

Hiring Practices, Duration Dependence, and Long-Term Unemployment

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Abstract

We develop an equilibrium search model of the labor market in which firms cannot observe worker quality prior to interviewing. Upon meeting an applicant, firms can interview workers at a cost to learn their type. Less productive workers are more likely to be turned away after an interview so that, on average, they are also unemployed for longer. In equilibrium, firms use the information contained in unemployment duration to screen workers before deciding whether or not to interview them. Thus, our model rationalizes new evidence on negative duration dependence in callback rates from Kroft et al. (2013a). We argue that the estimated duration dependence in callback rates helps to identify the degree of unobserved heterogeneity employers face in hiring process in our model. Since we can condition on unobservables within the model, we can decompose duration dependence in the job finding rate into its underlying sources: composition bias due to unobserved heterogeneity, and true duration dependence arising from employer screening.

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1 Introduction

Recent evidence has shown that firms statistically discriminate against applicants based on unemployment duration.¹ Using a large resume audit study, Kroft, Lange, and Notowidigdo (2013a) find that callback rates decline significantly over a worker’s unemployment spell. However, if the relevant information about a worker were observable to employers on a resume, callback rates would be independent of duration. Thus, their evidence supports the idea that there is unobserved worker heterogeneity that is at least partially revealed to firms before hiring, and always unobservable to the econometrician. Importantly, it also reinforces the idea that duration dependence in the empirical job-finding probability is confounded by composition bias due to the same unobserved heterogeneity that drives this statistical discrimination in the first place.²

Motivated by this evidence, we develop a model of employer screening in the face of unobserved heterogeneity, and use the information on callback rates from Kroft et al. (2013a) to identify the degree and nature of unobserved heterogeneity in our model. We build an equilibrium search model of the labor market in which firms have incomplete information about the workers who apply for their jobs. Upon meeting an applicant and viewing their resume, a firm can choose to interview the worker at a cost to learn their type. In our framework, firms and workers are heterogeneous in their productivity and less productive workers face a smaller subset of firms that are willing to employ them. It follows that less productive workers are more likely to be turned away after an interview so that, on average, they are also unemployed for longer. In equilibrium, firms use the information contained in unemployment duration about worker quality to statistically discriminate among applicants. Thus, the model is able to generate true duration dependence in job-finding probabilities, as

¹See Kroft et al. (2013a), Eriksson and Rooth (2011), and Oberholzer-Gee (2008).

²Kroft et al. (2013a) point this out and write, “Intuitively, “true” duration dependence in callback rates may arise as a result of optimizing behavior of firms that are dealing with such unobserved heterogeneity. This calls into question the standard practice of separately identifying state dependence and unobserved heterogeneity, since these two sources of duration dependence in job-finding rates interact in equilibrium.”

job-finding probabilities exhibit negative duration dependence even within skill groups.

Importantly, while these skill groups represent heterogeneity that is theoretically unobservable to the researcher, we can condition on them in our model to quantify the degree of true duration dependence, as long as the model is well-identified. In Section 2 we argue that the slope of the callback rate curve from Kroft et al. (2013a) helps to identify the degree and nature of unobserved heterogeneity that employers face in the hiring process, allowing us to tease apart several sources of duration dependence. Put simply, if the unobserved component of heterogeneity were common across workers, then callback rates would be independent of duration. This is because no new information would be revealed to firms during interviews, and thus hiring decisions would not reveal information to other firms. Consequently, unemployment duration would be uninformative to employers. In the Appendix, we discuss how identification changes when we introduce other common hypotheses for duration dependence such as the atrophying of skills in unemployment, or search intensity that declines with duration.

Lockwood (1991) has such a model where firms are homogeneous and there are two types of workers, high and low. Firms can test their applicants imperfectly and use the information from the test to inform their hiring decision. However, our model differs in several important respects. While our setup embodies a similar mechanism, we allow for heterogeneous firms and heterogeneous workers of more than two types to make a more serious attempt to bring the model to the data. In addition, we can tractably incorporate both aggregate shocks and endogenous separations. The former allows us to explore the dynamics in the model. The latter is particularly important since lower worker types will separate at higher rates in recessions, impacting the information contained in unemployment duration. We view this to be an important component of a model with employer screening since the information contained in duration changes depending on the state of the economy.

Blanchard and Diamond (1994) also have a model which delivers true duration dependence in job-finding probabilities. In their setup, matching occurs between workers and

firms via an Urn-Ball process. Unemployment arises because some firms receive multiple applications for one position, while some firms receive no applications and are left with an empty position. When faced with multiple applications, firms choose the lowest-duration worker. Therefore, in their model duration dependence arises because of assumptions on the hiring technology, whereas in our model, duration dependence arises endogenously due to information externalities and optimizing behavior on the part of employers.

Our model employs a version of the random search model developed in Lise and Robin (2013). While we abstract from on-the-job search, the setting is still particularly useful for us since we also will not need to keep track of the joint distribution of duration and skill in unemployment to solve the model with aggregate shocks, much like the authors do not need to keep track of the joint distribution of worker-firm pairs to solve their model - it suffices to know the surplus generated by all possible matches. While we have not yet exploited the model's ability to incorporate aggregate shocks, we intend to use their result in our setting to study how information externalities change with the aggregate state of the economy. For similar reasons, we can feasibly introduce skill atrophying during unemployment without adding any real complexity to the model's solution.³

The rest of the paper proceeds as follows. In Section 2, we describe in more detail how the callback rate curve, combined with our structural model, helps with identification of unobserved heterogeneity. In Section 3 we lay out the simplest version of our model. We simulate the model and show its key underlying mechanisms. Section 4 estimates the model and decomposes duration dependence in the job-finding probability into its sources. Finally, Section 6 concludes and discusses ongoing work for this project.

2 The Advantage of Callback Rates

Because we want to measure true duration dependence in job-finding probabilities, it is important that we can condition on unobserved heterogeneity and that unobserved hetero-

³See the Appendix for further discussion of these extensions.

geneity is well-identified. In this section, we sketch how the distribution of callbacks found in Kroft et al. (2013) can help with identification of key deep structural parameters. In so doing, we review the standard problem of identification in the empirical literature.

In its most general form, the job-finding probability can be written as:

$$f(o, x, z, d) = s(o, x, z, d) \cdot c(o, z, d) \cdot a(o, x, z)$$

where $s(\cdot)$ represents a measure of search intensity, $c(\cdot)$ represents the probability of getting an interview conditional on sending an application, and $a(\cdot)$ represents the probability of getting hired given that you received an interview. Here, o is a vector of observable variables (to both the firm and the researcher), x is a vector of unobservables that might be revealed upon an interview to the firm, but never to the researcher, z represents the aggregate state of the economy, and d is unemployment duration.

To give some examples, o might include education level, which is observable to both the researcher and the firm, even at the resume stage. This may affect a worker's search intensity, a worker's probability of getting a callback, and also the worker's probability of getting hired. x might include soft skills, which are not on a resume, are revealed in an interview to the firm, but remain unobservable to researchers. This is something that might affect a worker's search intensity, a worker's probability of getting a callback, and the probability of getting hired. Finally, z reflects aggregate conditions: for example, the probability of finding a job generally falls in recession. The key differences among these characteristics are (i) whether or not the firm can observe these characteristics and (ii) at what stage of the hiring process they are revealed.

Since identification problems involve x and not o , and a number of studies have shown that duration dependence exists even after controlling for observables, we consider the conditional job-finding probability:

$$f(x, z, d|o) = s(x, z, d|o) \cdot c(z, d|o) \cdot a(x, z|o)$$

The callback rate curve identified in Kroft et al. (2013a) is $c(d, z|o)$ above: it is conditional on characteristics one would have in a resume, depends on the aggregate state in several of their specifications, and is independent of x or search intensity. To identify true duration dependence, the object of interest is:

$$f(d|x, z, o) = s(d|x, z, o) \cdot c(d|z, o) \cdot a(x|z, o)$$

To fix ideas, abstract for a moment from search intensity. Then true duration dependence in job-finding probabilities would be given by $f(d|x, z, o) = c(d|z, o) \cdot a(x|z, o)$. Other than $c(d|z, o)$, which is given in Kroft et al. (2013), we cannot observe the other objects in this equation because we cannot condition on unobservable heterogeneity. This is the usual identification problem. The approach in the empirical literature has been to assume some functional form for duration dependence directly, and together with some assumptions on unobserved heterogeneity to estimate true duration dependence in the data.⁴

However, combined with a structural model, the curvature in the callback rate can tell us something about the extent of unobserved heterogeneity. For example, suppose there is no variation in unobserved heterogeneity. Then the callback rate curve would be independent of unemployment duration. All else equal, increasing the variance of the distribution implies that more information is contained in duration about unobserved heterogeneity. Firms thus screen workers more heavily on duration because it is now more likely that a worker is a low type if he is unemployed for longer, as higher types generally don't get turned down.⁵

Theories using skill deterioration in unemployment to explain duration dependence are equivalent to theories of declines in x that are correlated with duration. If firms know that skills deteriorate with duration, they will also use this information to screen workers in

⁴See, for example, Heckman and Singer (1984a) and Heckman and Singer (1984b). Heckman and Singer (1984b) show that if one provides a functional form for the duration model conditional on observables and unobservables, you can estimate the structural parameters and the distribution of unobserved heterogeneity with nonparameteric MLE.

⁵This is true up to the point where the skill level is irrelevant because everyone would hire the worker anyway. That is, as distribution of skills becomes heavily skewed toward skills that generate all firms positive surplus, this would no longer hold.

the hiring stage. So, while the the action of firms is similar in both cases, it is important to include this skill loss to correctly condition on unobservables and uncover true duration dependence. To separately identify these mechanisms, an additional assumption is necessary: that the rate of skill loss in unemployment does not vary over the bussines cycle. If this were the case, we could use the callback rate curves for both weak and tight labor markets (both of which were estimated in Kroft et al. (2013)) to separately identify skill loss in unemployment from the underlying distribution of unobserved heterogeneity.

More serious complications arise when trying to account for changes in search intensity with unemployment duration. In this case:

$$f(d|x, z, o) = s(d|x, z, o) \cdot c(d|z, o) \cdot a(x|z, o),$$

but we cannot observe search intensity conditional on unobservables in the data. The conditional callback rate curve is not enough to separately identify true duration dependence. Since no evidence exists on search intensity and unobservable characteristics, we can only hope to model the search intensity margin and rely on data linking search intensity to unemployment duration.⁶

3 Baseline Model

3.1 Environment

The economy consists of a continuum of infinitely lived workers indexed by their type $x \in [\underline{x}, \bar{x}]$ and, if unemployed, by their duration d . The exogenous distribution of worker types is given by $l(x)$ and the total measure of workers in the economy is exogenous such that $\int l(x)dx = 1$. There is a continuum of firms indexed by their type $y \in [\underline{y}, \bar{y}]$. Firms have access to a production technology given by $p(x, y)$. Unemployed workers have access to

⁶However, Krueger and Mueller (2010) find that “time devoted to job search is fairly constant regardless of unemployment duration for those who are ineligible for UI.”

home production technology $b(x)$ which depends on their type. Finally, the distribution of vacancies for each firm type is exogenous at $v(y)$ so that the total number of vacancies is $V = \int_y v(y)dy$. We begin by abstracting from aggregate shocks, but reintroduce them later on to study aggregate dynamics.

The joint distribution in unemployment of duration and skill $u(x, d)$ is endogenous and depends on the hiring decisions of firms. Unemployed workers contact firms at rate λ_0 . Upon meeting one another, which we refer to as the *resume stage*, firms cannot observe the worker's type x , but can readily infer the worker's unemployment duration d from their resume. Thus, x represents heterogeneity among workers that is observable after an interview, but unobservable at the resume stage. If there is any information contained in duration, firms can form expectations about the worker's type conditional on the observed duration. They can choose to reject the worker without an interview, or they can pay a cost κ to interview the worker and learn the worker's type x with certainty. If the firm chooses to interview the worker to learn their type, they decide on whether or not to consummate the match.

3.2 Value Functions

Let the value of a filled job to the firm be given by:

$$(3.1) \quad \Pi_t(w, x, y) = p(x, y) - w + \beta\{(1 - \delta)\Pi_{t+1}(w, x, y)\}$$

where $p(x, y)$ is the output of a match between a type x worker and type y firm, w is the wage paid to the worker, and δ is the probability the match exogenously dissolves. We assume that wages upon hiring are such that the firm extracts the entire surplus from the match. That is, if $B(x, d)$ represents the value of unemployment and $W(w, x, y, d)$ represents the value of employment to the worker, then wages will satisfy:

$$W(w, x, y, d) - B(x, d) = 0$$

When a firm meets with a worker, it forms expectations about the surplus of the match conditional on duration, $\int \Pi(w, x, y)u(x, d)dx$. If this is greater than or equal to the cost of interviewing the worker, the firm pays the cost and interviews the worker. If not, the firm immediately turns down the worker:

$$(3.2) \quad \int_{\underline{x}}^{\bar{x}} \Pi(w, x, y)u(x, \hat{d}(y))dx - \kappa = 0$$

Thus, (3.2) implicitly defines a cutoff strategy for each firm y stating that if the worker's duration d is less than some cutoff $\hat{d}(y)$, the firm interviews the worker and, if not, the firm turns down the worker. Let $\hat{d}^{-1}(y)$ be the firm type y such that given a specific duration, any firm below this type will not interview the worker.

The value of unemployment to a type x worker who has been unemployed for d periods is given by:

$$(3.3) \quad \begin{aligned} B_t(x, d) = & b(x) + \beta \left(1 - \int^{y=\hat{d}^{-1}(d)} \lambda_{0,t} \frac{v_t(y)}{V_t} [\mathbf{I}_{S(x,y)>0}] dy \right) B_{t+1}(x, d+1) \\ & + \beta \left(\lambda_{0,t+1} \int^{y=\hat{d}^{-1}(d)} \frac{v_t(y)}{V_t} \max\{W_{t+1}(w, x, y, d), B_{t+1}(x, d+1)\} dy \right) \end{aligned}$$

Unemployed workers earn their value of leisure $b(x)$. With probability $1 - \lambda_{0,t+1}$, they do not get contacted by a firm. With probability $\lambda_{0,t+1} \int^{\hat{d}^{-1}(y)} \frac{v_t(y)}{V_t} dy$, they get contacted by a firm, and the firm will not interview the worker. Finally, with probability $\lambda_{0,t+1} \int_{\hat{d}^{-1}(y)} \frac{v_t(y)}{V_t} dy$ the worker meets a firm willing to interview the worker. After the quality of the worker is learned, the firm and worker agree on whether or not to match. If they decide to consummate the match, the worker gets the value of the match, and otherwise, the worker remains unemployed.

Note that because the wage will be decided such that the worker gets no share of the

surplus, we can write this independently of duration as:

$$(3.4) \quad B_t(x) = b(x) + \beta B_{t+1}(x)$$

Thus, because this is independent of duration, match surplus will be independent of the unemployment duration when the worker gets hired.

A worker of type x who is employed with a firm of type y with a wage w earns a value of employment given by:

$$(3.5) \quad W_t(w, x, y) = w + \beta [\delta B_{t+1}(x) + (1 - \delta)W_{t+1}(w, x, y)]$$

We can add these together to get an expression for the surplus:

$$(3.6) \quad W_t(w, x, y) - B_t(x) + \Pi_t(w, x, y) = p(x, y) - b(x) + \beta(1 - \delta) \{W_{t+1}(w, x, y) - B_{t+1}(x) + \Pi_{t+1}(w, x, y)\}$$

Since the surplus is independent of the wage and unemployment duration of the worker, we can express the surplus as:

$$(3.7) \quad S(x, y) = p(x, y) - b(x) + \beta(1 - \delta)S_{t+1}(x, y)$$

3.3 Matching

At the beginning of the period, a measure $u_t(x, d)$ are unemployed type x workers with duration d and a measure $h_t(x, y)$ are employed type x workers at a type y firm. Some of the viable matches exogenously separate. Therefore, the stock of unemployed workers with duration d after the realization of the separation shock is:

$$u_{t+}(x, d) = [1 - \mathbf{1}\{d = 0\}]u_t(x, d - 1) + \mathbf{1}\{d = 0\} \int_{\underline{y}}^{\bar{y}} \delta h_t(x, y) dy$$

That is, anyone who separates will be unemployed with duration $d = 0$ and the remaining unemployed workers all increase their duration by one period. The stock of matches of type (x, y) immediately after the separation rate shock is given by:

$$h_{t+}(x, y) = (1 - \delta)h_t(x, y)$$

Now, there are $u_{t+}(x, d)$ type (x, d) workers and $h_{t+}(x, y)$ type (x, y) matches. Let us assume for now that there is no on-the-job search. Effective search effort is given by:

$$L_t = \int \int u_{t+}(x, d) dx dd$$

There is an exogenous measure $v_t(y)$ of type y vacancies:

$$V_t = \int v_t(y) dy$$

If we define $\lambda_{0,t}$ to be the rate at which effective searchers contact available vacancies, we can write the laws of motion as:

$$(3.8) \quad u_{t+1}(x, d) = u_{t+}(x, d) \left(1 - \int_{y=\hat{d}^{-1}(d)} \lambda_{0,t} \frac{v_t(y)}{V_t} [\mathbf{I}_{S(x,y)>0}] dy \right)$$

$$(3.9) \quad h_{t+1}(x, y) = h_{t+}(x, y) + \int_{d=\hat{d}(y)} q_t u_{t+}(x, d) [\mathbf{I}_{S(x,y)>0}] dd$$

4 Calibration and Estimation

We calibrate several model parameters and then estimate the remaining parameters via Simulated Method of Moments.⁷ We calibrate the model at a weekly frequency, so we

⁷The estimation is still work in progress. For the plots contained in this draft, we use $\kappa = .015$, $A = B = .01$, and $\lambda = .2$

set $\beta = .9992$ to match a monthly interest rate of 4% and $\delta = .005$ to match a monthly separation rate of 5%. We choose a weekly calibration for the following reason. In our model, the slope of the callback rate curve will depend on how much information is contained in unemployment duration, which will in turn depend on how many interviews a worker has had (among other things). If we use a monthly calibration, we would be limiting the number of interviews to at most one per month, which restricts the slope of the callback rate curve significantly. However, if we set the period to be a week, then a worker can have at most 4 interviews per month, so that being unemployed for a month is potentially very informative. We emphasize that we aggregate the weekly model-generated data appropriately to match our monthly targets.

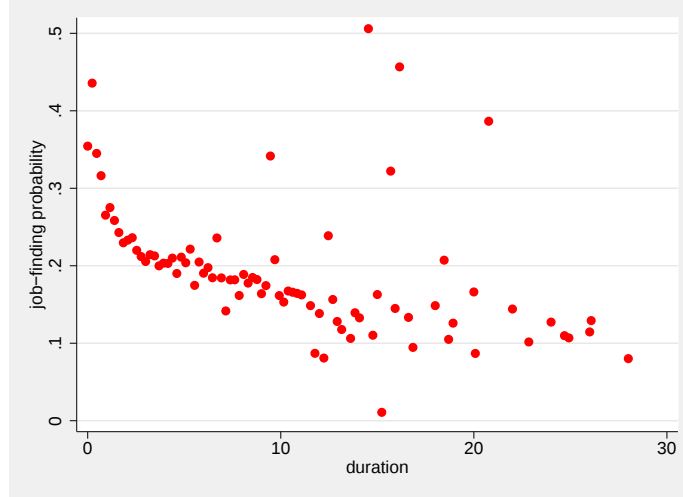
Table 1: Fixed Parameter Values

Parameter	Value	Description	Source
β	0.999	discount rate	weekly target
L	1.000	total labor force	normalization
δ	0.005	separation probability	weekly target
λ	0.200	contact rate	weekly target
κ	0.105	interview cost	.

4.1 Data

Our model speaks to moments in the data that are conditional on observables. Since we do not explicitly model observable characteristics, we must separately estimate the model for different groups of workers (i.e., highly educated males). Therefore, we construct conditional counterparts to familiar statistics such as the job-finding probability. To do so, we use data from the Current Population Survey spanning January 1976 through January 2013. We pool data from these years to construct the job-finding probability as a function of duration by matching monthly data. In so doing, we follow Kroft et al. (2013a) and convert weeks of unemployment into months, and merge months into two month groups after 16 months. Figure 1 depicts the empirical finding probability for male workers with a college degree

Figure 1: U.S. Job Finding Probability and Unemployment Duration, 1976-2013



Notes: This figure plots the job-finding probability at different durations for male workers with a college degree between the ages of 25 and 55.

between the ages of 25-55.⁸

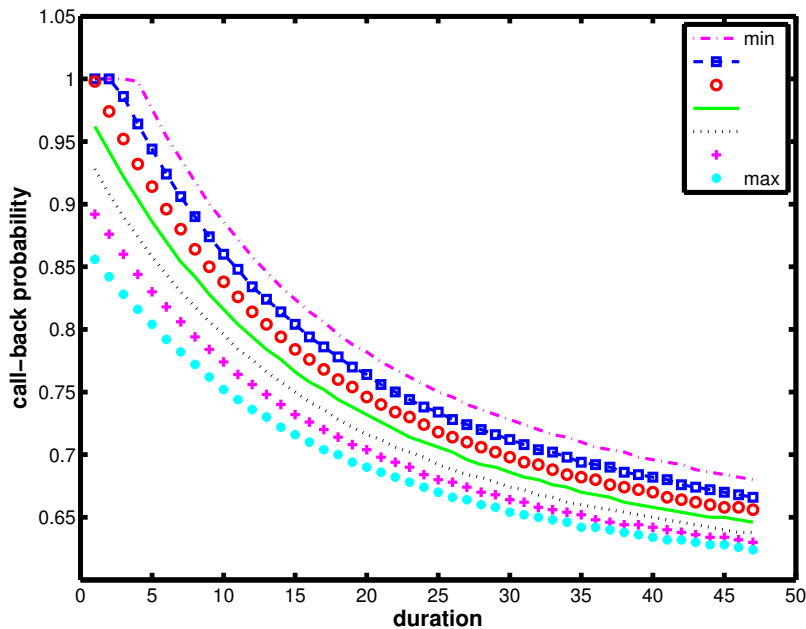
4.2 Identification

The key parameters in our model are the interview cost κ , the distribution of underlying unobserved heterogeneity, and the contact rate λ which governs the rate at which workers meet firms. To begin, we assume that the underlying distribution for unobserved heterogeneity is distributed as $x \beta(A, B)$ with shape parameters A and B to be estimated. This distribution is extremely flexible and allows for various possibilities of the underlying distribution. We assume that firm types are uniformly distributed on $[0, 1]$.

The data show that duration dependence in callback rates begins immediately: someone who has been unemployed for one month is already less likely to find a job than someone who is newly unemployed. Figure 2 plots the model-generated callback rate curve for different parameter values of the interview cost. In our model, if the interview cost is too low all firms will pay the cost and interview workers, even if they meet a worker with an unemployment duration of one month. If everyone gets interviewed, duration will not have any predictive

⁸Our baseline target will be this group. However, we plan to re-estimate the model for different groups separately.

Figure 2: Comparative Statics in Interview Cost κ



Notes: This figure depicts the model-generated callback curve for different interview cost parameters. The left-most curve corresponds to the highest interview cost parameter, while moving to the right corresponds to declines in the interview cost parameter.

power for callback in month 1 relative to a newly unemployed. On the other hand, if the interview cost is too high, then some firms will not interview workers who are newly unemployed, and thus will never participate in the market. Thus, we search for an interview cost that is small enough that all firms interview newly unemployed workers, and at the same time large enough that some firms no longer interview workers of duration greater than zero. Since in our model the only things which determine whether you get a callback conditional on meeting a firm are your unemployment duration and the distribution of vacancies, we search for an interview cost that will give a callback rate of 1.

To identify the distribution of unobserved heterogeneity, we use the slope of the callback rate curve from the resume audit study of Kroft et al. (2013a). Figure 3 shows how the callback rate curve changes when we change the shape parameters of the underlying distribution of unobserved heterogeneity, holding the mean of the distribution fixed.⁹ All else equal,

⁹The mean of the β distribution is $\frac{1}{1+\frac{A}{B}}$. This requires setting $A = B$.

increasing the variance of the distribution of underlying unobserved heterogeneity increases the slope of the callback rate curve. To understand the intuition, think first of the extreme case in which the variance is zero, and all workers have the same value for x . In equilibrium, firms know that higher durations do not correspond to (on average) lower unobserved productivities. Therefore, they are equally likely to interview workers of all durations and the callback rate curve would be flat. On the other hand, consider the case where workers are of two types, high and low. Consider the case where the variance is maximized and the two types are zero and one as compared to the case where there is a distribution of types towards the middle of the distribution. In the first case, the information revealed in duration is much sharper: since nobody ever turns down the high type, but many turn down the low type, the likelihood of meeting a high type who is unemployed for long is much lower. In the second case, when the workers are bunched together towards the middle of the distribution, much less information is revealed through duration since the set of firms who would reject or accept each of the workers hardly changes.

When we try to match the slope of this curve, we use estimates of its slope from Kroft et al. (2013b), who use the data from the resume audit study from Kroft et al. (2013a) and estimate the following model for duration dependence in callback rates:

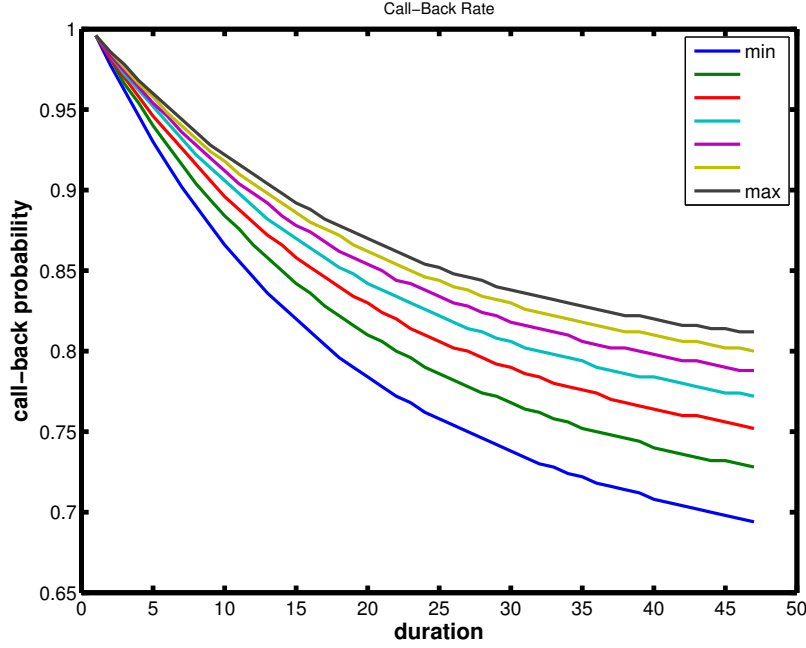
$$(4.1) \quad \gamma(d) = a_1 + (1 - a_1) \exp(-b_1 \cdot d)$$

where $\gamma(d)$ is the callback rate for a worker who has been unemployed for d months relative to the callback rate for a newly unemployed worker. The results, which are reported in the bottom half of Kroft et al. (2013a), Table 2. We simulate our model to generate callback rates for workers of different unobservable qualities and duration, and run the same estimation as above and try to match the parameters of the empirical call-back rate curve.¹⁰

The last parameter is the contact rate λ . In our setting, the contact rate fully controls the

¹⁰We try to match this as opposed to estimates from the linear probability model because our model will not be able to simultaneously generate a mean callback rate of .047 and a job-finding probability of .45. In any case, this empirical callback rate is time-less.

Figure 3: Comparative Statics in the Shape Parameters A and B



Notes: This figure depicts the model-generated callback curve for different shape parameters A , holding the mean of the underlying unobserved heterogeneity distribution fixed. The curve with the steepest slope represents the model-generated curve corresponding to the highest variance in unobserved heterogeneity.

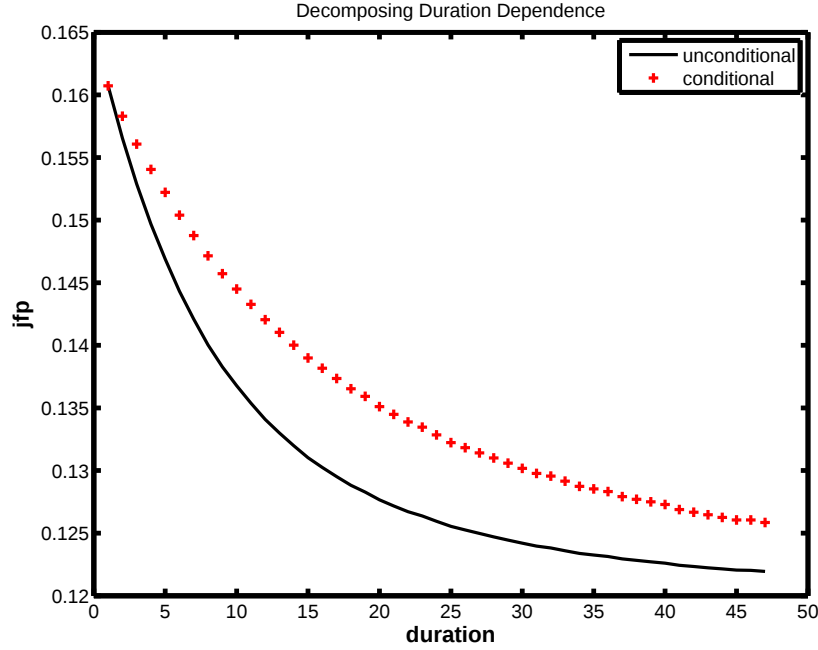
probability of finding a job in a given month. Thus, we target a weekly job-finding probability of .10 so that we generate a monthly average job-finding probability of approximately .45.

5 Measuring True Duration Dependence (TDD) in Job-Finding Probabilities

Using our estimated model, we decompose duration dependence in the job-finding probability into its underlying sources: composition bias due to unobserved heterogeneity and true duration dependence arising from employer screening. We first trace out the model-generated job-finding probability by unemployment duration. This is the black curve depicted in Figure 4 We write this model-generated curve as:

$$(5.1) \quad f(d) = \sum_x f(x, d)u(x, d)dx$$

Figure 4: True Duration Dependence In Job-Finding Probabilities



Notes: This figure depicts the model-generated job-finding probability, both unconditional on unobserved heterogeneity (the black line) and conditional on unobserved heterogeneity (the red line). The conditional curve is calculated via the equation for $f^{star}(d|x)$ in the text.

We then fix the distribution of duration and skill in unemployment at its duration zero counterpart, $u(x, 0)$ and create a hypothetical conditional job-finding probability curve by duration:

$$f^*(d|x) = \sum_x f(x, d)u(x, 0)dx$$

This hypothetical curve tells us what the job-finding probability would be at each duration if the distribution of skills were not changing as duration increased over time. Our preferred measure of true duration dependence is then the fraction of the estimated slope in the job-finding probability curve that can be explained by the slope of the curve that is not confounded by unobserved heterogeneity. That is, we first fit lines through $f(d)$ as well as $f^*(d)$ which gives two separate slope estimates, ρ and ρ^* respectively. Then our estimate for true duration dependence (TDD) is:

$$TDD = \frac{\rho^*}{\rho} \cdot 100$$

6 Conclusion

This paper develops an equilibrium search model of employer screening that endogenously generates true duration dependence in job-finding rates. Workers have skills that are unobservable on a resume, are revealed during an interview with an employer, and are permanently unobservable to researchers. More productive workers are less likely to be turned away conditional on an interview so that, on average, less productive workers are unemployed for longer. Firms recognize that unemployment duration contains this signal about the worker’s quality, and use this information to screen workers prior to interviewing them. Thus, the mechanism in our model rationalizes new evidence found in Kroft et al. (2013a) on callback rates.

We argue that this evidence, along with our structural model, can help to identify the degree of unobserved heterogeneity that firms face in the hiring process. Because we can discipline the degree and nature of unobserved heterogeneity, we can condition on it in our model to decompose duration dependence in job-finding probabilities into its underlying sources: composition bias due to unobserved heterogeneity and true duration dependence stemming from employer screening. To do so, we ask how the average job-finding probability would evolve over the duration of unemployment if we held the distribution of unobserved heterogeneity fixed at its distribution among the newly unemployed.

Going forward, it will be important to allow for other mechanisms that might deliver duration dependence such as skill deterioration in unemployment, time varying search intensity, or time varying reservation wages. In the Appendix, we show that the model is amenable to introducing aggregate shocks and skill deterioration. Importantly, we argue that we maintain identification of unobserved heterogeneity in this setting as long as skills deteriorate at the same rate no matter what the aggregate state is and we employ information on the callback rate for different aggregate states in Kroft et al. (2013a). Given that skill deterioration is a leading explanation of duration dependence, we feel it is important to

allow for such a mechanism in our model to accurately quantify true duration dependence in job-finding rates. Finally, an interesting question is whether these hiring practices are inefficient. Because an interview provides an information externality to other firms, firms might be under-interviewing and free-riding on duration too much.

7 Extensions

7.1 Skill Deterioration

To introduce skill deterioration, we assume that x declines in unemployment with probability γ_u and increases in employment with probability γ_e . Once a worker is at the highest (lowest) end of the distribution, their skill level is fixed. Accounting for this mechanism in the numerical solution of the model amounts to resolving for the surplus functions and incorporating skill loss and growth in the updating equations for the distributions of skill. At the very least, we can estimate the model under different parameterizations for the loss and growth of skill during unemployment and show how our decomposition of duration dependence changes for different parameter values.

7.2 Aggregate Shocks

In this section, we illustrate how aggregate shocks are tractable in the model. We follow Lise and Robin (2013) and show that the surplus is independent of the wage. Let $z \in [\underline{z}, \bar{z}]$ be the aggregate state of the economy and $\pi(z'|z)$ be the Markov transition matrix. The only thing that really changes in the model is that wages may have to be renegotiated after a shock leading to endogenous separations.

7.2.1 Wage Renegotiation

Let us suppose w is the wage inherited from $t - 1$ when the aggregate state was z . Incentive compatibility requires that the wage be renegotiated to a new value, if necessary, such that:

$$0 \leq W_t(w') - B_t(x, 0) \leq S_t(x, y, z')$$

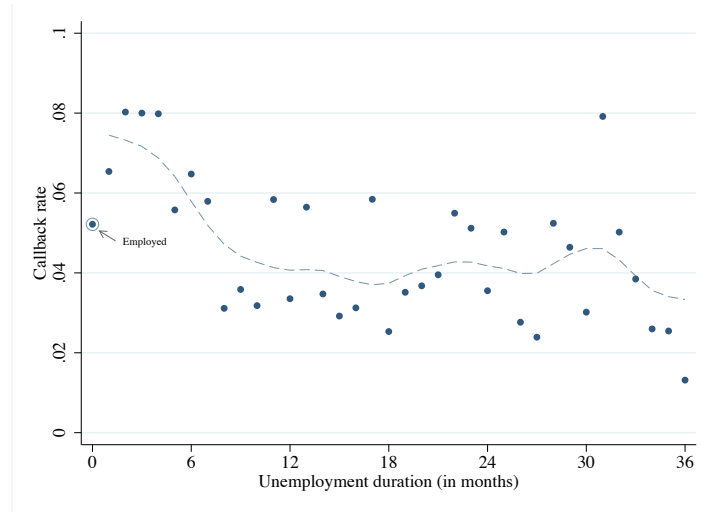
There are four cases to be considered:

1. Suppose that at the old wage, $0 \leq W_t(w, x, y) - B_t(x) \leq S_t(x, y, z')$ holds. Then the wage does not need to be renegotiated and $w' = w$.
2. Suppose that at the old wage, $W_t(w, x, y) - B_t(x) < 0 < S_t(x, y, z')$. Then the surplus for the worker is too low, so the firm takes all the surplus, and the wage is adjusted up to the point where the worker makes zero surplus, $w' = \phi_{0,t}(x, y)$.
3. Suppose that at the old wage, $W_t(w, x, y) - B_t(x) > S_t(x, y) > 0$. Then the firm's surplus is too low, so the worker takes all the surplus, driving the firm's surplus to 0.
4. Finally, if the surplus becomes negative, $S_t(x, y, z') < 0$, the worker and firm separate endogenously.

We need to take the endogenous separations into account now when we are computing the evolution of the distributions:

$$u_{t+}(x, d) = [1 - \mathbf{1}\{d = 0\}]u_t(x, d-1) + \mathbf{1}\{d = 0\} \left[\int_{\underline{y}}^{\bar{y}} \delta h_t(x, y) dy + \int_{\underline{y}}^{\bar{y}} (1 - \delta) \mathbf{I}_{S_{t+1}(x, y) < 0} h_t(x, y) dy \right]$$

Figure 5: Empirical Callback Rates by Unemployment Duration



Source: Kroft, Lange, and Notowidigdo (2013a)

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