions

Researchers investigating the relationship between employer-provided health insurance, wages, and turnover, have uncovered a number of empirical findings (not all of which are mutually consistent) that to date have not be explicable within an estimable dynamic model of labor market equilibrium. We propose such a model, and show that it has implications for labor market careers broadly consistent with the existing empirical evidence on the subject. Using SIPP data we estimate the model and, for the most part, obtain reasonable results. The model is able to capture some of the most salient features of the data without undue reliance on the introduction of measurement error and other artificial devices introduced solely to improve its fit.

We use model estimates to perform a limited experiment involving reductions in the cost of health insurance; given the current equilibrium framework, we view these cost reductions as arising from exogenous technological change. Not surprisingly, we find that reductions in the cost of health insurance result in substantial increases in coverage rates in both the employed and total populations. More interesting is the impact on productivity. As costs decrease, lower quality jobs are covered by health insurance and therefore last longer, on average, than they would have were the costs sufficiently high. There is an adverse selection mechanism at work that can result in lower mean steady state productivity when the cost of insurance decreases. We hasten to point out that this effect is solely a result of the manner in which we have introduced the health insurance productivity effect into the model. An alternative mechanism, for example, would be to have matches with health insurance to result in increased "instantaneous" productivity, e.g., $\theta'(d) = k^d\theta$, $k > 1$. In such a case we would have an equilibrium with many of the same qualitative properties as the one analyzed here, but in this case reductions in health insurance costs will in general lead to substantial productivity gains. In future work we plan to reanalyze the equilibrium under various specifications of the role of health insurance in the production technology.

We view one of the accomplishments of this paper as demonstrating theoretically and empirically that what may appear to be "job lock" is consistent with an equilibrium model in which all turnover is efficient. While we didn't emphasize the point, the model estimated here is innovative on at least two dimensions. First, we have estimated an equilibrium model in which jobs are (endogenously) differentiated along two dimensions: wages and health insurance provision. Second, the model allows for wage renegotiations with the employee's current firm. While empirical implementations of matching models (e.g., Miller, 1984; Flinn, 1986) are consistent with wage changes during an employment spell, they imply no dependence between the wages paid at successive employers. The bargaining model formulated and estimated here offers a more complete view of wage dynamics than others currently available in the literature.

A Approximation of Decision Rules in the OTJ Search Model

In this appendix, we present our strategy for deriving the equilibrium of the Nash bargaining model with OTJ search. The computational burden of solving this model is quite substantial and since estimation of the model requires knowledge of the equilibrium wage functions, $w_d(\theta, \theta^*)$ and the critical matches, θ^* and θ^{**}, we are forced to approximate the system of value functions to estimate the model with OTJ search. In doing so, we are able to easily solve for the equilibrium of the model without an excessive computational burden.

To begin, it is important to note that maximum value of θ for which the contract (w, d) would leave the firm with no profit equals $\widehat{\theta}(w, d) = w + d\phi$ and the equilibrium wage associated with the worker receiving all the rents from θ is $w^*(\theta, \theta) = \theta - d\phi$. Given these two implications of the model, we know that

$$\begin{aligned} V_f\left(\theta', w = \theta' - d\phi, d\right) &= 0 \\ V_e\left(\theta', w = \theta' - d\phi, d\right) &= Q\left(\theta'\right). \end{aligned}$$

Taking the first order Taylor series approximation to V_f and V_e with respect to w (around $w = \theta' - d\phi$), we have

$$\begin{aligned} V_f\left(\theta', w, d\right) &\approx 0 + \left(w - \theta' + d\phi\right) \left.\frac{\partial V_f\left(\theta', w, d\right)}{\partial w}\right|_{w=\theta'-d\phi} \\ V_e\left(\theta', w, d\right) &\approx Q\left(\theta'\right) + \left(w - \theta' + d\phi\right) \left.\frac{\partial V_e\left(\theta', w, d\right)}{\partial w}\right|_{w=\theta'-d\phi} \end{aligned}$$

Using Leibniz' rule, the derivatives evaluated at $w = \theta' - d\phi$ can be shown to equal

$$\begin{aligned} \left.\frac{\partial V_f\left(\theta', w, d\right)}{\partial w}\right|_{w=\theta'-d\phi} &= \frac{-1}{\rho + \eta_d + \lambda_e \widetilde{G}\left(\theta'\right)} \\ \left.\frac{\partial V_e\left(\theta', w, d\right)}{\partial w}\right|_{w=\theta'-d\phi} &= \frac{1}{\rho + \eta_d + \lambda_e \widetilde{G}\left(\theta'\right)} \end{aligned}$$

Therefore,

$$\begin{aligned} V_f\left(\theta', w, d\right) &\approx \frac{-\left(w - \theta' + d\phi\right)}{\rho + \eta_d + \lambda_e \widetilde{G}\left(\theta'\right)} \\ V_e\left(\theta', w, d\right) &\approx Q\left(\theta'\right) + \frac{\left(w - \theta' + d\phi\right)}{\rho + \eta_d + \lambda_e \widetilde{G}\left(\theta'\right)} \end{aligned}$$

Conditional on health insurance status d, the first order condition for maximization of the Nash bargaining problem, $S\left(w, \theta', \theta; d\right)$, is given by

$$\alpha \left(\frac{-\left(w - \theta' + d\phi\right)}{\rho + \eta_d + \lambda_e \widetilde{G}\left(\theta'\right)} \right) = (1 - \alpha) \left(Q\left(\theta'\right) + \frac{\left(w - \theta' + d\phi\right)}{\rho + \eta_d + \lambda_e \widetilde{G}\left(\theta'\right)} - Q(\theta) \right).$$

Hence, the equilibrium wage (conditional on health insurance status d) for this pair of matches equals

$$w_d\left(\theta',\theta\right)=\theta'+d\phi-(1-\alpha)\left(\rho+\eta_d+\lambda_e\widetilde{G}\left(\theta'\right)\right)\left(Q\left(\theta'\right)-Q\left(\theta\right)\right).$$

Plugging the equilibrium wage into the approximations to the value functions, we see that the equilibrium value functions depend solely on the threat points so that

$$\begin{aligned}V_f\left(\theta',w\left(\theta',\theta\right),d\left(\theta',\theta\right)\right) &= (1-\alpha)\left(Q\left(\theta'\right)-Q\left(\theta\right)\right)\\ V_e\left(\theta',w\left(\theta',\theta\right),d\left(\theta',\theta\right)\right) &= \alpha Q\left(\theta'\right)+(1-\alpha)\,Q\left(\theta\right).\end{aligned}$$

Given this result, we can rewrite the threat point (conditional on health insurance status d) as

$$\begin{aligned}Q_d\left(\theta\right) &= \frac{\theta-d\phi+\eta_d V_n+\lambda_e\int_\theta\left\{\alpha Q\left(\widetilde{\theta}\right)+(1-\alpha)\,Q\left(\theta\right)\right\}dG\left(\widetilde{\theta}\right)}{\rho+\eta_d+\lambda_e\widetilde{G}\left(\theta\right)}\\ &= \frac{\theta-d\phi+\eta_d V_n+\alpha\lambda_e\int_\theta Q\left(\widetilde{\theta}\right)dG\left(\widetilde{\theta}\right)}{\rho+\eta_d+\alpha\lambda_e\widetilde{G}\left(\theta\right)}.\end{aligned}$$

Since our particular focus (due to the data that we are using) is bargaining out of the nonemployment state, let us define the function $x_d\left(\theta\right)=Q_d\left(\theta\right)-V_n$ which can be shown to equal

$$x_d\left(\theta\right)=\frac{\theta-d\phi-\rho V_n+\alpha\lambda_e\int_\theta x\left(\widetilde{\theta}\right)dG\left(\widetilde{\theta}\right)}{\rho+\eta_d+\alpha\lambda_e\widetilde{G}\left(\theta\right)}$$

In order to compute the critical matches, θ^* for transitions out of nonemployment and θ^{**} for the provision of health insurance, we solve the two fixed point equations

$$x_0\left(\theta^*\right) = 0 \tag{17}$$

$$x_1\left(\theta^{**}\right) = x_0\left(\theta^{**}\right), \tag{18}$$

where equation (17) defines indifference between unemployed search and employment at (θ^*,θ^*) and equation (18) defines indifference between employment with insurance and employment without insurance. These equations translate into the pair of fixed point equations:

$$\begin{aligned}\theta^*-\rho V_n+\alpha\lambda_e\int_{\theta^*}x\left(\widetilde{\theta}\right)dG\left(\widetilde{\theta}\right) &= 0\\ \theta^{**}-\left(\frac{\rho+\eta_0+\alpha\lambda_e\widetilde{G}\left(\theta^{**}\right)}{\eta_0-\eta_1}\right)\phi-\rho V_n+\alpha\lambda_e\int_{\theta^{**}}x\left(\widetilde{\theta}\right)dG\left(\widetilde{\theta}\right) &= 0\end{aligned}$$

Writing the value of nonemployment as,

$$\rho V_n=b+\alpha\lambda_n\int_{\theta^*}x\left(\widetilde{\theta}\right)dG\left(\widetilde{\theta}\right)$$

we can see that

$$\theta^*=b+\alpha\left(\lambda_n-\lambda_e\right)\int_{\theta^*}x\left(\widetilde{\theta}\right)dG\left(\widetilde{\theta}\right).$$

In addition, the second fixed point equation can be rewritten as

$$
\begin{aligned}
0 &= \theta^{**} - \left(\frac{\rho + \eta_0 + \alpha \lambda_e \widetilde{G}(\theta^{**})}{\eta_0 - \eta_1} \right) \phi - \theta^* - \alpha \lambda_e \int_{\theta^*} x\left(\widetilde{\theta}\right) dG\left(\widetilde{\theta}\right) + \alpha \lambda_e \int_{\theta^{**}} x\left(\widetilde{\theta}\right) dG\left(\widetilde{\theta}\right) \\
\theta^{**} &= \theta^* + \left(\frac{\rho + \eta_0 + \alpha \lambda_e \widetilde{G}(\theta^{**})}{\eta_0 - \eta_1} \right) \phi + \alpha \lambda_e \int_{\theta^*}^{\theta^{**}} x\left(\widetilde{\theta}\right) dG\left(\widetilde{\theta}\right).
\end{aligned}
$$

Finally, by taking linear approximations of the $x_d(\theta)$ functions, which are given by,

$$
\begin{aligned}
\widetilde{x}_0(\theta) &= 0 + \frac{(\theta - \theta^*)}{\rho + \eta_0 + \alpha \lambda_e \widetilde{G}(\theta^*)} \\
\widetilde{x}_1(\theta) &= \frac{\phi}{\eta_0 - \eta_1} + \frac{(\theta - \theta^{**})}{\rho + \eta_1 + \alpha \lambda_e \widetilde{G}(\theta^{**})},
\end{aligned}
$$

we can summarize the equilibrium solely in terms of the parameters of the model. In particular,

$$
\begin{aligned}
w_d\left(\theta', \theta^*\right) &= \theta' - d\phi - (1 - \alpha) \left(\rho + \eta_d + \lambda_e \widetilde{G}\left(\theta'\right) \right) \widetilde{x}_d\left(\theta'\right) \\
\theta^* &= b + \alpha (\lambda_n - \lambda_e) \int_{\theta^*} \widetilde{x}_d\left(\widetilde{\theta}\right) dG\left(\widetilde{\theta}\right) \\
\theta^{**} &= \theta^* + \left(\frac{\rho + \eta_0 + \alpha \lambda_e \widetilde{G}(\theta^{**})}{\eta_0 - \eta_1} \right) \phi + \alpha \lambda_e \int_{\theta^*}^{\theta^{**}} \widetilde{x}_d\left(\widetilde{\theta}\right) dG\left(\widetilde{\theta}\right).
\end{aligned}
$$

Table 1: Summary Statistics

Statistic	
Number of right censored unemployment spells	148
Number of transitions from unemployment to a job with insurance	419
Number of right censored job spells with insurance	319
Number of transitions from insured job to unemployment	42
Number of transitions from insured job to another job	58
Number of transitions from unemployment to a job without insurance	857
Number of right censored job spells with insurance	498
Number of transitions from uninsurd job to unemployment	196
Number of transitions from uninsured job to another job	163
Mean right censored unemployment duration	43.39 (33.20)
Mean uncensored unemployment duration	32.76 (31.47)
Mean right censored insured job spell duration	73.81 (38.19)
Mean uncensored insured job spell duration	36.53 (29.98)
Mean right censored uninsured job spell duration	55.75 (38.71)
Mean uncensored uninsured job spell duration	28.55 (23.01)
Mean wage for jobs with insurance	11.46 (6.22)
Mean wage for jobs without insurance	7.43 (5.13)

Note: Based on the 1990 to 1993 panels of the Survey of Income and Program Participation. The sample excludes all individuals who were self-employed, attended school, served in the military, or participated in any welfare program over the length of the survey. Wages are hourly and spell durations are in weeks.

Table 2: Maximum likelihood estimates without on-the-job search

Parameter	**Estimate**	**Std. Error**
Dissolution rate for jobs with insurance, η_1	0.004631	0.000371
Dissolution rate for jobs without insurance, η_0	0.008556	0.000427
Unemployed worker-firm match rate, λ	0.041175	0.011928
Mean log productivity level, μ_θ	1.958298	0.639748
Standard deviation of log productivity levels, σ_θ	0.950106	0.420361
Critical match out of unemployment, θ^*	5.006112	0.684493
Critical match for the provision of health insurance, θ^{**}	15.618906	2.761807
Standard deviation of measurement error distribution, σ_ε	0.426765	0.030229
Probability health insurance measured correctly, q	0.950512	0.027814
Unemployment utility flow, b	-6.020611	5.678204
Health insurance premium, ϕ	6.753304	2.965559

Note: Estimates based on the following assumptions: the annual discount rate is set to 0.08, the bargaining power parameter is set to 0.5, and the measurement error distribution is log normal with mean 1. Standard errors on the unemployment utility flow and the health insurance premium are computed using the asymptotic distribution of the other parameters.

Table 3: Maximum likelihood estimates with on-the-job search

Parameter	**Estimate**	**Std. Error**
Dissolution rate for jobs with insurance, η_1	0.001105	0.000304
Dissolution rate for jobs without insurance, η_0	0.006138	0.000453
Unemployed worker-firm match rate, λ	0.028712	0.002617
Employed worker-firm match rate, λ_e	0.009921	0.002443
Mean log productivity level, μ_θ	2.372048	0.182393
Standard deviation of log productivity levels, σ_θ	0.551677	0.078487
Critical match out of unemployment, θ^*	4.908189	0.735607
Critical match for the provision of health insurance, θ^{**}	14.800773	1.448271
Standard deviation of measurement error distribution, σ_ε	0.424127	0.021616
Probability health insurance measured correctly, q	0.914059	0.019368
Unemployment utility flow, b	-2.101609	1.871326
Health insurance premium, ϕ	4.347064	1.138715

Note: Estimates based on the following assumptions: the annual discount rate is set to 0.08, the bargaining power parameter is set to 0.5, and the measurement error distribution is log normal with mean 1. Standard errors on the unemployment utility flow and the health insurance premium are computed using the asymptotic distribution of the other parameters.

Table 4: Implied Parameter Estimates

Statistic	**OTJ search**	**No OTJ search**
Probability job provides health insurance, $p\,(d=1)$	0.3031	0.3155
Mean unemployment duration	37.7912	37.7837
Mean duration for jobs with insurance	444.5612	215.9491
Mean duration for jobs without insurance	84.6771	116.8716
Mean wage for jobs with insurance	12.4007	12.1294
Mean wage for jobs without insurance	7.1435	7.1630
Steady state unemployment rate	0.1632	0.2032
Steady state health insurance coverage rate	0.5819	0.3665
Steady state coverage rate of employed population	0.6954	0.4599

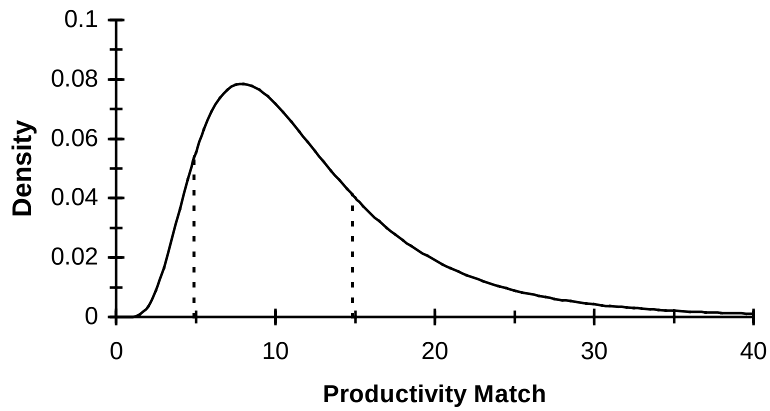
Note: Durations are measured in weeks and wages are hourly. The estimates on mean wages takes into account the measurement error distribution.

Table 5: Policy Simulations: Changes in the Health Insurance Premium

		Percent Decrease			
Statistic	**Baseline**	**20%**	**40%**	**60%**	**80%**
θ^{*}	4.910	4.927	4.867	4.699	4.415
θ^{**}	14.805	13.300	11.604	9.603	7.136
$p\,(d=1)$	0.303	0.378	0.480	0.622	0.814
Unemployment rate	0.163	0.157	0.151	0.144	0.138
Health insurance coverage rate	0.582	0.632	0.688	0.749	0.815
Coverage rate of employed population	0.696	0.750	0.809	0.875	0.945
Mean productivity	13.635	13.668	13.635	13.527	13.346

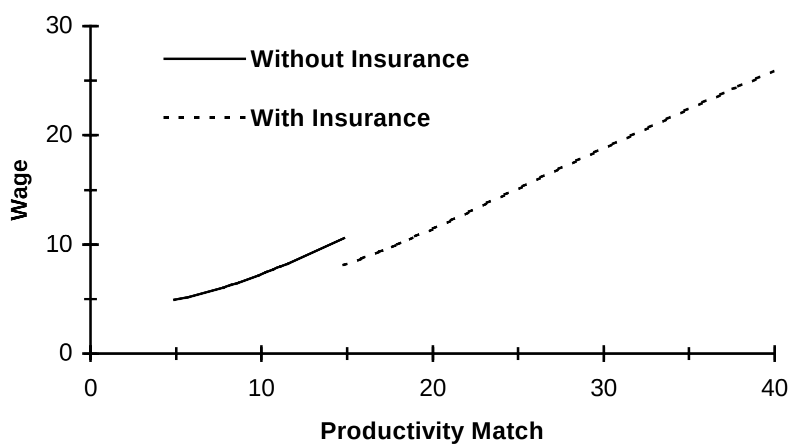
Note: Simulations are based on the parameter estimates for the model with on-the-job search presented in Table 3.

Figure 1. Productivity Density



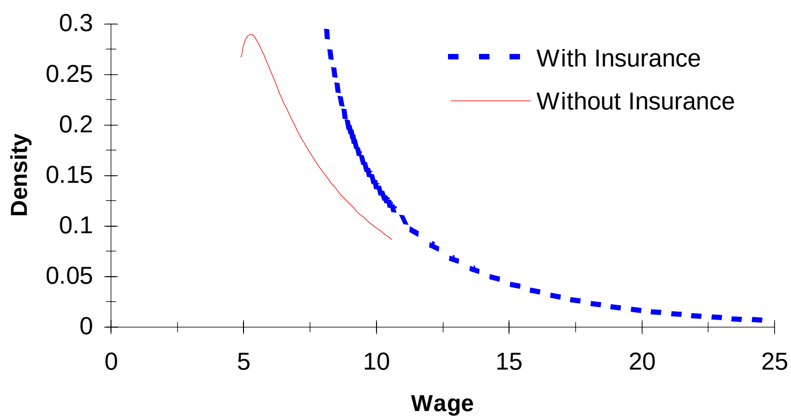
Note: Based on the parameter estimates for the model with on-the-job search presented in Table 3. The dotted vertical lines represent the critical matches for transitions out of unemployment and for the provision of health insurance, respectively.

Figure 2. Wage functions



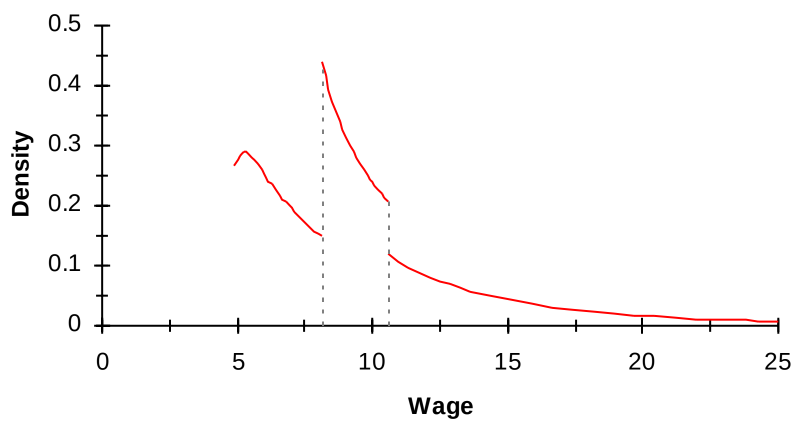
Note: The wage functions represent the first wage following an unemployment spell. Figure is based on the parameter estimates for the model with on-the-job search presented in Table 3.

Figure 3. Conditional Wage Densities



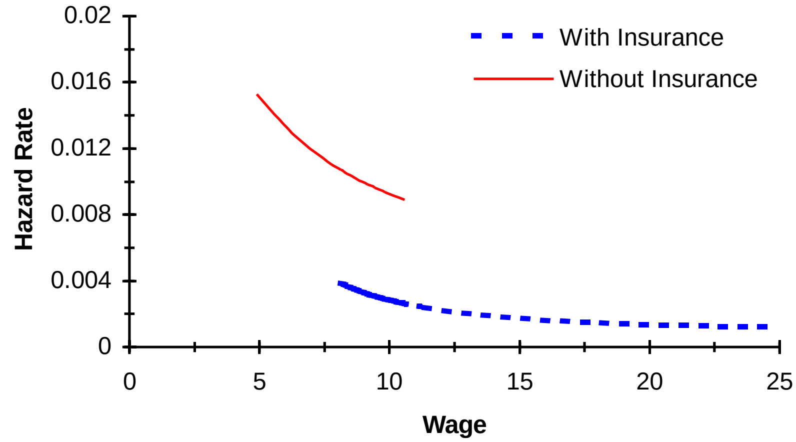
Note: Based on the parameter estimates for the model with on-the-job search presented in Table 3. Wages represent the first wage reported in the first job following an unemployment spell.

Figure 4. Unconditional Wage Density



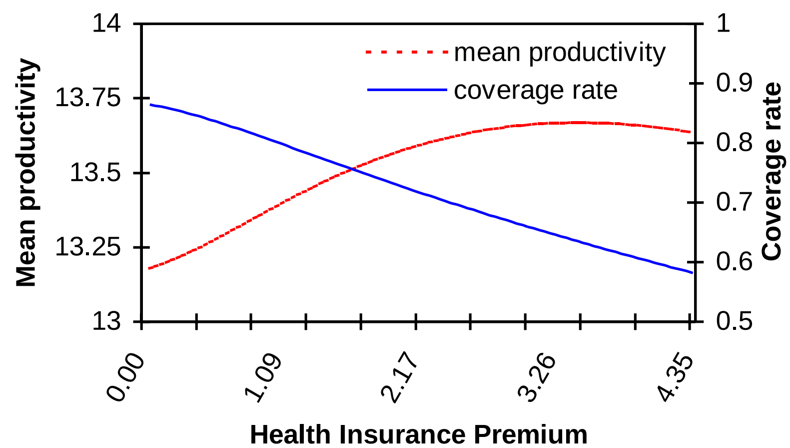
Note: Based on the parameter estimates for the model with on-the-job search presented in Table 3. Wages represent the first reported wage in the first job following an unemployment spell. The dotted vertical lines represent the minimum wage paid in a job that provides health insurance and the maximum wage paid in a job that does not provide insurance, respectively.

Figure 5. Hazard Rate Comparisons



Note: Based on the parameter estimates for the model with on-the-job search presented in Table 3. Wages represent the first wage in the first job following an unemployment spell. The hazard rate equals the weekly rate of exiting the current employment state, either through a dismissal to unemployment or a job change.

Figure 6. Policy Simulations



Note: Simulations are based on the parameter estimates for the model with on-the-job search presented in Table 3. The definitions of mean productivity and coverage rate are contained in the text.

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