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Effect of labor market policies on unemployment when firms adapt their recruitment strategy

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ABSTRACT

Firms conduct interviews to select who to hire. Their recruitment strategies affect not only the hiring rate but also job destruction rate as more interviews increase the chances of finding the right worker for the job; a link mostly overlooked in the literature. I model this recruitment behavior and investigate the effects of labor market policies on unemployment. These policies change the value of hiring the right worker, altering firms' incentives to conduct interviews. Policies further affect job creation and destruction when firms adapt their recruitment strategies. Net effect of a policy on unemployment depends on the magnitude of change in job creation versus destruction. Qualitative analysis reveals that the effect of a policy on unemployment is mostly weakened with the introduction of firms' recruitment behavior to the model. Firing taxes still increase unemployment, albeit at a lower rate. The effect of hiring subsidies on unemployment is even reversed: Unemployment increases with hiring subsidies if firms adapt. Minimum wage and unemployment insurance policies are also analyzed.

1. Introduction

The importance of a search for information in the labor market has been widely recognized, starting from the seminal work of Stigler (1962). Empirical studies cited below document that firms exert effort to assess the suitability of candidates before the hiring decision. Labor market policies can alter firms' incentives to put effort into finding the best candidate among applicants. Hence, ignoring firms' selection effort while evaluating the effects of policies on the unemployment rate may be misleading. This paper develops a model of hiring behavior of firms and investigates the unemployment rate response to firing taxes, hiring subsidies, minimum wage and unemployment insurance policies in the presence of such channel.

Search by firms is centered around the selection of the best candidate among applicants of a vacancy. van Ours and Ridder (1993) use data from the Netherlands and find that vacancies are mostly filled among applicants that apply for the job shortly after the vacancy is opened, but that hiring takes place long after the application process. Similarly, van Ours and Ridder (1993), Barron et al. (1985), Barron and Bishop (1985) and Barron et al. (1997) find that employers put effort into assessing the suitability of applicants to select the best candidate. Moreover, as firms search more thoroughly for a better candidate the cost they incur increases (Barron and Bishop, 1985). Thus, search by an employer affects not only the arrival rate of an employee but also the compatibility of the new hire for that job as well as the vacancy cost. A better suited match will be more productive and last longer. However, in a standard search model à la Pissarides (2000), the intensity of a search by an employer only affects the arrival rate of a candidate.[1]

To formally analyze the selection efforts of firms, I employ a discrete time infinite horizon search and matching model in which workers and firms are homogeneous and there is a match specific quality: The quality of an employment relationship between a firm and a worker (match) can be good or bad. Good matches generate a positive surplus while bad matches do not, and hence are not desirable. A vacant firm and an unemployed worker decide whether to form the employment relationship with limited information regarding the quality of the match, which is acquired as explained below. The quality is completely revealed after parties observe the output. Employment relationships which are inferred to be bad are terminated in equilibrium.

When a firm posts a vacancy, it picks the number of workers to conduct interviews with, incurring some cost. An interview is a draw from a distribution and the value drawn is the probability of the quality of the match between the firm and the worker being good. At the end of the interviews, the firm selects the worker with whom it has the highest probability of having a good match.[2] If the selected worker is available for hire, as she may not be if she chooses some other firm she

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[1] Pissarides (1984b) also models employer search ("job advertisement") in a similar fashion.

[2] If firms pick only one interview, then there is no "selection".

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interviewed with, the firm and the selected worker decide whether to form the employment relationship based on this probability. Even though this probability is the highest among possibly multiple interview outcomes, it may not be high enough to convince the parties to start the employment relationship. Hence, the model has a threshold probability below which hiring does not take place. If the probability is above the threshold (if the chances of the match quality being good are high enough), then the firm and the worker form the employment relationship. When the production takes place, match quality is learned observing the output.

Since a firm interviews possibly a multiple number of workers and picks the one with the highest probability, firms' search behaviors determine the equilibrium distribution of the probability of new hires being good matches. This distribution governs the fraction of formed employment relationships that are good. Consequently, it affects the average productivity in the economy as well as the job durations. Firms choose the number of interviews to maximize the value of their vacancies. A firm's choice of interviews depends on the surplus good matches can generate, the cost of the interviews, and the distribution that probabilities are drawn from at the interviews.

Unemployment in this model is determined by the inflows from and outflows to employment. Inflow rates are due to exogenous idiosyncratic destruction shocks to matches and separation decisions of firm–worker pairs who learn that their match is bad. Outflows result from hirings. Hiring occurs if the worker who is the firm's best option is available for hire and the probability of their match quality being good is high enough. The number of interviews in the economy affects unemployment through changing these inflow and outflow rates. These rates are directly affected by the selection decisions of firms and indirectly affected through the general equilibrium effects on the number of vacancies in the economy as well as the threshold value. All else equal, the inflow rate depends negatively on the selection as more interviews reduce the fraction of new employment relationships that have bad quality, therefore reducing separations into unemployment. As more interviews increase the chances of an acceptable match, the direct effect of selection on outflows is positive.

In the presence of firms' selection efforts, any labor market policy can potentially alter the incentives to interview, generating an extra channel through which policies affect the unemployment rate. I calibrate the model to match US labor market moments and use this model to analyze the unemployment rate response to firing taxes, hiring subsidies, minimum wage and unemployment insurance policies and the contribution of the selection effort channel to such response. Firing taxes are known to increase unemployment as they discourage firms to open vacancies, thereby reducing the job finding rate. In an economy with selection effort, implementing a firing tax increases firms' incentives to conduct interviews. Incentives arise because good matches become more valuable as they save firms from paying the firing tax. As more interviews increase the chances of a good match thereby reducing separations, we observe less increase in the unemployment rate as a response to a firing tax than we would have observed in a counterfactual economy without selection (without adjustment in the number of interviews). The mitigating effect of the selection on unemployment increases with the firing tax. Adjustment through the selection choices of firms also mitigates welfare losses associated with the firing tax policy.

With a hiring subsidy in place, hiring the wrong worker becomes relatively less costly, reducing firms' incentives to invest in selection. A decline in the number of interviews increases bad matches in the economy, thus increasing separations. Moreover, there is more hiring (vacancies) in equilibrium as not only the hiring subsidy, but also the decline in the total vacancy cost due to less interviews increases job creation. In the calibrated model, for low values of subsidy, the effect of increasing the job finding rate dominates (as the policy is not large enough to change firms' selection decisions), and the unemployment rate falls. As the hiring subsidy increases, the effect of increasing separations dominates and the unemployment rate goes up. Welfare loss moves in the same direction as unemployment. In contrast, in an economy with no selection, the hiring subsidy monotonically reduces unemployment and increases welfare.

The paper also looks at the implications of minimum wage and unemployment insurance policies. The equilibrium effects of a minimum wage policy are qualitatively the same as those of a firing tax policy. The number of interviews increases with minimum wage while the unemployment flow rates decrease and unemployment increases. Unemployment insurance directly affects only the outside option of a worker. Hence, there is no direct effect of unemployment insurance on a selection decision. Moreover, the quantitative analysis reveals that general equilibrium effects are not strong enough to change firms' selection decisions, given the calibrated parameters. Firms choose not to change their number of interviews for plausible values of an unemployment insurance policy. Nonetheless, unemployment increases with unemployment insurance.

This paper is related to the recent literature that models firm selection. Villena-Roldán (2012) develops a model of firms' recruitment behavior to explain the negative duration dependence of unemployment and re-employment wages. Firms interview applicants, who are heterogeneous in their innate productivity, and observe their productivity. They hire the most productive workers, generating an endogenous positive relationship between unemployment exit rate and productivity, and hence wages. Wolthoff (2014) develops a directed search model with worker-specific productivity in which firms decide on the number of interviews they conduct. He characterizes the equilibrium and looks at its implications over the business cycle.[3] Tasci (2006) models firms' recruitment choices as deciding between two different screening technologies with one being more costly and more effective (i.e., delivering matches with higher expected probability of good quality) than the other. He shows that firms change their choices of technology as a response to productivity shocks and this behavior can explain some of the volatility of the key labor market indicators over the business cycle.[4]

Other studies analyze economic environments where there are multiple job applications. Blanchard and Diamond (1994) aim to understand how the composition of unemployment affects wages if firms hire the worker with the least amount of unemployment duration among multiple job applicants. They find that wage dynamics in a model with ranking changes significantly compared to a model with random hiring. Moen (1999) argues that one aspect of the returns to investment in human capital is its effect on the probability of being unemployed. As firms will hire workers with the highest productivity, workers with higher human capital are more likely to be hired in the presence of multiple job applicants. Similarly, Gavrel (2012) uses an urn-ball model where firms select among multiple job applicants. Employing such a model with worker heterogeneity, he investigates the efficiency of the equilibrium. Albrecht et al. (2006) analyze the equilibrium of a directed search model with multiple applicants and random selection, in which there can be competition among vacancies to hire the same worker.[5] In all these models, firms' selections (applicant ranking) affect the hiring and (in some) the job productivity in a fashion similar to this paper. Different from these studies with multiple job applicants, separations also depend on firms' hiring actions in this paper.

This work is also related to papers that study labor market policies.

[3] Also, Merkl and van Rens (2012) develop a model with ex ante heterogeneous workers in their training costs. In the model firms hire workers with training costs below some threshold value. They argue that with such selective hiring, welfare costs of unemployment are larger.

[4] In a model with a similar worker selection, Chugh and Merkl (2015) characterize efficient allocations and business cycle fluctuations. Also see Gautier (2002) for a study of externalities in the presence of non-sequential search.

[5] Also see Albrecht et al. (2003).

The closest to it is Pries and Rogerson (2005), where they develop a model to explain worker and job turnover differences between the US and Europe through differences in hiring practices. In their model, the hiring strategy is the cutoff probability of a match quality being good. This paper is an extension of their model as it adds another dimension to the hiring strategy: Firms can choose the number of interviews they conduct and hence can have direct effect on employment duration and productivity as well as the cost of a vacancy. The results obtained from a counterfactual economy of this model where firms cannot adjust the number of interviews they conduct are consistent with those in Pries and Rogerson (2005). Pissarides (1985) finds that employment subsidies reduce unemployment while unemployment benefits and wage taxes raise it. Kitao et al. (2011) find that a hiring subsidy increases the job finding rate as well as endogenous separations (which occur because a hiring subsidy increases the reservation productivity). As a result, unemployment also increases.[6]

The rest of the paper is organized as follows. The following section lays out the model. The equilibrium of the model is defined and analyzed in Section 3. Section 4 discusses the different labor market policies while Section 5 presents the quantitative results of the model. Section 6 concludes the analysis.

2. Model

To formally analyze the selection efforts of firms, I employ a discrete time infinite horizon search and matching model. There is a unit measure of homogeneous workers and a continuum of ex ante identical firms. All agents are risk neutral, and they discount the future at rate β. A worker can be either unemployed or employed while a firm is either vacant (looking for a worker) or producing. A firm can employ at most one worker. Vacancies incur a cost and the unemployed workers receive unemployment value b. The production unit in the economy is a firm–worker pair and wages are bargained so as to share the total surplus the production unit generates (Nash bargaining).

The production unit produces $y = y^k$ amount of output, where k is the quality of the match between the worker and the firm. The output y^k takes on the value y^g (y^b) if the quality of the match between the firm and the worker is good (bad), where $y^g > y^b$. I assume that $y^b = b$ and $y^g > b$. Under this assumption bad matches are undesirable in equilibrium, firm and worker pairs terminate such matches.[7] The Nash bargaining assumption guarantees the unanimity of the separation or match activation (production) decision.[8] In addition to endogenous separation, production units that are active (that produce in the current period) are subject to an exogenous destruction at rate δ.

There is limited information regarding the quality of a match ex ante. A worker–firm pair does not know match quality for certain before they start producing. However, they know the probability of the quality of this match being good when they decide whether to form the employment relationship. This information is revealed during the following selection process.

Selection process: Let the number of unemployed workers be **U** and the number of vacant jobs be **V**. An unemployed worker applies to all vacancies.[9] Hence, each firm receives **U** many applications and *decides* on how many workers to interview (n), where n is a positive integer. An interview is a meeting between a vacant firm and an unemployed worker during which the firm learns the probability of the quality of that match being good. The probability of a match quality being good, γ, is drawn from a distribution Ψ. The firm collects information on the probability of the quality of the match with the worker interviewed being good, γ_i, from each one of the n interviews. Based on this information, the firm selects the worker who is most likely to be a good match, i.e., $\max\{\gamma_1, \gamma_2, \gamma_3, \ldots, \gamma_n\}$, and contacts this worker.

It is possible that a worker may be the best option of more than one firm; hence, multiple firms can contact one worker. If so, the worker picks one of the firms randomly.[10] Then, the firm reveals the value of γ to the worker and they decide whether to form the employment relationship.[11] Note that the highest γ firm chooses among n draws may still not be a high enough probability for the firm and the worker to activate the match. As will be discussed later, there is a cutoff probability in equilibrium, above which hiring takes place.

Let χ be the probability that an unemployed worker ends up with a match. Note that the worker will be in a match (which may or may not result in hiring) as long as she has at least one firm contacting her. No firm will contact a worker if she either does not get any interviews, or is not successful in any of her interviews. A worker does not get an interview from a firm with $1 - n/U$ probability. An interviewed worker is not selected at the end of interviews with $1 - 1/n$ probability. As a worker applies to V many jobs, the probability that no firm contacts her is

$$1 - \chi = \left(1 - \frac{n}{U} + \frac{n}{U}\left(1 - \frac{1}{n}\right)\right)^V = \left(1 - \frac{1}{U}\right)^V = \left(1 - \frac{\theta}{V}\right)^V = e^{-\theta},$$

where $\theta = \mathbf{V}/\mathbf{U}$ is the market tightness. We get the last equality as **U** and **V** go to infinity (as the number of unemployed and vacancies is large) while holding the market tightness, θ, constant. Hence

$$\chi = 1 - e^{-\theta}. \tag{1}$$

Since a worker can potentially receive multiple offers, it is possible that the worker chosen by the firm may not be available. Hence, it is possible that a firm may not end up being in a match even if it contacts the best applicant among the interviewees. Let ϕ be the probability that the selected worker is available. Note that there are χU many workers in a match with a firm deciding whether to activate their match, and ϕV many firms in a match. Since the number of firms and workers in a match should be the same, we can derive ϕ as

$$\phi = \frac{\chi}{\theta} = \frac{1 - e^{-\theta}}{\theta}. \tag{2}$$

One interesting note here is that the match probability of a firm, ϕ, does not depend directly on the number of interviews it picks. A firm's selection decision affects how likely the hiring of that worker is, as more interviews increase the chances of γ being above the threshold level. The number of interviews chosen in the economy affects the probability of a selected worker being available for hire through its equilibrium effect on the market tightness (θ).

3. Equilibrium

Let V be the value of a firm with a vacancy. Moreover, let $J(\gamma)$ denote the value of a match to the firm which is a good match with γ probability. The value of a vacancy can formally be written as:

[6] Also see Bucher (2010), Gavrel et al. (2010), Marimon and Zilibotti (1999) and Pissarides (1984a) as examples of studies of labor market policies in different settings.

[7] The weaker assumption that $y^b \le b$ would suffice for bad quality matches be undesirable.

[8] That is because parties bargain over the net surplus of the match, and if the surplus is positive (negative) they decide to produce (separate or not form the match).

[9] This assumption guarantees that the firms will get more applications than the number of interviews they would choose.

[10] If firms that do not end up with their best candidate were allowed to contact other applicants interviewed, they would have still ended up a vacancy with some probability. The model would have a more complicated probability of the worker firm contacts being available for hire, which would still be lower than one. The assumption that the firm contacts only its first choice allows us to simplify the probability that the worker firm contacts is available for hire.

[11] The assumption that a worker does not learn γ at the interview simplifies the modeling as the worker would be indifferent and pick randomly if she receives multiple offers.

$$V = \max_{n^j}\left[-C(n^j) + \beta(1-\phi)V + \beta\phi\int_0^1 J(\gamma)d\Psi^{n^j}(\gamma)\right], \tag{3}$$

where n^j is the firm's choice of number of interviews. The firm will incur a vacancy cost $C(n^j)$, which depends on the number of interviews it conducts. $C(n^j)$ is an increasing function of n^j and $C(1) > 0$. With $1-\phi$ probability, the firm will not be in a match at the end of the interviews, and will continue to have a vacancy in the subsequent period. With ϕ probability, the selected worker will be available and hence the firm will be in a match with the worker, in which case the firm will get an expected value of $J(\gamma)$. This expectation is over γ, which depends on the number of interviews the firm chooses as this number will govern the possible γ realizations. In the equation above Ψ^{n^j} is the distribution of the maximum statistics of n^j draws from Ψ.

Eq. (4) formalizes the problem of a firm that is in a match with a worker:

$$J(\gamma) = \max\{V, E(y|\gamma) - w(\gamma) + \beta\delta V + \beta(1-\delta)(\gamma J(1) + (1-\gamma)J(0))\}, \tag{4}$$

where $E(y|\gamma) = \gamma y^g + (1-\gamma)y^b$ is the expected value of output and $w(\gamma)$ is the wage. The firm decides whether to produce with the worker or not. If the production does not take place, the firm gets its outside option value V. If the production takes place, the firm gets the current period profits (output net of the wage paid to the worker) and the discounted value of being in a match in the subsequent periods. If the production unit gets the exogenous destruction shock (δ), then the employment relationship will not survive to the next period. If the match survives (which happens with $(1-\delta)$ probability), then its quality is learned; with γ $(1-\gamma)$ probability it is good (bad) quality and gets the value of $J(1)(J(0))$.

Let U be the present value of unemployment to a worker. Moreover, let $W(\gamma)$ be the present value of being in a match for a worker where γ is the probability that the match quality is good. If a worker is unemployed, she gets the unemployment benefit, b, at the current period. With $1-\chi$ probability the worker does not get any offers from firms, thus continues to be unemployed in the subsequent period. The worker gets at least one offer with χ probability and gets an expected value from being in a match with a firm. The value of unemployment can be formally expressed as follows[12]:

$$U = b + \beta(1-\chi)U + \beta\chi\int_0^1 W(\gamma)d\Psi^n(\gamma). \tag{5}$$

The value of being in a match for a worker is:

$$W(\gamma) = \max\{U, w(\gamma) + \beta\delta U + \beta(1-\delta)[\gamma W(1) + (1-\gamma)W(0)]\}. \tag{6}$$

If a worker is in a match with a firm with γ probability of the match quality being good, the worker decides whether to have the employment relationship or be unemployed. If the worker chooses the employment relationship, she gets the wage in the current period. If the match survives to the next period and it is a good match, the worker will get the value of being in a good match, $W(1)$. If the match is revealed to be a bad one, which will happen with probability $1-\gamma$, the worker will get the value of being in a bad match, $W(0)$.

The wage is the outcome of a Nash bargaining where the worker's bargaining power is μ. The wage is determined such that the worker's net gain from being in the match is μ fraction of the total net surplus this match generates. Hence, the worker's and the firm's decision about the employment relationship formation is unanimous. In equilibrium there is a cutoff probability γ^* such that for all $\gamma > \gamma^*$ a match is acceptable, hence parties form the employment relationship and start producing (hiring takes place). On the other hand, if γ is below the threshold level, then the hiring does not take place and parties keep searching. The probability that a match will be acceptable is:

$$Pr(\gamma > \gamma^*) = \int_{\gamma^*}^1 d\Psi^n(\gamma). \tag{7}$$

Also let $E(\gamma|\gamma^*)$ be the expected probability of the match quality being good conditional on hiring, which is defined as:

$$E(\gamma|\gamma^*) = \frac{\int_{\gamma^*}^1 \gamma d\Psi^n(\gamma)}{\int_{\gamma^*}^1 d\Psi^n(\gamma)}. \tag{8}$$

To define the equilibrium, let the mass of matches that are known to be good quality be e^g and the mass of matches whose quality is yet unknown be e^u.

Equilibrium: The steady state equilibrium is a list $\{e^g, e^n, v, u, w(\gamma), \gamma^*, J(\gamma), V, W(\gamma), U, n, \chi, \phi\}$ such that

- $\{J(\gamma), V, W(\gamma), U\}$ satisfy Eqs. (3)–(6).
- There is free entry; v/u satisfies V=0.
- $w(\gamma)$ is the solution to the Nash bargaining, so that

  $$W(\gamma) - U = \mu[W(\gamma) - U + J(\gamma) - V].$$

- Cutoff probability γ^* makes firms and workers indifferent to forming an employment relationship $(W(\gamma^*) = U, J(\gamma^*) = V)$.
- The flows between employment and unemployment states are constant:

  $$e^g = (1-\delta)e^g + e^u(1-\delta)E(\gamma|\gamma^*),\ e^u = u\chi Pr(\gamma > \gamma^*),\ u = 1 - e^u - e^g,$$

where χ, $Pr(\gamma > \gamma^*)$ and $E(\gamma|\gamma^*)$ are defined, respectively, in Eqs. (1), (7) and (8).
- n solves firm's maximization problem:

  $$n = \arg\max_{n_j}\left[-C(n^j) + \beta(1-\phi)V + \beta\phi\int_0^1 J(\gamma)d\Psi^n(\gamma)\right],$$

where ϕ is defined in Eq. (2).

One can characterize the equilibrium in terms of three values: selection effort n, market tightness $\theta = v/u$ and cutoff probability γ^*. The total net surplus of a match, $S(\gamma)$, is the summation of present values for the firm and the worker in a match, net of their outside options, i.e., $S(\gamma) = W(\gamma) - U + J(\gamma) - V$. The net surplus is:

$$S(\gamma) = \max\{0, E(y|\gamma) - (1-\beta)U + \beta(1-\delta)(\gamma S(1) + (1-\gamma)S(0))\}, \tag{9}$$

making use of the equilibrium condition that V=0. For a given value of n and γ^*, the market tightness is determined by the free entry condition, V=0. The free entry condition implies:

$$0 = (1-\beta)V = -C(n) + \beta\phi(1-\mu)\int_0^1 S(\gamma)d\Psi^n(\gamma).$$

Using the equation above, we can rewrite the value of unemployment as

$$(1-\beta)U = b + \beta\chi\mu\int_0^1 S(\gamma)d\Psi^n(\gamma) = b + \theta C(n)\frac{\mu}{1-\mu}. \tag{10}$$

Notice that values of good and bad match surpluses ($S(0)$ and $S(1)$) are independent of the value of γ, as γ governs the probability of their realizations, not the realized values directly. Also, the worker's outside option does not depend on a particular realization of γ. Hence, the surplus in Eq. (9) is linearly increasing in γ, and thus we can write the surplus as $S(\gamma) = S'(\gamma^*)(\gamma - \gamma^*)$, where[13]

[12] The value of unemployment can be written as $U = b + \beta(1-\chi)U + \beta\chi\int_0^1 \hat{\chi}(\gamma|n)W(\gamma)d\Psi$, where $\hat{\chi}(\gamma|n)$ is the probability that the worker gets an offer with γ probability of quality of the match with a prospect employer being good. The probability that a worker is selected by a firm after an interview with the γ probability of match quality being good is $\hat{\chi}(\gamma|n) = \Psi^{(n-1)}(\gamma)$.

$$S'(\gamma^*) = \frac{(y^g - y^b)}{1 - \beta(1-\delta)(1-\gamma^*)}.$$

Then, we can rewrite the free entry condition as:

$$\frac{C(n)}{\beta\phi(1-\mu)} = \frac{(y^g - y^b)}{1 - \beta(1-\delta)(1-\gamma^*)} \int_{\gamma^*}^{1} (\gamma - \gamma^*) d\Psi^n(\gamma). \tag{11}$$

The market tightness solves the free entry equation above, where $S'(\gamma^*) \int_{\gamma^*}^{1} (\gamma - \gamma^*) d\Psi^n$ is the expected value of surplus, conditional on hiring. Note that the right-hand side of Eq. (11) is decreasing in γ^*. Thus, for a given n, as γ^* increases, the number of vacancies should decrease, reducing θ and increasing ϕ, to make the free entry condition hold again. Hence, the free entry condition implies a negative relationship between γ^* and θ, for a given n.

For a given number of interviews n and market tightness θ, the value of γ^* is determined by the optimal hiring condition.[14] Recall that γ^* leaves workers and firms indifferent between forming the production unit and staying unattached. We use the equation $S(\gamma^*) = 0$ and the value of unemployment in equilibrium to get the optimal hiring condition:

$$(1-\beta)U = y^b + \gamma^* S'(\gamma^*). \tag{12}$$

With a higher number of vacancies, it gets easier for workers to receive an offer while firms get lower chances of their best candidate being available. A higher θ increases the worker's outside option which makes the surplus from the match at the cutoff probability decrease. Hence, there is a positive relationship between γ^* and θ in the optimal hiring equation.

Choice of interviews: For a given ϕ (or θ) and γ^*, the number of interviews n is the solution to the following optimization problem: In a symmetric equilibrium, n is an equilibrium if $\forall\ n^j \neq n$:

$$\frac{(y^g - y^b)}{(1 - \beta(1-\delta)(1-\gamma^*))}\left(\int_{\gamma^*}^{1} (\gamma - \gamma^*) d\Psi^n - \int_{\gamma^*}^{1} (\gamma - \gamma^*) d\Psi^{n^j}\right) > \frac{C(n) - C(n^j)}{\beta(1-\mu)\phi}, \tag{13}$$

where $\phi = \frac{(1 - e^{-\theta})}{\theta}$.

The choice of the number of interviews depends on the productivity gap between good and bad matches, the exogenous destruction rate, the probability distribution, and the cost structure of interviews. As the productivity difference between good and bad matches increases (decreases), firms are more (less) likely to choose a high number of interviews, as the return from more interviews increases (decreases) for all n values. Moreover, if the cost increases more with additional interviews, then firms are less likely to select a high number of interviews.

Equilibrium unemployment: Unemployment is determined by two components: flows into and out of unemployment. In this model, unemployment outflow, the job finding probability, is defined as

$$f = \chi \int_{\gamma^*}^{1} d\Psi^n(\gamma) = (1 - e^{-\theta}) \int_{\gamma^*}^{1} d\Psi^n(\gamma). \tag{14}$$

There are two sources that jointly determine the transition from unemployment to employment. The first is that the worker needs to be the best worker interviewed, i.e., she needs to get some offers. Second, the worker needs to be good enough to be hired (the probability of match quality being good should be above the threshold). The market tightness, the cutoff value, and the number of interviews determine the equilibrium value of these probabilities. As the number of vacancies increases, so does the probability that a worker receives at least one offer. Hence, the job finding probability increases with the market tightness. An increase in the equilibrium number of interviews has the same effect, which is to increase the probability of having an acceptable match as the empirical distribution, (Ψ^n), improves. However, an increase in the cutoff value decreases this transition rate as a lower fraction of new matches would be acceptable.

The transition rate from employment into unemployment, the job separation rate, is

$$s = \frac{\delta}{\delta + (1-\delta)E(\gamma|\gamma^*)},$$

where $E(\gamma|X)$ is defined in Eq. (8). The total number of separations depends on the exogenous destruction rate and the conditional expected probability of the match quality being good. As the number of interviews increases, we expect the separation rate to decrease since the higher is the fraction of matches that are good, the lower is the separation rate (the conditional expected probability of the match quality being good increases with interviews). Moreover, a higher cutoff value implies a lower separation rate as it also increases the share of new matches that are good quality.

Following simple algebra on the equilibrium flow equations and substituting δ from the separation rate equation in and rearranging terms gives the familiar unemployment equation:

$$u = \frac{s}{s+f}.$$

4. Selection effort and labor market policies

This section explores the effects of labor market policies on unemployment when we take selection by firms into account. Policies discussed are firing taxes, hiring subsidies, minimum wage and unemployment insurance policies. All policies are subsidized through a lump-sum tax, τ, on all workers in the economy.[15]

Firing tax: Assume that the government cannot separate "voluntary" separations from exogenous destructions. Hence, the government taxes all separations at an amount of p^f. Introducing a firing tax will make the outside option of a firm that is about to make a hiring decision differ from the outside option of an already producing job as the latter is subject to a firing tax. Let $\widetilde{J}(\gamma)$ be the value of a new match. We can formally describe the value of a new and existing match as

$$\widetilde{J}(\gamma) = \max\{V, E(y|\gamma) - \widetilde{w}(\gamma) + \beta\delta(V - p^f) + \beta(1-\delta)(\gamma J(1) + (1-\gamma)J(0))\},$$
$$J(\gamma) = \max\{V - p^f, E(y|\gamma) - w(\gamma) + \beta\delta(V - p^f) + \beta(1-\delta)(\gamma J(1) + (1-\gamma)J(0))\}.$$

The value of a vacancy is:

$$V = \max_{n^j}\left[-C(n^j) + \beta(1-\phi)V + \beta\phi \int_0^1 \widetilde{J}(\gamma) d\Psi^{n^j}(\gamma)\right].$$

There is no change in the Bellman equations of the worker, except that the value of a new ($\widetilde{W}(\gamma)$) versus existing ($W(\gamma)$) employment relationship can be different:

$$U = b - \tau + \beta(1-\chi)U + \beta\chi \int_0^1 \widetilde{W}(\gamma) d\Psi^n(\gamma),$$
$$\widetilde{W}(\gamma) = \max\{U, \widetilde{w}(\gamma) - \tau + \beta\delta U + \beta(1-\delta)(\gamma W(1) + (1-\gamma)W(0))\},$$
$$W(\gamma) = \max\{U, w(\gamma) - \tau + \beta\delta U + \beta(1-\delta)(\gamma W(1) + (1-\gamma)W(0))\}.$$

[13] We take the derivative of Eq. (9) with respect to γ and use $S(1) = S'(\gamma^*)(1-\gamma^*)$.

[14] There is such cutoff since the surplus generated by a bad match is negative ($\frac{y^b - b - \theta C(n)\frac{\mu}{1-\mu}}{1-\beta(1-\delta)} < 0$ as $y^b = b$) and surplus generated by a good match is positive.

[15] When the policy in consideration is a tax then τ is subsidy to all workers (it is negative).

Note that since policy considered here is a tax collected by the government, $\tau < 0$, i.e., collected taxes are distributed to all workers.

The surplus of an existing match is

$$S(\gamma) = W(\gamma) - U + J(\gamma) - (V - p^f) = \max\{0, E(y|\gamma) - \tau - (1-\beta)(U - p^f) + \beta(1-\delta)\gamma S(1)\},$$

while the surplus for a new match is

$$\widetilde{S}(\gamma) = \widetilde{W}(\gamma) - U + \widetilde{J}(\gamma) - V = \max\{0, E(y|\gamma) - \tau - (1-\beta)(U - p^f) - p^f + \beta(1-\delta)\gamma S(1)\}.$$

Note that the surplus from a new match is still linear in the good quality match output. Hence, we can express the surplus as $\widetilde{S}'(\gamma^*)(\gamma - \gamma^*)$, where

$$\widetilde{S}'(\gamma^*) = \frac{y^g - y^b + \beta(1-\delta)p^f}{1 - \beta(1-\delta)(1-\gamma^*)}.$$

The free entry and the optimal hiring equations are:

$$\frac{C(n)}{\beta\phi(1-\mu)} = \widetilde{S}'(\gamma^*)\int(\gamma - \gamma^*)\Psi^n(\gamma),$$
$$b + \theta C(n)\frac{\mu}{1-\mu} = y^b - \beta p^f + \gamma^*\widetilde{S}'(\gamma^*).$$

For a given value of n, a firing tax will shift the free entry curve to the right on (θ, γ^*) plane as it increases the expected value of employment relationships (through increasing $\widetilde{S}'(\gamma^*)$). The optimal hiring equation shifts left on (θ, γ^*) plane with a firing tax. This is because a firing tax reduces the worker's outside option, making the surplus from the match at the margin decline. Hence, we expect a higher cutoff probability whereas a change in market tightness potentially depends on the parameter values. Given the parameter restrictions of this model, formal derivations show that a firing tax reduces the market tightness.

Note that, as only good matches can survive, a firing tax increases the relative value of good matches, giving firms incentives to increase their selection. Whether firms will do so in equilibrium depends on whether the increase is large enough to cover the cost of more interviews as well as the general equilibrium effects of the cutoff probability and the market tightness on the expected surplus.

Hiring subsidy: Let us suppose that the government subsidizes new hires. Let p^h be the amount of hiring subsidy. The introduction of a hiring subsidy creates a gap between the value of a new match and that of an existing one as the former receives a subsidy. The value of a new job, $\widetilde{J}(\gamma)$, is:

$$\widetilde{J}(\gamma) = \max\{V, p^h + E(y|\gamma) - \widetilde{w}(\gamma) + \beta\delta V + \beta(1-\delta)(\gamma J(1) + (1-\gamma)J(0))\},$$

while the value of a vacancy is:

$$V = \max_{n^j}\left[-C(n^j) + \beta(1-\phi)V + \beta\phi\int_0^1 \widetilde{J}(\gamma)d\Psi^{n^j}(\gamma)\right].$$

The value of existing matches, $J(\gamma)$, is the same as in Eq. (4). There is no change in the Bellman equations of the worker either.

The surplus for an existing match is:

$$S(\gamma) = W(\gamma) - U + J(\gamma) - (V) = \max\{0, E(y|\gamma) - \tau - (1-\beta)U + \beta(1-\delta)\gamma S(1)\}.$$

The surplus for a new match is:

$$\widetilde{S}(\gamma) = \widetilde{W}(\gamma) - U + \widetilde{J}(\gamma) - V = \max\{0, p^h + E(y|\gamma) - \tau - (1-\beta)U + \beta(1-\delta)\gamma S(1)\}. \quad (15)$$

Note that the surplus from a new match is still linear in the good quality match output. Hence, we can express the surplus as $\widetilde{S}'(\gamma^*)(\gamma - \gamma^*)$, where

$$\widetilde{S}'(\gamma^*) = \frac{y^g - y^b - \beta(1-\delta)p^h}{1 - \beta(1-\delta)(1-\gamma^*)}$$

The free entry and the optimal hiring equations are:

$$\frac{C(n)}{\beta\phi(1-\mu)} = \widetilde{S}'(\gamma^*)\int(\gamma - \gamma^*)\Psi^n(\gamma),$$
$$b + \theta C(n)\frac{\mu}{1-\mu} = y^b + p^h + \gamma^*\widetilde{S}'(\gamma^*).$$

A hiring subsidy increases the value of a new match. For a given value of n, a hiring subsidy will shift the optimal hiring equation to the right on (θ, γ^*) plane as a new employment relationship now generates more surplus, all else the same. Since the expected future profits are not as high as the initial one, the free entry curve shifts to the left on (θ, γ^*) plane. Hence, we would expect a lower cutoff probability with a hiring subsidy. How the market tightness would change depends on which curve shifts how much. A formal analysis shows that the market tightness increases with a hiring subsidy.

Note that this analysis is for a given n. Firms are likely to change their selection behaviors as well. Hiring subsidy is for all new hires, regardless of the quality of a match. Hence, the policy reduces relative returns to a good quality match. As a result, firms would be less likely to invest in a selection effort. We can also see from the free entry equation that returns to conducting more interviews ($\widetilde{S}'(\gamma^*)$) is decreasing with hiring subsidy, giving firms less incentive to invest in interviews. The policy also affects the firm's incentives to selection as it changes the worker's outside option and the value of threshold probability.

Minimum wage: Suppose that the minimum wage, ϖ, is set at a level that is higher than the wage earned at the threshold probability, i.e., $\omega(\gamma^*) < \varpi$. In this case, for any match with probability γ such that $\omega(\gamma) \geq \varpi$ wages are outcomes of Nash bargaining as before and both firms and workers agree on the hiring decision. Matches with probability γ such that $\omega(\gamma) < \varpi$, have a disagreement as workers would like to be in the match while firms would not since they will have to pay workers the minimum wage, which is higher than the wage from Nash bargaining.

The optimal hiring is such that $J(\gamma^*) = V$ and $\omega(\gamma^*) = \varpi$. This implies the following wage equation:

$$\gamma^*(y^g - y^b) + y^b + \beta(1-\delta)\gamma^* J(1) = \varpi,$$

making use of the equilibrium condition V=0. Supposing that the minimum wage does not bind at $\gamma = 1$, we have $J(1) = (1-\mu)S(1)$, and

$$S(1) = \frac{y^g - (1-\beta)U}{1 - \beta(1-\delta)},$$

since wages are set according to Nash bargaining when the minimum wage is not binding. The wage equation implies that, holding $J(1)$ constant, an increase in the minimum wage increases the cutoff probability. However, the unemployment value and hence $J(1)$ will also change. Hence, we cannot analytically conclude how U will change with the minimum wage.

Unemployment insurance: Suppose the government distributes unemployment insurance. This is the same as increasing the value of b in the Bellman equations of the benchmark economy. Note that an increase in unemployment benefit increases the worker's outside option; hence the optimal hiring equation shifts left on (θ, γ^*) plane. As a result, we would expect a lower market tightness and a higher cutoff probability. It will not directly affect the firm's selection effort choice as a change in unemployment value affects the match surplus regardless of whether it is good or bad. However, an increase in the cutoff probability will reduce the expected surplus, while a decline in the market tightness will increase it. Hence the effect of unemployment insurance on the selection effort is ambiguous.

5. Quantitative analysis

I assign values to the parameters of the model to match some of the US labor market facts. The time period of the model is a month. I set $\beta = 0.9967$, to get an annual interest rate of 4 percent. The bargaining power of the workers is generally set to a number between 0.3 and 0.5 in the literature.[16] I set the workers' bargaining power parameter (μ) to its most commonly used value, that is 0.5.

Observe that multiplying $C(n)$, y^g, y^b, and b by the same number does not change the solution to the equation system. Thus, I normalize b to 1. I also set $y^b = b$, which is sufficient for bad matches to be terminated in equilibrium. Davis et al. (1996) report that around one-quarter of annual job loss is due to plant shutdowns in manufacturing.[17] I calibrate the value of exogenous job destruction rate so that 23 percent of all job destructions is exogenous. To pin down the good match output, I target the ratio of the highest wage workers can earn to the lowest wage to be 1.3 in the steady state. Topel and Ward (1992) find that the cumulative change in wages over the first 10 years of work history that is associated with job change is around 33 percent.[18]

I follow Pries and Rogerson (2005) and assume that Ψ is a mean-zero normal distribution, re-scaled for the unit interval. I assume that the vacancy cost is linear in the number of interviews: $C(n) = c + \kappa(n-1)$. We are left with three parameters to be determined; the standard deviation of Ψ and the cost function parameters. First, I find the total vacancy cost as this is sufficient to solve for the market tightness and the cutoff probability, for a given n. To find the values of the total vacancy cost and the standard deviation of the distribution, I set the number of interviews conducted in equilibrium to three.[19] I target job finding probability of 0.4 and separation probability of 0.03. Shimer (2012) finds the average job finding and separation probabilities to be 0.4 and 0.03, respectively, from 1948 to 2007. Then, I find the (c, κ) pair for which n=3 is the equilibrium and the implied total cost of vacancy is the same as the calibrated value, given the rest of the parameters. There is a narrow range of such pairs that delivers the calibrated equilibrium outcomes. As the qualitative nature of the findings do not change, I report the results for the average of these values. Parameter values are displayed in Table 1.

I use the calibrated benchmark model above to assess the effects of each of the policies discussed above on the flow rates and the unemployment rate. I also report the welfare loss associated with each policy.[20] I use the loss measure used in Pries and Rogerson (2005). As such, I report the welfare loss as the percentage decrease in total output required in the benchmark economy to get the same total utility as in the economy with the policy.

Firing tax: I compute the equilibrium outcomes for firing taxes that are up to 2.5 times the lowest wage earned in the benchmark equilibrium. Firing taxes increase the number of interviews firms conduct as well as the equilibrium value of the threshold probability (Fig. 1, Table A1). Both separation and job finding probabilities decrease (Fig. 2). The job separation rate declines as with more selection there are less bad matches in equilibrium, resulting in lower endogenous separations. The job finding probability declines mainly due to a decline in the market tightness. Observe that a lower separation rate would reduce unemployment while a lower job finding rate would increase it. Pissarides (2000, Chapter 9) analyzes effects of firing subsidy and finds that it reduces both job creation and destruction, leaving qualitative effects on unemployment rate ambiguous. In this calibration exercise, the unemployment rate increases with firing taxes since the change in the job finding rate is stronger (Fig. 3).[21]

Table 1
Parameter values.

β	0.996	Discount factor
b	1	Unemployment income
y^b	b	Bad match output
μ	0.5	Workers' bargaining power
δ	0.0069	Exogenous job destruction rate
c	0.865	Vacancy creation cost
y^g	1.84	Good match output
σ_Ψ	0.169	Standard deviation of distribution
κ	0.212	Interview cost parameter

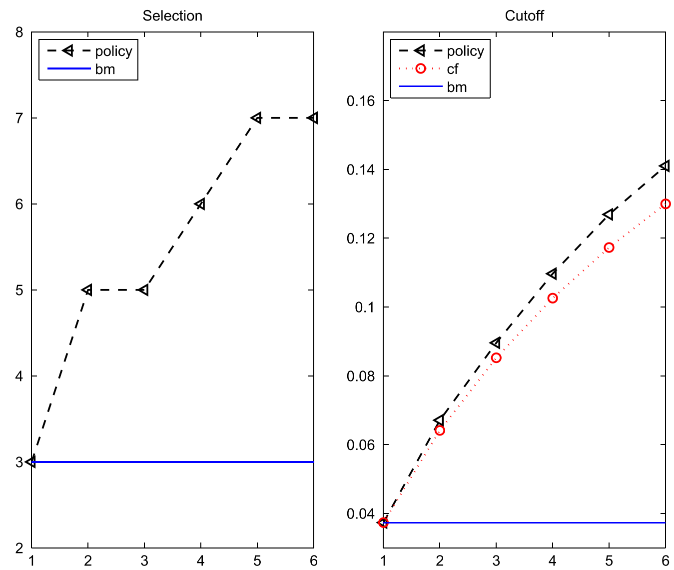

Fig. 1. Response to firing tax: selection and cutoff probability.

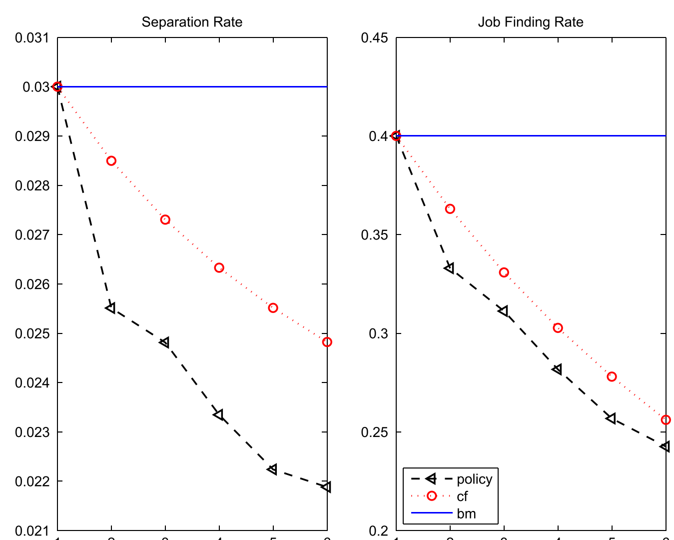

Fig. 2. Response to firing tax: flow rates.

[16] See Petrongolo and Pissarides (2001) for a literature survey.

[17] See also Davis and Haltiwanger (1998).

[18] Pries and Rogerson (2005) use wage ratio of 1.25.

[19] The reported average number of interviews conducted in Barron and Bishop (1985) is around 4. Moreover, targeting a different number of interviews does not change the main results of this paper.

[20] Acemoglu and Shimer (1999) find that in models where firms have to make investment before they hire a worker and wages are bargained after the investment decision, the equilibrium is inefficient. In this model the number of interviews selected in equilibrium is suboptimal and the Hosios condition cannot restore the social optimality (given the socially optimal number of interviews, market tightness and the cutoff probability are socially optimal under the Hosios condition). Also see Hosios (1990) efficiency, Gavrel (2012) and Julien and Mangin (2016) for inefficiency of equilibrium in search and matching models.

[21] Note that in this model matches that separate after the first period are subject to firing taxes, too, which may not have practical relevance. As firms care about whether

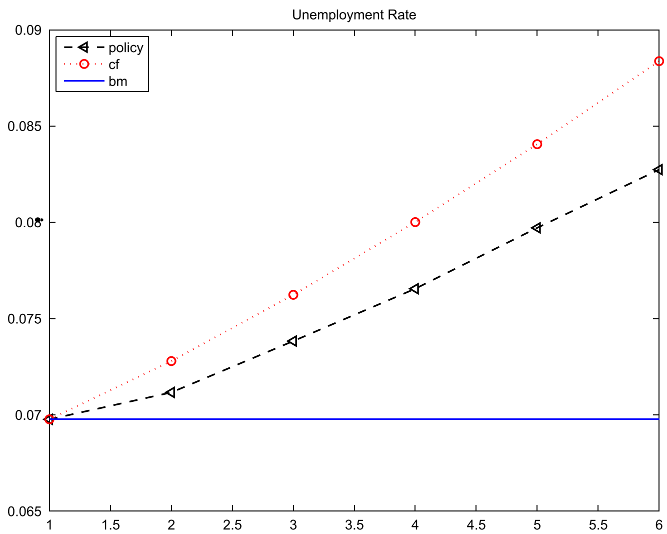

Fig. 3. Response to firing tax: unemployment rate. *Note*: Solid line represents the benchmark economy, dashed line shows the economy with the policy measure, and dotted line shows the counterfactual economy.

To tease out the role of selection, I conduct the following counterfactual exercise: I compute the equilibrium outcomes for the same firing tax rates under the assumption that firms cannot change the number of interviews they conduct. In this counterfactual exercise, the increase in the unemployment rate is higher, as in this case there is not much change in the separation rate while there is still a decline in the job finding rate. Moreover, the welfare loss due to policy is less when firms can adjust their number of interviews. This is due to the fact that the number of vacancies, and hence the total vacancy cost, is lower with more selection, despite the increasing cost per vacancy. A decline in total production due to lower employment is also muted in the presence of the selection channel as a higher fraction of new matches are good.

Hiring subsidy: A hiring subsidy has the opposite effect on the labor market outcomes and the selection effort. Fig. 4 shows how the equilibrium number of interviews and the cutoff probability changes as the rate of the hiring subsidy increases (also see Table A2). Introducing the hiring subsidy (that is up to 30 percent of the lowest wage in the benchmark case) to the economy (or increasing the subsidy) reduces the number of interviews conducted by firms. Similarly, the cutoff probability that is required for an acceptable match goes down with the hiring subsidy. As a result, separations in the economy rise. The job finding probability also increases as there are more vacancies and more matches are acceptable (Fig. 5). How unemployment reacts to this depends on how much the job finding and the separation rates increase, respectively, as their rise has opposing effects on the unemployment rate. For this calibration exercise, when firms respond to a hiring subsidy by reducing their number of interviews, we see a relatively stronger change in separation rate, resulting in an increase in unemployment (Fig. 6). As unemployment can increase with the hiring subsidy, we can observe welfare losses, as opposed to little gain in the counterfactual economy. With hiring policies for which firms adjust their selection, welfare goes down as in these cases both the number of employees declines and the number of vacancies rises.

In the counterfactual economy, the response of the cutoff probability to a hiring subsidy is less than it is in the presence of the selection effort (Fig. 4). The job separation probability increases with

(*footnote continued*)
they would pay the firing cost, when in the future they do so would not affect the qualitative nature of the results. Moreover, it abstracts away from links between firing taxes and unemployment benefits (see Blanchard and Tirole, 2008) and all separations are taxed by the government. Hence, findings should be interpreted with caution.

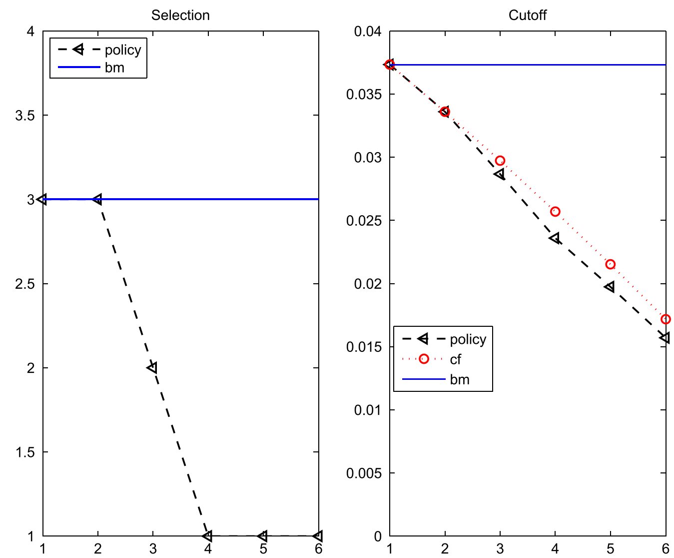

Fig. 4. Response to hiring subsidy: selection and cutoff probability.

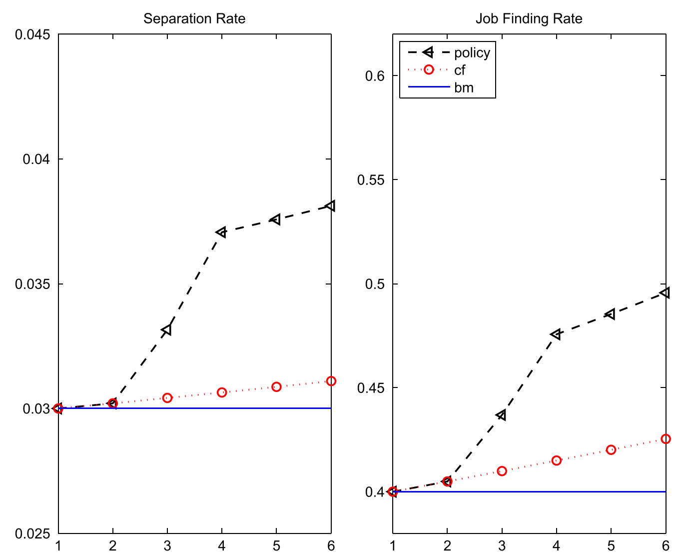

Fig. 5. Response to hiring subsidy: flow rates.

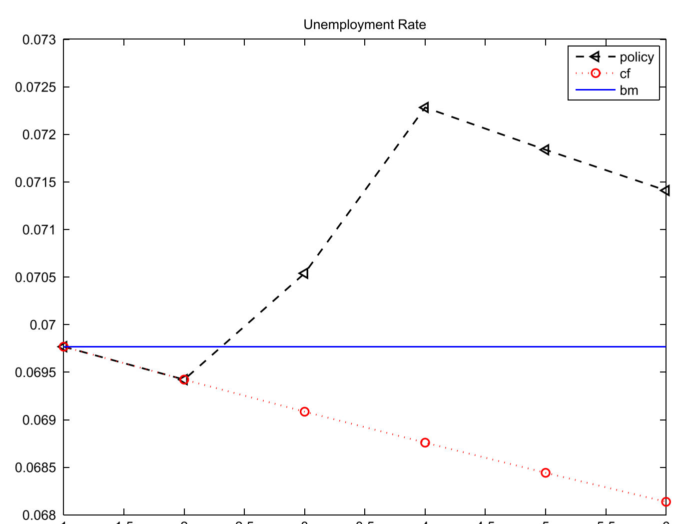

Fig. 6. Response to hiring subsidy: unemployment rate. *Note*: Solid line represents the benchmark economy, dashed line shows the economy with the policy measure, and dotted line shows the counterfactual economy.

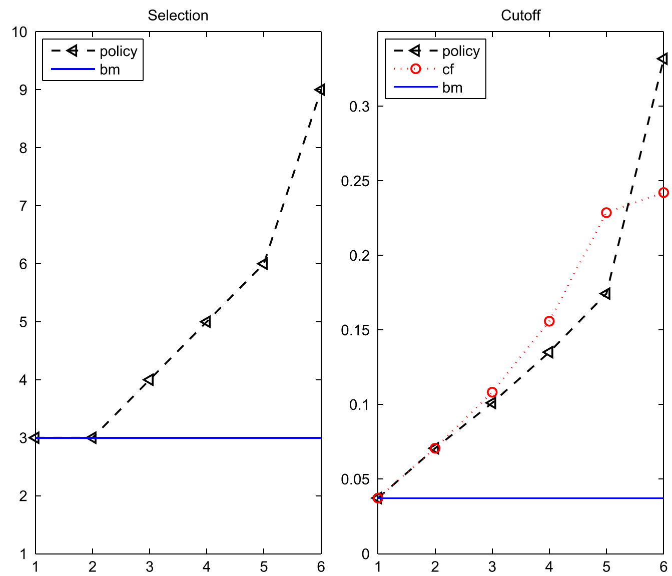

Fig. 7. Response to minimum wage: selection and cutoff probability.

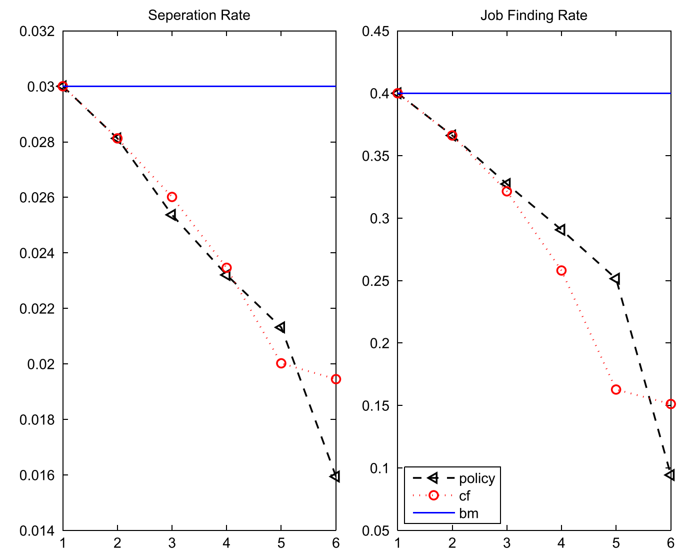

Fig. 8. Response to minimum wage: flow rates.

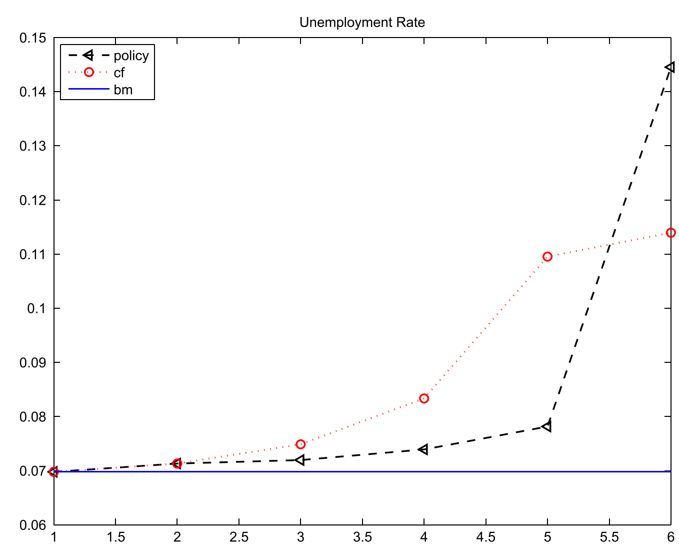

Fig. 9. Response to minimum wage: unemployment rate. *Note*: Solid line represents the benchmark economy, dashed line shows the economy with the policy measure, and dotted line shows the counterfactual economy.

the subsidy, but at a much smaller pace. The selection effort affects separations significantly. The job finding probability also increases in the counterfactual exercise, but less so than in the presence of selection (Fig. 5). As a result, the unemployment rate is expected to monotonically decline with the hiring subsidy when the firms' selection effort channel is ignored. The hiring subsidy is welfare improving as it increases overall employment.

Pissarides (2000, Chapter 9) also analyzes effects of hiring subsidy. When job destruction is exogenous, hiring subsidy increases job creation, thereby increasing hirings and decreasing unemployment rate. When endogenous job destruction is introduced (à la Mortensen and Pissarides, 1994 model), both job creation and destruction increase with hiring subsidy, generating a qualitatively ambiguous effect on the rate of unemployment. We have the same qualitative response in this model. Quantitative analysis shows that the increase in separations is strong enough to increase the unemployment rate for many policy rates.

Minimum wage: I look at the equilibrium response to minimum wages that are up to five percent of the lowest wage in the benchmark equilibrium. As Fig. 7 displays, a minimum wage policy increases the number of interviews as well as the cutoff probability (also see Table A3). As a result, we observe a decline in the separation rate and the job finding rate (Fig. 8). These declines are such that the unemployment rate rises. Notice that this response is qualitatively similar to firing taxes. When we compute the response of the counterfactual economy without the selection channel to the minimum wage policy, we observe that the increase in the cutoff probability is larger, whereas changes in the separation and the job finding rates are relatively less. Similar to a firing tax policy, welfare losses are smaller with the selection (Fig. 9).

The effect of minimum wage on unemployment found in this paper is in line with other studies on minimum wage. For instance Flinn (2006) estimates a continuous-time search model and finds that unemployment increases with the minimum wage. Acemoglu (2001) argues that in an economy where high-paying and low-paying jobs coexist, minimum wage (and unemployment compensation) policies increase unemployment. However, the policy changes the composition of jobs towards high-paying ones and therefore increases average labor productivity. Similarly, firms become more selective and increase the number of interviews they conduct with a higher minimum wage policy in this model, increasing both unemployment and productivity.

Unemployment insurance: I compute the equilibrium outcomes for unemployment benefits that are up to 30 percent of the lowest wage observed at the benchmark equilibrium. The cutoff probability increases with unemployment benefit while the market tightness decreases, as discussed before. For this calibration, the equilibrium number of interviews does not change. Unemployment increases, mostly due to the decreasing job finding rate (results are reported in Table A4). Lastly, the welfare declines with the unemployment insurance as employment declines.

Unemployment insurance is known to increase unemployment (Cahuc and Zylberberg, 2004). We observe the same relationship here as well. Unemployment insurance is also known to act as a search subsidy for workers to find better jobs (see for instance Burdett, 1979; Marimon and Zilibotti, 1999; Acemoglu, 2001). For instance Marimon and Zilibotti (1999) argue that low unemployment insurance in the US would make workers accept poor (low paying) matches as they do not have a safety net, thereby creating a "working poor" class. On the contrary, very generous unemployment insurance in continental Europe would make workers overly selective (declining socially efficient employment offers) and generating high unemployment. Moreover, Gavrel (2012) adds applicant ranking to the model Marimon and Zilibotti (1999) use, and shows that in such a model unemployment benefit increases both unemployment and average output. Average output increases because lower job creation reduces mismatch as firms

Table A1
Response to firing tax policy.

$\tilde{p}^*$	0	0.5	1	1.5	2	2.5
Benchmark economy						
n	3	5	5	6	7	7
χ	43.0	35.7	34.8	31.5	28.6	27.9
γ^*	0.037	0.067	0.090	0.110	0.127	0.141
$Pr(\gamma > \gamma^*)$	92.9	93.2	89.6	89.4	89.7	87.1
$E(\gamma\|\gamma^*)$	22.5	26.5	27.3	29.1	30.5	31.1
u	6.98	7.12	7.38	7.65	7.97	8.27
f	40.0	33.3	31.1	28.2	25.7	24.3
s	3.00	2.55	2.48	2.33	2.22	2.19
y	1.69	1.69	1.69	1.69	1.68	1.68
Welfare loss	0	0.04	0.45	0.81	1.26	1.73
Counterfactual economy						
χ	43.0	41.8	40.6	39.4	38.3	37.2
γ^*	0.037	0.064	0.085	0.103	0.117	0.130
$Pr(\gamma > \gamma^*)$	92.9	86.8	81.5	76.8	72.6	68.9
$E(\gamma\|\gamma^*)$	22.5	23.7	24.8	25.7	26.5	27.3
u	6.98	7.28	7.62	8.00	8.41	8.84
f	40.0	36.3	33.1	30.3	27.8	25.6
s	3.00	2.85	2.73	2.63	2.55	2.48
y	1.69	1.69	1.68	1.68	1.67	1.66
Welfare loss	0	0.42	0.92	1.48	2.08	2.74

Firing tax is $\tilde{p}^*$ times the lowest wage in benchmark. n: number of interviews; χ: probability of getting at least one offer; γ^*: cutoff probability; $E(\gamma|\gamma^*)$: conditional probability of match quality being good; u: unemployment rate; f: job finding rate; s: separation rate; y: total production in the economy. All values, except for n, γ^* and y, are in percent.

are more likely to hire more suitable workers. In this model, unemployment insurance reduces surplus from all matches, making firms and workers demand a higher expected surplus to accept a match. Hence, unemployment insurance increases the shares of new matches that are good quality as well as the output per worker, though its effect is quantitatively small.

6. Concluding remarks

The literature on the theoretical analysis of firms' search behaviors is relatively scarce. To contribute towards this gap, I employ a discrete time infinite horizon model with homogeneous workers and firms and match specific output. The quality of an employment relationship between a firm and a worker (match) can be either good or bad. Good matches produce a higher output, while bad matches are undesirable. The true quality of the match is unknown before the employment relationship starts and it is revealed after the parties observe the output.

Unemployed workers apply to all vacancy posts and firms pick the number of workers to conduct interviews with, incurring some cost. An interview reveals the probability of the worker being a good match for the firm. Firms choose the number of interviews to maximize the value of their vacancy and select the worker with the highest probability of the match quality being good among workers interviewed. A firm's choice of interviews depends on the productivity gap between a good and a bad match output, the cost of the interview, the probability of a match in the subsequent periods, the cutoff rule for an acceptable match, as well as the distribution that governs the probability of a match quality being good.

As a firm hires the worker with the highest probability of being a good match among all the workers interviewed, firms' search behaviors endogenously determine the distribution of the probability of a match quality being good. Hence, search by firms affects not only the probability of finding a worker, but also the productivity of the job, as well as the flow from employment to unemployment. Moreover, the number of interviews also determines the total cost of a vacancy,

Table A2
Response to hiring subsidy policy.

$\tilde{p}^*$	0	0.06	0.12	0.18	0.24	0.30
Benchmark economy						
n	3	3	2	1	1	1
χ	43.0	43.2	47.4	52.3	52.5	52.8
γ^*	0.037	0.034	0.029	0.024	0.020	0.016
$Pr(\gamma > \gamma^*)$	92.9	93.7	92.3	90.9	92.4	94.0
$E(\gamma\|\gamma^*)$	22.5	22.3	20.3	18.1	17.8	17.5
u	6.98	6.94	7.05	7.23	7.18	7.14
f	40.0	40.5	43.7	47.6	48.5	49.6
s	3.00	3.02	3.32	3.71	3.76	3.81
y	1.69	1.69	1.69	1.68	1.68	1.68
Welfare loss	0	−0.05	0.24	0.65	0.60	0.55
Counterfactual economy						
χ	43.0	43.2	43.4	43.5	43.7	43.9
γ^*	0.037	0.034	0.030	0.026	0.022	0.017
$Pr(\gamma > \gamma^*)$	92.9	93.7	94.5	95.3	96.2	97.0
$E(\gamma\|\gamma^*)$	22.5	22.3	22.1	22.0	21.8	21.6
u	6.98	6.94	6.91	6.88	6.84	6.81
f	40.0	40.5	41.0	41.5	42.0	42.5
s	3.00	3.02	3.04	3.06	3.09	3.11
y	1.69	1.69	1.69	1.69	1.70	1.70
Welfare loss	0	−0.05	−0.10	−0.14	−0.18	−0.23

Hiring subsidy is $\tilde{p}^*$ times the lowest wage in benchmark. n: number of interviews; χ: probability of getting at least one offer; γ^*: cutoff probability; $E(\gamma|\gamma^*)$: conditional probability of match quality being good; u: unemployment rate; f: job finding rate; s: separation rate; y: total production in the economy. All values, except for n, n, γ^* and y, are in percent.

Table A3
Response to minimum wage policy.

$\tilde{p}^*$	1	1.01	1.02	1.03	1.04	1.05
Benchmark economy						
n	3	3	4	5	6	9
χ	43.0	43.0	39.5	36.4	33.6	23.8
γ^*	0.037	0.071	0.101	0.135	0.174	0.332
$Pr(\gamma > \gamma^*)$	92.9	85.2	82.9	79.9	74.9	39.7
$E(\gamma\|\gamma^*)$	22.5	24.0	26.7	29.2	31.9	42.9
u	6.98	7.13	7.19	7.39	7.81	14.45
f	40.0	36.6	32.7	29.1	25.2	9.4
s	3.00	2.81	2.54	2.32	2.13	1.59
y	1.69	1.69	1.69	1.69	1.68	1.57
Welfare loss	0	0.11	0.06	0.22	0.70	9.88
Counterfactual economy						
χ	43.0	43.0	42.8	42.1	40.4	41.2
γ^*	0.037	0.071	0.108	0.156	0.229	0.242
$Pr(\gamma > \gamma^*)$	92.9	85.2	75.2	61.3	40.3	36.7
$E(\gamma\|\gamma^*)$	22.5	24.0	26.0	28.9	34.0	35.0
u	6.98	7.13	7.49	8.33	10.95	11.40
f	40.0	36.6	32.2	25.8	16.3	15.1
s	3.00	2.81	2.60	2.35	2.00	1.95
y	1.69	1.69	1.69	1.67	1.63	1.62
Welfare loss	0	0.11	0.49	1.52	4.96	5.41

Minimum wage is $\tilde{p}^*$ times the lowest wage in benchmark. n: number of interviews; χ: probability of getting at least one offer; γ^*: cutoff probability; $E(\gamma|\gamma^*)$: conditional probability of match quality being good; u: unemployment rate; f: job finding rate; s: separation rate; y: total production in the economy. All values, except for n, n, γ^* and y, are in percent.

further affecting job creation.

I analyze the unemployment rate response to different labor market policies in the presence of the selection channel. When labor market policies in place are strong enough to alter firms' interview decisions, we observe that the selection channel mitigates the effect of such policies on the unemployment rate. For some policies, the mitigating effect could be strong enough to reverse the direction of the response.

Table A4
Response to unemployment insurance policy.

$\tilde{p}^*$	0	0.06	0.12	0.18	0.24	0.30
n	3	3	3	3	3	3
χ	43.0	39.2	35.1	30.8	26.1	21.2
γ^*	0.037	0.038	0.040	0.041	0.042	0.043
$Pr(\gamma > \gamma^*)$	92.9	92.7	92.5	92.2	91.9	91.6
$E(\gamma\|\gamma^*)$	22.5	22.5	22.6	22.6	22.7	22.7
u	6.98	7.61	8.42	9.50	11.02	13.27
f	40.0	36.4	32.5	28.4	24.0	19.4
s	3.00	2.99	2.99	2.98	2.97	2.97
y	1.69	1.68	1.67	1.65	1.62	1.58
Welfare loss	0	1.14	2.60	4.50	7.13	11.01

Unemployment insurance is $\tilde{p}^*$ times the lowest wage in benchmark. n: number of interviews; χ: probability of getting at least one offer; γ^*: cutoff probability; $E(\gamma|\gamma^*)$: conditional probability of match quality being good; u: unemployment rate; f: job finding rate; s: separation rate; y: total production in the economy. All values, except for n, γ^* and y, are in percent.

The findings of this paper indicate that firms' strategic behaviors while hiring can matter significantly. Further research should focus more on understanding the complex hiring processes.

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Appendix A

See Tables A1–A4.

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