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Optimal Government Policies Related to Unemployment

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Abstract

This article studies the optimal government policies related to unemployment in a frictional labor market. To achieve the optimal allocation, we find that the government should not issue unemployment compensation or subsidies for hiring costs. Moreover, as both firms and households experience disastrous consequences related to the minimum wage, the government should not intervene in the labor market to influence the wage rate and should not set any minimum wage. What the government can do is to make appropriate expenditures on matching efficacy. Furthermore, considering heterogeneous labor abilities in the model does not change our main finding.

Keywords

minimum wage, search and matching, unemployment, welfare

Public finances are a critical mechanism because government expenditure and fiscal policies affect private resource allocation and long-run welfare. Public economists have devoted considerable efforts to measuring the

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welfare effects of different fiscal policies and of alternative ways of financing government spending. In this article, we focus on the welfare effects of government policies specifically related to unemployment.

To improve the efficiency of the labor market, the government can assist firms to hire workers, encourage people to search for a job (to participate in the labor market), or directly increase matching efficacy between job seekers and recruiters. The government can reduce the costs of posting vacancies and recruiting workers to help firms to hire workers. The government can encourage people to search for a job or to participate in the labor market by increasing the wages they earn when employed, such as raising the minimum wage, or provide unemployment compensation even when job seekers do not obtain a job opportunity. To increase matching efficacy, the government can supply publicly funded education or job training programs. Examples of government spending on matching efficacy include the employment service offices provided by various governments.[1]

Note that minimum wage legislation is not a policy directly aimed at unemployment, instead being a policy that many governments around the world use to address what they consider to be unfairly low wages, resulting from an unequal socioeconomic situation between employees and employers.[2] In addition, the purpose of unemployment compensation is to prevent the unemployed from experiencing excessive hardship. Unemployment compensation, rather than encouraging participation in the labor market as intended, usually has an adverse effect, tending to encourage the unemployed to remain unemployed rather than seek employment. However, both policies do influence unemployment and the operation of the labor market. Thus, in this article, we investigate the effects of four policies related to unemployment, namely, the minimum wage, unemployment compensation, subsidies for hiring costs, and public spending on matching efficacy.

As we analyze unemployment and related macroeconomic variables, the setting of a competitive labor market is not suitable for our investigation. Moreover, evidence indicates that the labor market is frictional in the real world. According to Diamond (1982), Mortensen (1982), and Pissarides (1984), informational and institutional barriers exist in job searching, recruiting, and vacancy creation in the labor market. As the above four fiscal policies affect agents' behavior in the labor market, it is appropriate to analyze the impact of such legislation in a frictional labor market.

In this article, we build a standard search model with labor market frictions and analyze the optimal government policies related to unemployment. We investigate the effects of the four above-mentioned policies. First, we study the effects of each policy in a decentralized economy. Then, we attempt to find the optimal values of each policy in a centrally planned economy.

The results of this article are as follows. When conducting the comparative statics in the decentralized economy, we find that both unemployment compensation and minimum wages reduce employment, output, and consumption. Thus, firm profits and household welfare decline. In contrast, government spending on matching efficacy and subsidies for hiring costs has benefits in terms of employment and output. However, our numerical exercises suggest that subsidies for hiring costs eventually reduce firm profit and that excessively large subsidies diminish household welfare, whereas we find that public spending on matching efficacy is required to maximize household welfare.

Regarding the optimal policies, we find that the government should not issue unemployment compensation and should not subsidize hiring costs for firms. Furthermore, as both firms and households experience disastrous consequences related to the minimum wage, the government should not intervene in the labor market to influence the wage rate and should not set any minimum wage. What the government can do is to make appropriate expenditures on matching efficacy.

A mandatory minimum wage should only apply to low-wage employees. That is, in this article, we further discuss whether such heterogeneity will change our main finding. We consider heterogeneous labor abilities in the model and find similar results to those found using the benchmark model. The optimal fiscal policies related to unemployment are to spend on matching efficacy, not to provide unemployment compensation, subsidize hiring costs for firms, or set any minimum wage.[3]

A related paper by Lang and Kahn (1998) examines the effects of the minimum wage in a search model with heterogeneous workers. They find that, even though minimum wage laws increase employment, the increased competition from higher-productivity workers as a result of the minimum wage makes lower-productivity workers worse off, without making higher-productivity workers better off. Unlike their study, we investigate and determine alternative policies, in addition to examining the impact of minimum wage legislation. Furthermore, we are able to determine the optimal policies that can achieve the optimal allocation under a centrally planned economy.

The structure of this article is as follows. In the second section, we set up a benchmark model with labor market frictions and analyze the individual optimizations. The third section studies the comparative statics and provides some quantitative results. In the fourth section, we discuss the optimal policies under a centrally planned economy. We further discuss the results under the model with heterogeneous labor abilities in the fifth section. Finally, concluding remarks are provided in the sixth section.

The Benchmark Model

We consider a discrete-time model with a continuum of identical, infinitely lived firms, a continuum of identical, infinitely lived large households, and a fiscal authority. We consider a large household setup such that there is no heterogeneity in welfare between the employed and the unemployed. Employment at a given time is predetermined and changes only gradually, as the unemployed find new employment and as old jobs become redundant.

Labor Matching

The labor market exhibits search frictions. The creation of new jobs requires that firms post vacancies (v_t) and that the unemployed search for job opportunities (s_t). According to Diamond (1982), new jobs can be interpreted as being generated by the following constant returns matching technology: $M_t = m(g_m)(s_t)^{\beta}(v_t)^{1-\beta}$, where $m(g_m) > 0$ measures the degree of matching efficacy, g_m is the government spending on matching efficacy with $m^{'}(g_m) > 0 > m^{''}(g_m)$, and $\beta \in (0, 1)$ is the contribution of a job seeker in the formation of a match. We define the rates at which aggregate job search and aggregate vacancy posting lead to a new job match as $\mu_t = M_t/s_t$ and $\eta_t = M_t/v_t$, respectively. That is, μ_t denotes the job-finding rate for the unemployed and η_t is the recruitment rate for a firm.

The Government

The government utilizes four policies to address unemployment, which are the minimum wage, unemployment compensation, subsidies for hiring costs, and public spending on matching efficacy. Assume that every firm follows the labor market regulations and laws. The government legislates the minimum wage and the firms cannot pay the workers less than the required level. Therefore, the government does not need to pay anything for this legislation.

In addition, following the setting in Merz (1995), Arseneau and Chugh (2006), Atolia, Gibson, and Marquis (2016), among others, we assume that the firm's hiring cost is linear in terms of vacancies as follows: κv_t, where $\kappa > 0$ is referred to as a unit hiring cost. To encourage firms to provide more job vacancies, the government subsidizes a fraction, $t_v \in [0, 1]$, of hiring costs.

The government levies lump-sum taxes to finance the unemployment compensation scheme, subsidies for hiring costs, and public spending on matching efficacy. The government's flow budget constraint is as follows:

$$bs_t + t_v \kappa v_t + g_m = T_t, \tag{1}$$

where b is unemployment compensation, and T_t is lump-sum taxes. To simplify the model, we assume that the government has no other public expenditure and levies no distortionary taxes, including labor income, capital income, and consumption taxes. As those taxes change the relative prices of factors and agents' behavior in the labor market, we exclude them to focus on the pure effects of each of the unemployment policies.

Households

The representative large household has a unified preference and pools all resources and utility of its members. In period t, a fraction e_t of the members of the large household consists of the employed, and the remaining fraction $1 - e_t$ is unemployed. Unemployed members decide whether to participate in a job search (s_t, participation) or not to participate ($1 - e_t - s_t$, nonparticipation, is interchangeably referred to as leisure according to Arseneau and Chugh 2012). The level of employment from the household's perspective is given by the following process:

$$e_{t+1} = (1 - \psi)e_t + \mu_t s_t, \tag{2}$$

where ψ is the (exogenous) job separation rate. Thus, the change in employment $(e_{t+1} - e_t)$ is equal to the inflow of workers into the employment pool $\mu_t s_t$, net of the outflow as a result of job separation (ψe_t).

The household's discounted lifetime utility is

$$U = \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho} \right) \mathrm{t} u(c_t, 1 - e_t - s_t), \tag{3}$$

where $\rho > 0$ is the time preference rate, c_t is consumption, and $u(c_t, 1 - e_t - s_t)$ is the representative large household's utility function, in which $u_i > 0 > u_{ii}$, $i = 1, 2$. In addition, the utility function satisfies the conditions that the marginal utility of consumption (leisure) is zero when consumption (leisure) goes to infinity and the marginal utility of consumption (leisure) goes to infinity when consumption (leisure) is zero.

We use k_t to denote capital, with δ as its depreciation rate. Furthermore, we use w_t and r_t to denote the effective wage rate and the rental rate, respectively. Assume that the government legislates the minimum wage, $\bar{w}$. Thus, the employed actually earn wages, $w_t + \omega$, where $\omega = \bar{w} - w_t > 0$ when $w_t < \bar{w}$, whereas $\omega = 0$ when $w_t \geq \bar{w}$. The representative large household's budget constraint is

$$k_{t+1} = (w_t + \omega)e_t + R_t k_t - c_t + bs_t + \pi_t - T_t, \tag{4}$$

where $R_t = 1 + r_t - \delta$ is the gross return on capital, and π_t is the firm's profits because households own the shares of firms.

The household's dynamic programming problem is to choose $\{c_t, s_t, e_{t+1}, k_{t+1}\}_{t=0}^{\infty}$ to maximize the present discounted value of lifetime utility in equation (3), subject to the equations (2) and (4). The household's necessary conditions can be simplified into the following two equations.

The first is the consumption Euler equation:

$$u_{1,t} = \frac{1}{1+\rho} u_{1,t+1} R_{t+1}. \tag{5a}$$

Next, we have the employment–search tradeoff condition:

$$\frac{u_{2,t} - u_{1,t}b}{\mu_t} = \frac{1}{1+\rho}\left[-u_{2,t+1} + u_{1,t+1}(w_{t+1} + \omega) + (1-\psi)\frac{u_{2,t+1} - u_{1,t+1}b}{\mu_{t+1}}\right], \tag{5b}$$

which states that, in the optimum, today's marginal utility of leisure is equal to the discounted sum of tomorrow's household's surplus from a successful search plus a continuation value if the match is not separated.

Firms

The representative firm produces output and creates and maintains multiple job vacancies. The firm produces a single final good y_t by renting capital and employing labor under the following Cobb–Douglas production technology: $y_t = f(k_t, e_t) = Ae_t^{\alpha} k_t^{1-\alpha}$, where $A > 0$ and $\alpha \in (0, 1)$. The employment from the firm's perspective in the next period is

$$e_{t+1} = (1-\psi)e_t + \eta_t v_t. \tag{6}$$

Thus, the change in employment is equal to the inflow of employees $(\eta_t v_t)$, net of the outflow (ψe_t).

The firm's flow profit is

$$\pi_t = f(k_t, e_t) - (w_t + \omega)e_t - r_t k_t - (1 - t_v)\kappa v_t. \tag{7}$$

Note that the firm cannot pay the workers less than $\bar{w}$, and thus, the actual salary is $w_t + \omega$.

The firm's necessary conditions can be simplified into the following two equations. The first equates the marginal product of capital with the rental rate as follows:

$$f_1(k_t, e_t) = r_t. \tag{8a}$$

The second equation is the following vacancy creation condition:

$$\frac{\kappa(1-t_v)}{\eta_t} = R_{t+1}^{-1}\left[f_2(k_{t+1}, e_{t+1}) - (w_{t+1} + \omega) + (1-\psi)\frac{\kappa(1-t_v)}{\eta_{t+1}}\right]. \tag{8b}$$

The above condition states that, in the optimum, today's marginal cost of vacancy creation and maintenance equals the discounted marginal benefit of recruitment tomorrow, which is the sum of the firm's surplus from a successful match and the savings in terms of the marginal cost of vacancy creation and maintenance if the match is maintained.

Wage Bargaining

The effective wage rate is determined by Nash bargaining, which maximizes the product of the firm's and the worker's surplus from a match. Note that the effective wage rate above is that occurring in the situation without government intervention, that is, $\omega = 0$. The worker's surplus acquired from a successful match is evaluated in terms of the augmenting value of supplying an additional worker: $w_t u_{1,t} - (b u_{1,t} + u_{2,t})$. With normalization, we obtain $w_t - \left(b + \frac{u_{2,t}}{u_{1,t}}\right)$, where the terms in parentheses can be interpreted as the worker's reservation wage. The firm's surplus gained from a successful match is gauged by its added value from recruiting an extra worker: $f_2(k_t, e_t) - w_t$.

Thus, the wage at time t is solved by the following cooperative bargaining game: $\max_{w_t}\left[w_t - \left(b + \frac{u_{2,t}}{u_{1,t}}\right)\right]^{\gamma}[f_2(k_t, e_t) - w_t]^{1-\gamma}$, where $\gamma \in (0,1)$ is the worker's bargaining share. This implies that the wage is

$$w_t = \gamma f_2(k_t, e_t) + (1-\gamma)\left(b + \frac{u_{2,t}}{u_{1,t}}\right), \tag{9}$$

which is a weighted average of the marginal product of labor and the reservation wage.

The Aggregate Resources and Search Equilibrium

Unlike the labor market, the goods market is frictionless. Using the household's budget constraint, equation (4), the firm's profit function, equation (7), and the government's balanced budget constraint, equation (1), we obtain an aggregate goods market constraint as follows:

$$k_{t+1} - (1-\delta)k_t + c_t = y_t - \kappa v_t - g_m. \tag{10}$$

Furthermore, the matching number is equal to the job search inflow into the employment pool and is also equal to newly occupied vacancies, that is, $m(g_m)(s_t)^{\beta}(v_t)^{1-\beta} = u_t s_t = \eta_t v_t$ in equilibrium. Thus, the employment equilibrium condition is as follows:

$$e_{t+1} = (1-\psi)e_t + m(g_m)(s_t)^{\beta}(v_t)^{1-\beta}. \tag{11}$$

Under a given set of government policies $\{T_t, b, t_v, g_m, \omega\}$, a search equilibrium consists of the household choice $\{c_t, s_t, e_{t+1}, k_{t+1}\}$, the firm choice $\{v_t, k_t, e_{t+1}\}$, prices $\{r_t, w_t\}$, and matching rates $\{M_t, \mu_t, \eta_t\}$, such that (1) households optimize, (2) firms optimize, (3) the employment evolution conditions hold, (4) labor market matching and wage bargaining conditions are met, (5) the government's budget is balanced, and (6) all markets clear.

Effects of the Government's Policies

This section analyzes the effects of the government's unemployment policies, including unemployment compensation, subsidies for hiring costs, public spending on matching efficacy, and minimum wages. In the following subsections, we first investigate the comparative statics and then attempt to find the optimal unemployment policy that can further increase output and household welfare.

Steady State

According to the above calculations, equations (5a), (5b), (8b), (10), and (11), along with equations (8a) and (9), describe a five-dimensional dynamical system with variables $\{c_t, s_t, v_t, k_{t+1}, e_{t+1}\}$. At the steady state, all variables are constant. Equations (5a), (10), and (11), along with equation (8a), imply that capital, vacancies, and consumption are the functions of employment and search. We rewrite the above equations as follows:[4]

$$k = \left[\frac{(1-\alpha)A}{\rho+\delta}\right]^{\frac{1}{\alpha}} e \equiv k(\overset{+}{e}), \tag{12a}$$

$$v = (\psi e)^{\frac{1}{1-\beta}}[m(g_m)]^{\frac{-1}{1-\beta}}s^{\frac{-\beta}{1-\beta}} \equiv v(\overset{+}{e}, \overset{-}{s}; \overset{-}{g_m}), \tag{12b}$$

$$c = \left(\frac{\rho+\delta}{1-\alpha} - \delta\right)k(e) - \kappa v(e,s;g_m) - g_m \equiv c(\overset{+}{e}, \overset{+}{s}; \overset{?}{g_m}). \tag{12c}$$

Combining equations (5b) and (9), we find that the effective wage rate is also a function of employment and search as follows:[5]

$$w = \frac{\gamma(\rho+\psi+\mu)}{\rho+\psi+\gamma\mu}\alpha A\left[\frac{(1-\alpha)A}{\rho+\delta}\right]^{\frac{1-\alpha}{\alpha}} + (1-\gamma)\frac{\mu\omega+[2(\rho+\psi)+\mu]b}{\rho+\psi+\gamma\mu} \equiv w(\overset{+}{e}, \overset{-}{s}; \overset{+}{\omega}, \overset{+}{b}). \tag{12d}$$

By substituting equations (12a) through (12d) into equations (5b) and (8b), we obtain the following long-run employment-search tradeoff condition and vacancy creation condition, respectively:

$$ES(\overset{+}{e}, \overset{+}{s}; \overset{?}{g_m}, \overset{-}{\omega}, \overset{-}{b}) \equiv u_2(e,s) - u_1(e,s;g_m)\frac{\mu(e,s)[w(e,s;\omega,b)+\omega]+b(\rho+\mu)}{\rho+\psi+\mu(e,s)} = 0, \tag{13a}$$

$$VC(\overset{+}{e}, \overset{-}{s}; \overset{-}{g_m}, \overset{-}{t_v}, \overset{+}{\omega}, \overset{+}{b}) \equiv \frac{\kappa(1-t_v)(\rho+\psi)}{\eta(e,s;g_m)} - \alpha A\left[\frac{(1-\alpha)A}{\rho+\delta}\right]^{\frac{1-\alpha}{\alpha}} + w(e,s;\omega,b) = 0. \tag{13b}$$

Equation (13a) is referred to as Locus *ES* and equation (13b) is referred to as Locus *VC* in figure 1. Both loci can be used to determine (e, s) at the steady state.

Regarding the slope of Locus *ES*, higher employment increases consumption but also reduces the marginal utility of consumption, and thus increases the marginal utility of leisure, net of the marginal utility of consumption. In the optimum, to decrease the marginal utility of leisure, it is necessary to increase leisure time, and thus to decrease searching time. As a result, higher employment results in a reduced search time, and thus, locus *ES* is negatively sloping in the (e, s) plane. Note that when $e = 0$, $c = -g_m < 0$, which is infeasible. Therefore, in depicting Locus *ES*, the level of e cannot be lower than e_0, where e_0 is the level at which $c = 0$. When $e = e_0$, the level of the second term in equation (13a) goes to infinity as u_1 goes to infinity when $c = 0$. To maintain the condition in equation (13a), it is required that $s = 1 - e_0$. This is because when $e = 1 - s$, the level of the first term in equation (13a) goes to infinity as u_2 goes to infinity when $1 - e - s = 0$. In the same situation, when $e = 1$, it is required that $s = 0$ to enable the levels of μ and the second term in (13a) to go to infinity (see Locus *ES* in figure 1).

Turning to Locus *VC*, equation (13b) infers that Locus *VC* is positively sloping. Furthermore, it is easy to show that when $e = 0$, given s, the first

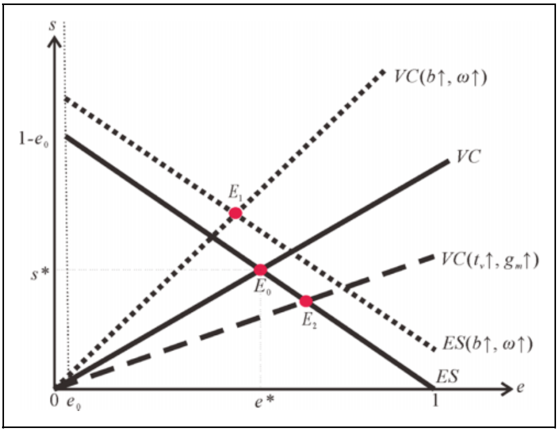

Figure 1. The steady state and comparative statics.

term of equation (13b) equals zero, and the levels of the last three items in equation (13b) are constant, implying that s must equal zero. Furthermore, when $e = 1$, it can be directly derived from equation (13b) that s is a positive constant. Thus, equation (13b) is a positively sloping locus that starts from the origin (see Locus VC in figure 1).

Therefore, a positively sloping Locus VC and a negatively sloping Locus ES must intersect and the intersection is unique. Thus, there exists a unique steady state (see figure 1, solid line, point E_0).

Comparative Statics

Now, we analyze the comparative-static effects of changes in the government's unemployment policies. When b is increased, the level in equation (13a) decreases, whereas that in equation (13b) increases. Thus, Locus ES needs to shifts rightward (as e needs to be increased) and Locus VC needs to shifts leftward (as e needs to be decreased) to maintain the conditions in equations (13a) and (13b). That is, the level of s must increase, whereas the level of e is uncertain (see point E_1 in figure 1). Here, we expect that e should decline. The wage rate is increasing in b, and this reduces the firm's incentive to create job vacancies because of the higher wages required for workers. Thus, the level of v declines. Lower vacancies reduce the matching equilibrium level of employment and long-run capital and output decline. Consumption is likely to decline as well, as the negative effects on employment and output are expected to dominate the positive effect on search.

An increase in t_v only reduces the level in equation (13b). Thus, e needs to increase to maintain the condition in equation (13b). Thus, Locus *VC* shifts rightward, whereas Locus *ES* does not change. The level of e increases, whereas the level of s decreases. Thus, the level of v increases according to equation (12b) (see point E_2 in figure 1). Intuitively, lower hiring costs resulting from higher government subsidies increase firms' incentives to create more job vacancies. This increases the matching equilibrium level of employment as well as long-run capital and output. Note that the higher t_v lowers household disposable income, and thus, the effect on consumption is ambiguous.

If the government increases the minimum wage (a higher ω), it decreases the level in equation (13a), whereas it increases that in equation (13b). Similar to the result of an increase in b, the level of s must increase, whereas the level of e is uncertain (see point E_1 in figure 1). Here, we expect that e should decline. Although a higher ω increases the incentive for the unemployed to search for jobs, it reduces the firm's incentive to create job vacancies owing to the higher payments required for workers. Thus, the level of v declines. The matching equilibrium level of employment, long-run capital, output, and consumption decline as well.

Finally, if the government spends more money on increasing the matching efficacy (a higher g_m), it decreases the level of equation (13b), whereas the effects on equation (13a) are uncertain. Thus, Locus *VC* needs to shift rightward (as e needs to be increased) to maintain the condition in equation (13b). Assuming that the change in Locus *VC* dominates that in Locus *ES*, we find that the level of e increases, whereas the level of s decreases. The result is similar to point E_2 in figure 1. Intuitively, a higher g_m increases the matching efficacy, which increases employment in equilibrium. Thus, long-run capital and output also increase. However, the higher g_m lowers the household's disposable income, and thus, the effect on consumption is ambiguous.

Using the above inference, equations (12a) through (12d) and (13a) and (13b), we can deduce the effects of the four government policies on macroeconomic variables. The results are provided in table 1.

The above results imply that government spending on matching efficacy and subsidies for hiring costs have benefits in terms of employment and output. Therefore, if the government wants to reduce unemployment or increase output, it could consider implementing these policies. However, the role of the government is not only to increase production but also to enhance household welfare. As the two policies have different effects on consumption and leisure, their impact on household welfare is ambiguous.

Table 1. The Effects of the Government Policies.

Policies	e	s	v	k	y	c
b	−	+	−	−	−	−
t_v	+	−	+	+	+	?
ω	−	+	−	−	−	−
g_m	+	−	?	+	+	?

In regard to unemployment compensation, it is well known that this policy cannot reduce the unemployment rate and it may even have the opposite effect.[6] However, this policy, which belongs to the category of social welfare policies, is used to reduce impacts on income for the unemployed. Therefore, even though it has negative impacts on employment and output, it continues to be implemented in many countries.

In regard to the minimum wage, workers generally desire the government to raise the minimum wage, whereas firms typically want the opposite to occur. Our results show that households are not benefited by this policy. Raising the minimum wage will further increase unemployment and reduce output, which, in turn, could reduce household welfare.

Calibration

To more clearly understand the impact of the various policies on firm profits, as well as on household welfare, we undertake a numerical analysis. To quantify the results, we calibrate the model in the steady state to reproduce key features that are representative of the US economy, using weekly frequencies (one-twelfth of a quarter). According to Shimer (2005), the monthly separation rate is 0.034 and the monthly job-finding rate is 0.45. Based on these data, we calculate the weekly separation rate $\psi = 1 - (1 - 0.034)^{1/4} = 0.0086$ and the weekly job-finding rate $\mu = 1 - (1 - 0.45)^{1/4} = 0.1388$. According to Organization for Economic Co-operation and Development statistics, the labor force participation rate in the United States during the period 1970 to 2007 was about 0.742, and thus in our model, $e + s = 0.742$. In the steady state, equations (2), (6), and (11) yield the long-run matching equilibrium condition as $\mu s = \eta v = m(g_m)s^{\beta}v^{1-\beta} = \psi e$. Then, we calibrate the fraction of labor in employment and in search as $e = 0.6987$ and $s = 0.0433$, respectively. Moreover, we follow Hagedorn and Manovskii (2008), who find that monthly labor market tightness is 0.634, and obtain a weekly labor market tightness of $1 - (1 - 0.634)^{1/4} = 0.2222$, that is, the vacancy-searching worker ratio is $v/s = 0.2222$. Thus, we use the long-run matching equilibrium condition to calibrate and obtain $\eta = 0.6248$ and $v = 0.0096$.

In the real business cycle literature, it is common to use a capital share of output of between 0.30 and 0.40 (see the examples in Cooley 1995). Following Arseneau and Chugh (2006), we set $\alpha = 1 - 0.3 = 0.7$, and normalize $A = 1$. Assume that a quarterly depreciation rate of capital is 5 percent, then $\delta = 1 - (1 - 0.05)^{1/12} = 0.0043$. In addition, we set $\rho = 0.0025$. Then, we use equation (12a) and the production function to calibrate the values of capital and output as $k = 157.0449$ and $y = 3.5465$, respectively. Data from the Penn World Table suggest that the consumption–output ratio and the government spending–output ratio in the US economy during the period 1970 to 2007 were around 0.67 and 0.1, respectively. We assume that the entire government expenditure is put toward spending on matching efficacy, that is, $b = 0$ and $t_v = 0$. Thus, we set the initial $c/y = 0.67$ and $g_m/y = 0.1$ and obtain $c = 2.3761$ and $g_m = 0.3546$, respectively. We use the data and equation (12c) to calibrate $\kappa = 15.1465$. Then, we can use equation (13b) to calibrate the total wage at $w + \omega = 3.2836$.

To simplify the model, we assume that the representative large household's utility function is as follows: $u(c_t, 1 - e_t - s_t) = \ln(c_t) + \chi \frac{(1-e_t-s_t)^{1-\sigma}}{1-\sigma}$, where $\chi > 0$ measures the importance of leisure relative to consumption in utility. We use a conventional additively separable utility between consumption and leisure, with a unit intertemporal elasticity of substitution (IES) for consumption that is different from the IES of leisure, which is $1/\sigma > 0$. The IES for labor ranges from close to 0 (MaCurdy 1981) to 3.8 (Imai and Keane 2004). Following Hansen and Imrohoroglu (2009), we choose a middle value of the Frisch labor supply elasticity at 2 as our benchmark case, which implies that $\sigma = 0.1739$.

Moreover, we use equation (13a) to calibrate the degree of leisure relative to consumption in utility as $\chi = 1.0110$. The value of γ is in the commonly used range between 0.3 and 0.6 (e.g., Andolfatto 1996; Shi and Wen 1999; and Domeij 2005). We choose a middle value of the worker's bargaining share at 0.45 as our benchmark case and use equation (12d) to calibrate the effective wage at $w = 3.2710$. Thus, $\omega = 0.0126$.

Furthermore, we equate bargaining power and the elasticity of the matching function to internalize the externality generated by the search friction, that is, the Hosios condition is met initially, and thus $\beta = y = 0.45$. This setting is needed to compare the results in a decentralized economy with those in a centrally planned economy in the next section. Under the above assumption, the matching number is calibrated at

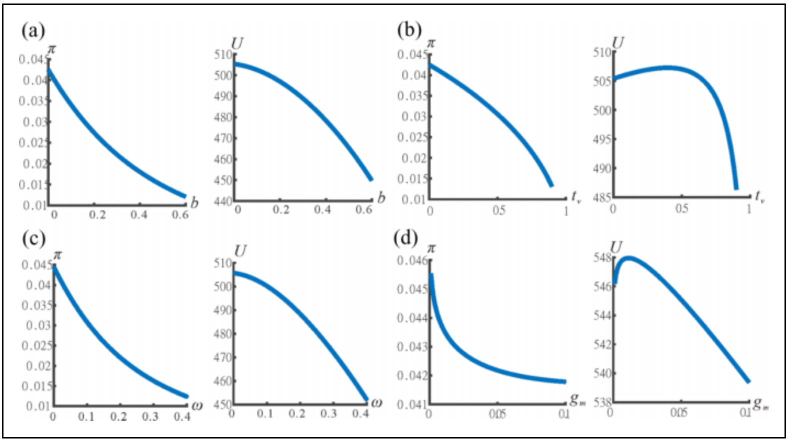

Figure 2. The comparative statics under different values of *b*, t_v, ω, and g_m.

$M = 0.3175$. To simplify the analysis, we assume that $m(g_m) = m_0 + m_1 g_m^{\text{Ø}}$, where $m_0 > 0$, $m_1 > 0$, and $\text{Ø} \in (0, 1)$. As $m(g_m)$ is concave on g_m, we set $\text{Ø} = 0.2$. If the government does not spend any money on increasing matching efficacy, $m(g_m) = m_0$, which should be positive. To obtain a plausible value, we set $m_1 = 0.1$ and obtain $m_0 = 0.2362$.

Using the above parameters and variables, we can obtain the firm's profit and the household's welfare as $\pi = 0.0425$ and $U = 505.3790$, respectively. Note that the household's welfare in the long run is as follows: $U = (1 + \rho)u(c, 1 - e - s)/\rho$.

Now, we investigate the comparative statics by undertaking a numerical analysis. In the previous theoretical analysis, we could discuss the effects of the government policies only on labor and goods market variables. Now, we extend this analysis to examine the effects on firm profits and household welfare.

First, we discuss the influence of unemployment compensation. We change the value of b from 0 to 0.6 and illustrate the results in figure 2-(a). To save space, we only show the effects of each policy on firm profits and household welfare. Consistent with Table 1, a higher b increases job search efforts, while reducing employment, capital accumulation, output, and consumption. In addition, firms reduce their vacancy creation when b increases. As firms produce less output, their profits diminish. Furthermore, household welfare is decreased as a result of lower consumption.

To examine the effects of government subsidies for hiring costs, we alter the value of t_v from 0 to 0.9. The results are consistent with those in Table 1, and are shown in figure 2-(b). Note that consumption is increased as t_v increases when t_v is not too large. However, the opposite effect occurs when t_v is large. We find that consumption decreases as t_v increases when $t_v > 0.86$. That is, household welfare first increases as t_v increases and then falls when $t_v > 0.4$. In addition, although firm production increases as t_v increases, with benefits for profits, the increasing vacancy creation increases total hiring costs, which reduces firm profits. Our results show that the latter effect dominates the former effect, and thus, firm profits are decreasing in t_v.

While a superficial examination suggests that subsidies for hiring costs have benefits for firms, in fact their profits will decline as a result of such subsidies. Therefore, from the firm's point of view, subsidies should be zero, whereas from the household perspective, the best subsidy rate is 0.4.

Regarding minimum wages, a higher minimum wage means that the difference (ω) between the minimum wage and the effective wage (the bargaining wage) is larger. Note that if the minimum wage is smaller than the bargaining wage, this policy has no effect on firms and households. Therefore, we only discuss the situation where the minimum wage is larger than the bargaining wage. We vary the value of ω from 0 to 0.4 and display the results in figure 2-(c). Consistent with Table 1, setting a minimum wage, which has an adverse impact on output and employment, also has disastrous consequences for firms and households. Both firm profits and household welfare are reduced.

Finally, we study the effect of public spending on matching efficacy. We change the value of g_m from 0 to 0.5. The results, which are consistent with those in Table 1, are shown in figure 2-(d). Output increases as g_m increases. However, following an initial increase, consumption then decreases because a higher g_m reduces household disposable income. Thus, household welfare first increases and then decreases when g_m increases. We obtain the welfare-maximizing level of spending, assuming no changes to the other policies, as $g_m = 0.0113$.

Based on the above results, unemployment compensation and minimum wages are not beneficial policies either for firms or for households. In contrast, positive subsidies for hiring costs and spending on matching efficacy may have benefits for households. Here, we particularly focus on the effects of policies on household welfare. As firms can continue to earn high profits even if the government policies discussed reduce their welfare, the impacts on household welfare are far more significant than the impacts on firms. Our numerical exercises suggest that both b and ω should be 0, whereas the welfare-maximizing values of t_v and g_m are uncertain. Note that in the above exercises, we change one policy at a time. To obtain the welfare-maximizing policies, we need to discuss the optimal allocation under a centrally planned economy.

Before that, we further check the results when the Hosios rule is not met. Using the same benchmark parameters and observable values except that $\beta = 0.3$, and the same steps of calibration, we can investigate the comparative statics under different fiscal policies. Remember that we only change one policy at one time and take the other policies as given. The results are similar to those in the benchmark model. Both b and ω should not be implemented, whereas the government may subsidize the hiring costs or spend on matching efficacy. The welfare-maximizing value of g_m is 0.008 and that of t_v is 0.68. The welfare-maximizing value of t_v is larger than that in the benchmark model. Intuitively, when $\beta = 0.3 < \gamma = 0.45$ (i.e., $1 - \beta > 1 - \gamma$), the firm's bargaining power is smaller than the elasticity of vacancies in the matching function. The firms will create too few vacancies. That is, the government needs to subsidize the hiring costs more to encourage the firms to post more vacancies.

In contrast, if $\beta > \gamma$, we should have the opposite results. Thus, we also check the results under $\beta = 0.7 > \gamma = 0.4$. The welfare-maximizing values of each policy are $g_m = 0.019$, $t_v = 0$, $b = 0.15$, and $\omega = 0.1$, respectively. Remember that we only change one policy at one time and take the other policies as given. As we predicted before, when a firm's bargaining power is larger than the elasticity of vacancies in the matching function, the firms will create too many vacancies. Therefore, the government does not need to subsidize the hiring costs. However, in this situation, the worker's bargaining power is smaller than its elasticity in the matching function and thus too few people search for a job. That is, minimum wage legislation or unemployment compensation is needed to encourage people to participate in the labor market.

The Centrally Planned Economy

As comparative statics cannot determine the welfare-maximizing policies, we now investigate the optimal policies under a centrally planned economy. The central planner's objective is to maximize the household's discounted lifetime utility, equation (3), subject to the aggregate goods market clearance constraint, equation (10), and the employment equilibrium condition, equation (11).

The equilibrium conditions in the centrally planned economy are as follows. First, we have the following consumption Euler equation, which is the same as the combination of equations (5a) and (8a):

$$u_{1,\,t} = \frac{1}{1+\rho} u_{1,\,t+1}[f_1(k_{t+1},\ e_{t+1}) + 1 - \delta]. \tag{14a}$$

Next, we obtain the consumption–leisure tradeoff condition:

$$\frac{u_{2,\,t}}{u_{1,\,t}} = \frac{\beta}{1-\beta}\kappa\frac{v_t}{s_t}. \tag{14b}$$

Moreover, we have the employment–search tradeoff condition:

$$\frac{u_{2,\,t}}{m(g_m)\beta s_t^{\beta-1} v_t^{1-\beta}} = \frac{1}{1+\rho}\left[-u_{2,\,t+1} + u_{1,\,t+1}f_2(k_{t+1},\ e_{t+1}) + (1-\psi)\frac{u_{2,\,t+1}}{m(g_m)\beta s_{t+1}^{\beta-1} v_{t+1}^{1-\beta}}\right]. \tag{14c}$$

Finally, the optimal level of spending on matching efficacy is as follows:

$$\frac{m(g_m)}{m'(g_m)} = \frac{\kappa v_t}{1-\beta}. \tag{14d}$$

The optimal allocations for c_t, s_t, v_t, k_{t+1}, e_{t+1}, and g_m are derived from equations (10), (11), and (14a) through (14d).

As equations (10), (11), and (14a) are the same as those in the decentralized economy, we can obtain the optimal policies by comparing the remaining equations, (14b) through (14d), in the centrally planned economy with those in the decentralized economy, equations (5b), (8b), and (9). That is, if the government policies (the values of b, t_v, ω, and g_m) can make the variables in the decentralized economy achieve the optimal allocation in the centrally planned economy, then those are the optimal policies.

In the long run, if we combine equations (14b) and (5b), along with equation (9) and $\mu_t = M_t/s_t$, we can derive the following relationship between b and ω:

$$\left(1-\frac{\gamma}{\beta}\right)\frac{u_2(\rho+\psi)}{u_1\mu} = \left(1-\gamma+\frac{\rho+\psi}{\mu}\right)b + \omega. \tag{15a}$$

Equation (15a) implies that $\left(1-\gamma+\frac{\rho+\psi}{\mu}\right)b + \omega \geq\leq 0$ if $\beta \geq\leq \gamma$.

Next, combining equations (14c) and (8b), along with equation (9) and $\eta_t = M_t/v_t$, yields the condition of t_v as follows:

$$(1-\gamma)b + \omega = \tfrac{\kappa(\rho+\psi)}{\eta}\left(t_v + \tfrac{\beta-\gamma}{1-\beta}\right). \tag{15b}$$

By using equation (15a), we can derive that $t_v = -\frac{s}{\kappa v} b \geq\leq 0$ if $\gamma \geq\leq \beta$. That is, $t_v = 0$ when the Hosios rule holds.

The above results show that when $\gamma > \beta$, $t_v > 0$ and at least one of b and ω is negative, whereas when $\gamma < \beta$, b and (or) ω are (is) positive, but $t_v < 0$. Those are the theoretical optimal policies. However, a negative b, ω, or t_v is unrealistic. That is, it is not optimal for the government to provide unemployment compensation or hiring subsidies, or set any minimum wage, and instead should focus on match efficiency.

Using the same settings for parameters as those in the benchmark model, we obtain the optimal allocation as follows:[7] $c^* = 2.4189$, $s^* = 0.0433$, $v^* = 0.0104$, $k^* = 141.0481$, $e^* = 0.6275$, and $y^* = 3.1852$. Moreover, the optimal spending on matching efficacy is $g_m^* = 0.0079$, and of course $b^* = t_v^* = \omega^* = 0$. In addition, firm profits and household welfare are $\pi^* = 0.0457$ and $U^* = 548.1240$, respectively. Clearly, the level of firm profits and household welfare is higher in this context than in the decentralized economy.

To increase household welfare, the government should not provide unemployment compensation or subsidize hiring costs for firms. Moreover, as both firms and households experience disastrous consequences related to the minimum wage, the government should not intervene in terms of the wage rate in the labor market, that is, the government should not set any minimum wage. What the government can do is to increase matching efficacy. Even a small value of g_m has benefits for household welfare, and the government does not need to increase matching efficacy as much as possible to yield benefits. Note that in comparison to the value of output, the value of $g_m^* = 0.0079$ is not large. Nevertheless, we can determine the positive level of public spending on matching efficacy required to maximize household welfare.

Heterogeneous Labor Abilities

In the benchmark model, we assume that all agents are homogeneous. However, the minimum wage is not binding for all agents and usually only applies to the unskilled labor. To understand whether this heterogeneity will change the optimal policies, we consider heterogeneous labor abilities in the model and redo the above analyses.

Assume that a fraction a of the members of the large household is skilled people and the remaining fraction $1 - a$ is unskilled. In period t, a fraction $e_t^1(e_t^2)$ of the skilled (unskilled) members is employed, another fraction $s_t^1(s_t^2)$ is searching for jobs, and the remaining fraction $1 - e_t^1 - s_t^1(1 - e_t^2 - s_t^2)$ is outside the labor force. Hereafter, the superscript $i = 1, 2$ denotes the related variables for skilled and unskilled members, respectively. Thus, the level of employment of the skilled (unskilled) members from the household's perspective becomes the following process: $e^i_{t+1} = (1 - \psi^i)e^i_t + \mu^i_t s^i_t$.

The household's utility function and budget constraint are changed to: $u(c_t, 1 - e^1_t - s^1_t, 1 - e^2_t - s^2_t) = a[\ln(c_t) + \chi^1 \frac{(1-e^1_t-s^1_t)^{1-\sigma}}{1-\sigma}] + (1-a)[\ln(c_t) + \chi^2 \frac{(1-e^2_t-s^2_t)^{1-\sigma}}{1-\sigma}]$, and $k_{t+1} = w^1_t a e^1_t + w^2_t (1-a)e^2_t + R_t k_t - c_t + b^1 a s^1_t + b^2(1-a)s^2_t + \pi_t - T_t$, respectively.

As for the setting of the firm, the production technology is now: $y_t = f\left(k_t, ae^1_t, (1-a)e^2_t\right) = Ak_t^{1-\alpha-\varphi}(ae^1_t)^{\alpha}[(1-a)e^2_t]^{\varphi}$, where $\alpha, \varphi, \alpha + \varphi \in (0, 1)$ and $\alpha > \varphi$, because the productivity of the skilled labor is larger than that of the unskilled one. The employment for the skilled (unskilled) labor from the firm's perspective is $e^i_{t+1} = (1 - \psi^i)e^i_t + \eta^i_t v^i_t$. The firm's flow profit becomes $\pi_t = f\left(k_t, ae^1_t, (1-a)e^2_t\right) - w^1_t a e^1_t - w^2_t(1-a)e^2_t - r_t k_t - (1 - t^1_v)\kappa^1 v^1_t - (1 - t^2_v)\kappa^2 v^2_t$.

In addition, the matching technology now becomes $M^i_t = m^i(g_m)(s^i_t)^{\beta}(v^i_t)^{1-\beta}$, where $m^1(g_m) = m^1_0 + m^1_1 g^{\phi}_m$ and $m^2(g_m) = m^2_0 + m^2_1 g^{\phi}_m$. The two wage rates are changed to $w^1_t = \gamma f_{2,t} + (1-\gamma)(b^1 + \frac{u^1_{l,t}}{u_{c,t}})$ and $w^2_t = w^{2N}_t + \omega$, respectively, where $w^{2N}_t = \gamma f_{3,t} + (1-\gamma)(b^2 + \frac{u^2_{l,t}}{u_{c,t}})$.[8] Moreover, the government's flow budget constraint now is $b^1 a s^1_t + b^2(1-a)s^2_t + t^1_v \kappa^1 v^1_t + t^2_v \kappa^2 v^2_t + g_m = T_t$.

The analyses of equilibrium conditions, steady state, and comparative statics in the decentralized economy are similar to those in the benchmark model. To understand the impact of each of the fiscal policies more clearly, we also undertake a numerical analysis. Similarly, we calibrate the model in the steady state to reproduce key features that are representative of the US economy by using weekly frequencies. According to Hagedorn, Manovskii, and Stetsenko (2016), the average monthly job-finding rate is 0.3618 for skilled workers and 0.4185 for unskilled workers. In addition, the separation rate into unemployment, not adjusted for time aggregation, equals 0.0097 for the skilled and 0.0378 for the unskilled. Based on these data, we calculate the weekly separation rate for skilled and unskilled workers to be $\psi^1 = 1 - (1 - 0.0097)^{1/4} = 0.0024$ and $\psi^2 = 1 - (1 - 0.0378)^{1/4} = 0.0096$, respectively. The weekly job-finding rates for skilled and unskilled workers are calculated to be $\mu^1 = 1 - (1 - 0.3618)^{1/4} = 0.1062$ and $\mu^2 = 1 - (1 - 0.4185)^{1/4} = 0.1268$, respectively.

Moreover, we set the capital share of output at 0.35. Thus, $1 - \alpha - \varphi = 0.35$. As the productivity of skilled labor is larger than that of unskilled labor, to obtain a reasonable result, we set $\varphi = 0.2$ and thus

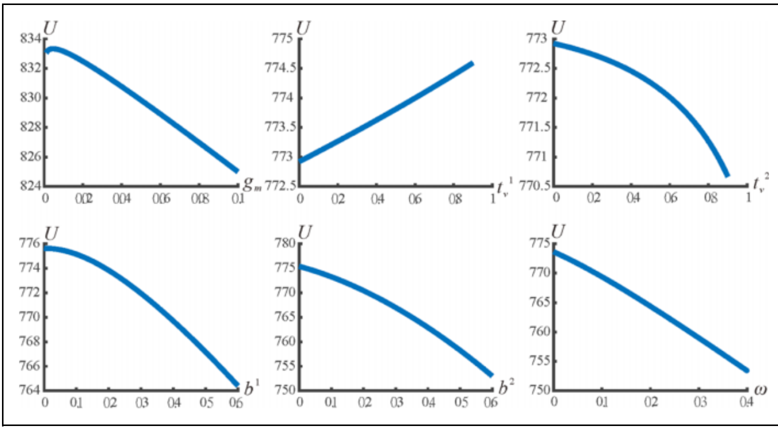

Figure 3. The comparative statics in the model with heterogeneous labor abilities.

$\alpha = 0.45$. To simplify the analysis, we rewrite the production function as follows: $y_t = Bk_t^{1-\alpha-\varphi}(e_t^1)^{\alpha}(e_t^2)^{\varphi}$, where $B \equiv Aa^{\alpha}(1-a)^{\varphi}$ is a constant. We normalize $B = 1$. In addition, we assume that half of the members in the large household are skilled labor, that is, $a = 0.5$.

Using the same steps as in the benchmark model, we can calibrate the related macroeconomic variables as follows:[9] $e^1 = 0.7254$, $e^2 = 0.6898$, $s^1 = 0.0166$, $s^2 = 0.0522$, $v^1 = 0.0037$, $v^2 = 0.0116$, $\eta^1 = 0.4780$, $\eta^2 = 0.5705$, $k = 308.6752$, $y = 5.9748$, $c = 4.0031$, $U = 772.9223$, and $\pi = 0.0258$.

Now, we can investigate the comparative statics under different fiscal policies. The results are shown in figure 3. Again, we only change one policy at one time and take the other policies as given. The results are similar to those in the benchmark model. We find that b^1, b^2, and ω should not be implemented. Moreover, the government may only subsidize the hiring costs for skilled labor and should not subsidize those for unskilled labor. Furthermore, the government may spend on matching efficacy (the welfare-maximizing level of spending, assuming no changes to the other policies, is $g_m = 0.005$). Similarly, to obtain the welfare-maximizing policies, we need to discuss the optimal allocation under a centrally planned economy.

As for the optimal allocation in the centrally planned economy, we can derive the following relationships:

$$\left(1 - \gamma + \frac{\rho + \psi^1}{\mu^1}\right) b^1 \geq\leq 0 \text{ if } \beta \geq\leq \gamma, \tag{16a}$$

$$\left(1-\gamma+\frac{\rho+\psi^2}{\mu^2}\right)b^2+\omega \geq\leq 0 \text{ if } \beta \geq\leq \gamma, \tag{16b}$$

$$t_v^1=-\tfrac{s^1}{\kappa^1 v^1}b^1 \geq\leq 0 \text{ if } \gamma \geq\leq \beta, \tag{16c}$$

$$t_v^2=-\tfrac{s^2}{\kappa^2 v^2}b^2 \geq\leq 0 \text{ if } \gamma \geq\leq \beta. \tag{16d}$$

As a negative b^1, b^2, t_v^1, t_v^2, or ω is implausible, equations (16a) through (16d) imply that it is not optimal for the government to provide unemployment compensation or hiring subsidies, or set any minimum wage, and instead should focus on match efficiency. In that situation, $b^1 = b^2 = t_v^1 = t_v^2 = \omega = 0$.[10]

The above results show that considering heterogeneous labor abilities in the model does not change our main finding. The government should not provide unemployment compensation, subsidize hiring costs for firms, or set any minimum wage. If it wants to improve the efficiency of the labor market, what it can do is increase matching efficacy.

Concluding Remarks

This article studies the effects of government policies related to unemployment in a decentralized economy and attempts to determine the optimal policies in a centrally planned economy. When conducting comparative statics, we find that unemployment compensation and minimum wages are not beneficial policies for either firms or households. Both policies reduce output, firm profits, and household welfare. Moreover, although positive subsidies for hiring costs have benefits for output, they reduce firm profit, and excessively large subsidies will diminish household welfare. In regard to public spending on matching efficacy, which does enhance output, we can determine the positive level of spending required to maximize household welfare.

To achieve the optimal allocation, the government should not provide unemployment compensation and should not subsidize hiring costs for firms. Furthermore, as both firms and households experience disastrous consequences related to the minimum wage, the government should not intervene in terms of the wage rate in the labor market and should not set any minimum wage. What the government can do is to make suitable expenditures on matching efficacy. In addition, considering heterogeneous labor abilities in the model does not change our main finding.

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Notes

1. For information on these institutions in the United States, refer to http://www.servicelocator.org/EmploymentServices.asp, and for those in Europe, refer to http://ec.europa.eu/social/main.jsp?catId=105. In addition, matching efficacy usually relates to structural unemployment, and a related discussion can be found in Lubik (2009, 2013).
2. Regarding minimum wage legislation, Stigler (1946) considered whether such legislation reduces poverty as well as other efficient alternatives. Afterward, Kaufma (1989), Cahuc and Michel (1996), DiNardo, Fortin, and Lemieux (1996), and Brown (1998) have attempted to analyze the effects of a legal minimum wage on unemployment, inequality, and income. A general review of the minimum wage can be found in Sobel (1999) and Neumark and Wascher (2006).
3. To simplify the model, we do not consider mismatch generated by two-sided heterogeneity which may increase the welfare-enhancing benefits of unemployment insurance. A more general discussion can be seen in Marimon and Zilibotti (1999) in which authors consider two-sided heterogeneity in the search model and show that differences in unemployment insurance can explain the differences in unemployment rates between the United States and Europe.
4. The variable without subscript t represents the value in the long run.
5. Note that $\mu = \psi e/s$ and $dw/d\mu > 0$. In addition, $\eta = (\psi e)^{\frac{-\beta}{1-\beta}}[m(g_m)]^{\frac{1}{1-\beta}}s^{\frac{\beta}{1-\beta}}$.
6. In 2002, the unemployment rate in Germany was 8.7 percent and climbing (reaching 11.2 percent in 2005), with a major factor being that the unemployed was paid approximately half of their previous income for the duration of their unemployment. The Hartz reforms to the unemployment benefit policy encouraged the unemployed to obtain flexible temporary jobs from 2002, and, from

2005, reduced the unemployment compensation for the long-time unemployed (those out of work for more than a year). As a result of these reforms, the unemployment rate in Germany was reduced significantly, falling to 5.5 percent by 2012.

7. We use the same settings of α, A, ρ, σ, ϕ, γ, β, χ, ψ, δ, κ, m_0, and m_1 as those in the benchmark model. The variables with superscript $*$ are the steady-state values in the centrally planned economy.
8. Note that $f_{1,t} = (1-\alpha-\varphi)y_t/k_t, f_{2,t} = \alpha y_t/(ae_t^1), f_{3,t} = \varphi y_t/[(1-a)e_t^2]$, $u_{c,\,t} = 1/c_t$, $u_{l,t}^1 = \chi^1(1-e_t^1-s_t^1)^{-\sigma}$, and $u_{l,t}^2 = \chi^2(1-e_t^2-s_t^2)^{-\sigma}$.
9. We use the same settings of ρ, σ, ϕ, γ, β, δ, m_1^1, m_1^2, c/y, and g_m/y as those in the benchmark model. Moreover, we set $e^1+s^1 = e^2+s^2 = 0.742$ and $t_v^1 = t_v^2 = 0$. In addition, we assume that $b^1/w^1 = b^2/w^2$ and use the setting of the bargaining wages to calibrate b^1 and ω. Other parameters are calibrated at $g_m = 0.5975$, $\kappa^1 = \kappa^2 = 3.7691$, $m_0^1 = 0.1527$, $m_0^2 = 0.1997$, $\mathrm{b}^1 = 0.2513$, $\mathrm{b}^2 = 0.1132$, $\omega = 0.0187$, $\chi^1 = 1.3857$, and $\chi^2 = 0.5974$.
10. Using the same settings and steps of calibration, we obtain the optimal allocation as follows: $c^* = 4.1530$, $s^{1*} = 0.0080$, $s^{2*} = 0.0377$, $v^{1*} = 0.0091$, $v^{2*} = 0.0183$, $k^* = 282.4586$, $e^{1*} = 0.6671$, $e^{2*} = 0.6242$, $y^* = 5.4674$, $g_m^* = 0.0062$, $\pi^* = 0.0534$, and $U^* = 837.9262$. Clearly, the level of firm profits and the household welfare is higher than in the decentralized economy.

References

Andolfatto, David. 1996. "Business Cycles and Labor-market Search." *The American Economic Review* 86:112–32.

Arseneau, David M., and Sanjay K. Chugh. 2006. "Ramsey Meets Hosios: The Optimal Capital Tax and Labor Market Efficiency." International Finance Discussion Papers No. 870, Board of Governors of the Federal Reserve System, Washington, DC.

Arseneau, David M., and Sanjay K. Chugh. 2012. "Tax Smoothing in Frictional Labor Markets." *Journal of Political Economy* 120:926–85.

Atolia, Manoj, Jone Gibson, and Milton Marquis. 2016. "Labor Market Volatility in the RBC Search Model: A Look at Hagedorn and Manovskii's Calibration." *Computational Economics*, forthcoming.

Brown, Charies. 1998. "Minimum Wage Laws: Are They Overrated?" *Journal of Economic Perspective* 2:133–45.

Cahuc, Pierre, and Philippe Michel. 1996. "Minimum Wage Unemployment and Growth." *European Economic Review* 40:1463–82.

Cooley, Thomas F. 1995. *Frontiers of Business Cycle Research*. Princeton, NJ: Princeton University Press.

Diamond, Peter A. 1982. "Wage Determination and Efficiency in Search Equilibrium." *Review of Economic Studies* 49:217–27.

DiNardo, John, Nicole M. Fortin, and Thomas Lemieux. 1996. "Labor Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach." *Econometrica* 64:1001–44.

Domeij, David. 2005. "Optimal Capital Taxation and Labor Market Search." *Review of Economic Dynamics* 8:623–50.

Hagedorn, Marcus, and Iourii Manovskii. 2008. "The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited." *The American Economic Review* 98:1692–706.

Hagedorn, Marcus, Iourii Manovskii, and Sergiy Stetsenko. 2016. "Taxation and Unemployment in Models with Heterogeneous Workers." *Review of Economic Dynamics* 19:161–89.

Hansen, Gary D., and Imrohoroglu, Selahattin. 2009. "Business Cycle Fluctuations and the Life Cycle: How Important Is On-the-job Skill Accumulation?" *Journal of Economic Theory* 144:2293–309.

Imai, Susumu, and Michael P. Keane. 2004. "Intertemporal Labor Supply and Human Capital Accumulation." *International Economic Review* 45:601–41.

Kaufma, Roger T. 1989. "The Effects of Statutory Minimum Rates of Pay on Employment in Great Britain." *Economic Journal* 99:1040–53.

Lang, Kevin, and Shulamit Kahn. 1998. "The Effect of Minimum-wage Laws on the Distribution of Employment: Theory and Evidence." *Journal of Public Economics* 69:67–82.

Lubik, Thomas A. 2009. "Estimating a Search and Matching Model of the Aggregate Labor Market." *Federal Reserve Bank of Richmond Economic Quarterly* 95:101–20.

Lubik, Thomas A. 2013. "The Shifting and Twisting Beveridge Curve: An Aggregate Perspective." Federal Reserve Bank of Richmond Working Paper, No. 13-16. FRB Richmond, VA, USA.

MaCurdy, Thomas E. 1981. "An Empirical Model of Labor Supply in a Life-cycle Setting." *Journal of Political Economy* 89:1059–85.

Marimon, Ramon, and Fabrizio Zilibotti. 1999. "Unemployment vs. Mismatch of Talents: Reconsidering Unemployment Benefits." *Economic Journal* 109: 266–91.

Merz, Monika. 1995. "Search in the Labor Market and the Real Business Cycle." *Journal of Monetary Economics* 36:269–300.

Mortensen, Dale T. 1982. "Property Rights and Efficiency in Mating, Racing and Related Games." *The American Economic Review* 72:968–79.

Neumark, David, and William Wascher. 2006. "Minimum Wages and Employment: A Review of Evidence from the New Minimum Wage Research." NBER

Working Paper No. 12663. National Bureau of Economic Research, Cambridge, MA, USA.

Pissarides, Christopher A. 1984. "Efficient Job Rejection." *Economic Journal* 94: 97–108.

Shi, Shouyong, and Quan Wen. 1999. "Labor Market Search and the Dynamic Effects of Taxes and Subsidies." *Journal of Monetary Economics* 43:457–95.

Shimer, Robert. 2005. "The Cyclical Behavior of Equilibrium Unemployment and Vacancies." *The American Economic Review* 95:25–49.

Sobel, Russell S. 1999. "Theory and Evidence on the Political Economy of the Minimum Wage." *Journal of Political Economy* 107:761–85.

Stigler, George J. 1946. "The Economics of Minimum Wage Legislation." *The American Economic Review* 36:358–65.

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