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Spillover effects of minimum wages in a two-sector search model

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Abstract:

Labor market studies on the effects of minimum wages are typically confined to the sector or worker group directly affected. We present a two-sector search model in which one sector is more productive than the other one and thus, pays higher wages. In such a framework, setting a minimum wage in the unproductive sector to reduce the wage gap causes a negative spillover effect on the productive sector. While the effect on job creation in the (targeted) unproductive sector is ambiguous, job creation in the (non-targeted) productive sector unambiguously decreases. This is driven by the fact that a minimum wage increases the outside option of unemployed workers - contributing to wage determination in the productive sector. Welfare effects are ambiguous. In principle, we cannot exclude that a minimum wage in a two-sector search model is welfare enhancing due to the possibility of an above optimal level of productive employment since firms do not take into account the effects of their individual job creation on aggregated search costs.

Keywords: minimum wages, matching models, two sectors, unemployment, welfare.

JEL classification: J60, J64, J31, E24.

Non-technical summary

The policy debate over the *need for minimum wages* has gained momentum in Europe, especially in Germany, over the past two years. While opponents of a minimum wage fear job losses, proponents assert that the impact of a minimum wage on employment will be benign. It is well known from the theoretical literature that the *employment effects* crucially depend on the labor market structure. In a competitive labor market model, the real wage is equal to the marginal productivity of labor, and the introduction of a minimum wage (above the competitive market wage) will inevitably lead to reduced employment. On the other end of the spectrum (monopsony model), if a single firm represents the labor demand side in a certain segment and acts like a monopolist in the product market, the firm maximizes its profits by choosing the lowest wage possible in order to attract enough employees to keep production at its desired level. Against this background, the introduction of a minimum wage will entail an increase in employment as long as the minimum wage is less than the competitive wage. Models of monopsonistic competition in labor markets are located somewhere in the middle ground between perfectly competitive and monopsonist models, assuming a certain degree of employer market power, and open the door to positive, neutral or negative effects. While there is no clear consensus in the empirical literature, the preponderance of evidence points to disemployment effects.

The studies on minimum wages so far have largely focused on the group or sector directly targeted. We depart from this pattern by investigating whether minimum wages exert a negative spillover effect on other non-targeted sectors. We present a labor market model in which, despite a homogenous pool of workers, two sectors exist that differ in their productivity due to structural or regional differences. The introduction of a minimum wage in the relatively unproductive sector unambiguously reduces employment in the *productive* sector, implying a *negative spillover effect*. On the other hand, the employment effect in the unproductive sector is ambiguous. The minimum wage in the unproductive sector increases the outside option of workers in the unproductive sector. An increasing outside option improves their bargaining position and ability to demand higher wages in the productive sector (i.e. the reservation wage increases), leaving firms less willing to hire. This effect increases the average duration of jobs in the unproductive sector and the chance of unproductive

employees to find employment in the productive sector. If this effect is strong enough, a minimum wage in the unproductive sector potentially increases employment in the unproductive sector and, depending on the parameters, increases overall employment. It seems especially noteworthy that even if aggregate employment rises, this comes at a cost to productive employment.

Prima facie, welfare seems to worsen unambiguously due to falling aggregate production. But it is worth mentioning that the most common measure for welfare in search models consists of aggregate production and aggregate search costs. Such costs stem from the continuous creation of vacancies that need to be filled. As a consequence, results regarding welfare effects are ambiguous in this model. Any deviation from the optimal level of employment in the canonical one-sector search model can lead to an increase in employment, which might be offset by higher search costs, leading to a decrease in welfare. Search models typically yield suboptimal employment in equilibrium. Job creation in the productive sector in competitive equilibrium of our two-sector search model also tends to be too high from a welfare point of view as individual firms in the productive sector do not take into account the effects of their vacancy opening on social costs, i.e. rising aggregate search costs, resulting in an inefficient market outcome.

Nicht-technische Zusammenfassung

Die wirtschaftspolitische Diskussion über die *Notwendigkeit eines Mindestlohns* hat in Europa, insbesondere in Deutschland, in den letzten zwei Jahren wieder Fahrt aufgenommen. Die Ansichten der Befürworter und Gegner des Mindestlohns unterscheiden sich vor allem hinsichtlich der *Beschäftigungswirkungen.* Während in der theoretischen und empirischen Literatur kein eindeutiger Konsensus herrscht, deuten die empirischen Studien doch mehrheitlich auf negative Effekte eines Mindestlohnes hin.

Die bisherigen Analysen zum Mindestlohn konzentrieren sich größtenteils auf die direkt betroffenen Gruppen oder Sektoren. Die vorliegende Arbeit hingegen geht der Frage nach, ob Mindestlöhne Übertragungseffekte in andere, nicht direkt betroffene Sektoren verursachen. Wir zeigen in einem theoretischen Modell gleichgewichtiger Arbeitslosigkeit, in dem es trotz homogener Arbeitnehmerschaft aufgrund von strukturellen oder regionalen Differenzen zwei unterschiedlich produktive Sektoren gibt, dass die Einführung eines Mindestlohnes im relativ unproduktiven Sektor eindeutig die Beschäftigung im relativ *produktiven* Sektor senkt und somit einen *negativen Übertrtagungseffekt* mit sich bringt. Die Beschäftigungseffekte im unproduktiven Sektor sind hingegen uneindeutig. Der Mindestlohn im unproduktiven Sektor senkt zwar aufgrund höherer Lohnkosten zunächst die Einstellungswahrscheinlichkeit im unproduktiven Sektor, er erhöht allerdings auch den Nutzenzuwachs, den ein Arbeitnehmer erfährt, wenn er im unproduktiven Sektor angestellt wird. Wir zeigen, dass der Reservationsnutzen steigt. Dies erlaubt den Arbeitnehmern im produktiveren Sektor höhere Löhne durchzusetzen und senkt gleichzeitig die Bereitschaft zur Schaffung neuer Stellen und die Wahrscheinlichkeit eines Arbeitnehmers, vom unproduktiven in den produktiven Sektor zu wechseln. Letzterer Effekt führt zu einer längeren erwarteten Dauer eines Beschäftigungsverhältnisses im unproduktiven Sektor, was den Anreiz steigert, neue Stellen zu schaffen. Ist dieser Effekt stark genug, kann ein Mindestlohn im unproduktiven Sektor dort sogar die Beschäftigung erhöhen und es ist, abhängig von der Parametrisierung unseres Modells, prinzipiell nicht ausgeschlossen, dass die aggregierte Beschäftigung steigt. Allerdings wird dies mit einer niedrigeren produktiven Beschäftigung erkauft. Auf den ersten Blick erscheint ein Mindestlohn somit eindeutig wohlfahrtsschädigend zu sein, weil er die aggregierte Produktion senkt.

Es ist allerdings hierbei zu beachten, dass sich das gängigste Wohlfahrtsmaß in Suchmodellen aus der aggregierten Produktion abzüglich der aggregierten Suchkosten ergibt. Dies bedeutet dann, dass Aussagen über Wohlfahrtseffekte in diesem Modellrahmen uneindeutig sind. In dem vorliegenden Zwei-Sektoren-Suchmodell ist das Marktgleichgewicht durch ein zu hohes Niveau an produktiver Beschäftigung gekennzeichnet, da es wegen der höheren Produktivität aus individueller Sicht tendenziell attraktiver ist, im produktiven Sektor Stellen zu schaffen, diese individuelle Entscheidung aber die Wirkungen auf die aggregierten Suchkosten, die überproportional im unproduktiven Sektor steigen, nicht einbezieht.

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1 Introduction

The public debate over minimum wages has gained momentum in Germany over the past two years. While the business community is expressing unease over the latest push for a minimum wage against the background of a slowing world economy and fear of job losses, advocates of such a move claim that such wages are necessary to create social justice, as large firms allegedly abuse their power to push wages below a socially desired level.[2] In their view, negative employment effects are not to be expected. But this public discussion is not confined to Germany. While the introduction of a (modest) minimum wage in Great Britain in 1999 has been largely perceived as successful, the relatively high level of minimum wages in France is often held responsible for the high unemployment rate of young and low-skilled employees. From the literature, it is well known that the employment effects of minimum wages crucially depend on the labor market structure. While most studies on minimum wages are usually confined to the sector directly affected, this paper presents a two-sector economy in which only one sector is directly affected by minimum wages and analyzes the resulting spillovers as well as the effects on unemployment, employment structure and welfare.

The effects of minimum wages on employment have been studied in a variety of different theoretical frameworks. In the "textbook" *competitive labor market model*, the real wage is equal to the marginal productivity of labor. If a minimum wage above the competitive market wage is introduced, this will inevitably lead to reduced employment. At the other end of the spectrum,

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[2]Recent newspaper articles on the discussion on minimum wage in Germany include for instance FT (2008), Spiegel Online (2008) and Economist (2006). Many leading German economists offer their view on minimum wages in Ifo (2008). For an influential, controversial recent empirical study, see König and Möller (2008).

monopsony models open the door to the possibility that (moderate) minimum wage increases can lead to employment growth, depending on the elasticity of labor supply. Those models go back to Stigler (1946). A monopsonist firm is assumed to be the only firm in a certain segment of the labor market that demands labor, giving the employer absolute market power. Hence, much like a monopolist in the product market, the monopsonist firm maximizes its profits by choosing the lowest wage possible in order to attract enough employees to keep production at its desired level. Hence, a monopsony remunerates the marginal employee with (potentially) less than its marginal productivity of labor. Against this background, the introduction of a minimum wage will entail an increase in employment as long as the minimum wage is less than the competitive wage. This strand of literature is surveyed by Bhaskar et al. (2002), Cahuc and Zylberberg (2004, ch. 12), Manning (2003, ch. 12) and Boal and Ransom (1997). *Models of oligopsony and monopsonistic competition* in labor markets are located somewhere in the middle ground between perfectly competitive and monopsonist models,[3] which might indeed be an accurate description of the labor market. These models assume a certain degree of employer market power, yet – at the same time – employers are competing for workers, which implies that firms face a less than perfectly elastic supply curve. If a minimum wage is introduced, two distinct channels can be expected. On the one hand, a moderate minimum wage can increase employment at the firm level through greater labor market participation. On the other hand, a binding minimum wage will eat into firms' profits and cause some firms to exit the market. The overall employment effect depends on which effect dominates. While, for instance, Bhaskar and To (1999) report ambiguous results when firms exit, Walsh (2003) and Bhaskar and To (2001) find an unambiguously positive and negative employment effect, respectively. Last, but not least, search frictions in *labor market search models* can, to a certain extent, also be interpreted as a source of monopsony power (for early accounts, see for instance Albrecht and Axell, 1984, and Burdett and Mortensen, 1998). Many of the theoretical results on employment and welfare presented so far crucially hinge on the exact nature of the search friction and on the bargaining power of workers. Ultimately, this is an empirical question. Two influential surveys on the empirical literature on minimum wages are Card and Krueger (1995) and Neumark and

[3]For a survey on oligopsony and monopsonistic competition, see for instance Bhaskar et al. (2002).

Wascher (2007). While the first study underlines the possibility that minimum wage effects on employment can be neutral or benign, the later concludes that "the preponderance of the evidence points to disemployment effects." Addison et al. (2009) find a modest positive employment effect once they allow for geographic-specific trends. The recent study by Flinn (2006) constitutes one of the few ambitious attempts to come up with empirical welfare effects of minimum wages.

In this paper, employment and welfare effects in a two-sector search economy are analyzed from a theoretical perspective. We extend the matching framework of Mortensen and Pissarides (1994, 1999, 2003) and Pissarides (2000) by introducing an additional sector. While both sectors revert to the same pool of homogenous workers, we assume differences in the sector productivity and label one sector *productive* and the other one *unproductive.* Such productivity differences can be motivated by economies with sectoral or regional differences, where the same type of worker can be employed in either sector (agricultural vs. industrial; exporting vs. non-exporting or urban vs. rural sector). Fuchs-Schündeln and Izem (2007) corroborate this assumption by showing that East and West German workers exhibit very similar skills after German reunification. They conclude that regional productivity differences between East and West Germany are largely driven by job characteristics. Todaro (1969) makes a similar argument for developing countries. Owing to search frictions, both sectors simultaneously exist. In the competitive equilibrium, wages in the productive sector are higher than those in the unproductive sector, as in Acemoglu (2001). Hence, workers who have the chance will change jobs from the unproductive to the productive sector.[4] We assume that the government will decide to introduce a minimum wage in the unproductive sector, which is, in principle, binding for the unproductive sector and equal to or smaller than the competitive wage negotiated in the productive sector.

Our first main result is that the minimum wage only unambiguously reduces job creation and employment in the *productive* sector, whereas its employment effect on the unproductive sector is ambiguous. This result stems

[4]We do not mean to say that the unproductive sector is truly unproductive, but simply less productive (in relative terms). Following Acemoglu (2001), we could also use the phrases "good" and "bad" jobs. Another rationale for such a dual labor market structure is given by Jones (1987), who applies a shirking framework and also introduces minimum wages in the less productive sector. Whereas he finds a positive spillover to the productive sector, we will see that our model generates a negative spillover.

from the fact that a minimum wage in the unproductive sector *ceteris paribus* increases the unemployed workers' outside option, as any employment in the unproductive sector now yields a higher wage. An increasing outside option improves their bargaining position and ability to demand higher wages in the productive sector (i.e. the reservation wage increases), leaving firms less willing to hire. However, if productive job creation falls, the chances of unproductive employees to find employment in the productive sector will fall as well, and the average duration of jobs in the unproductive sector will increase. On the one hand, this may trigger more job creation, on the other, higher wage costs decrease the incentive for job creation in the unproductive sector. Ultimately, the employment effect in the unproductive sector depends on which of these effects dominates. What are the consequences of a minimum-wage-induced increase in the outside option for the productive sector? We find that even a decrease in job creation in the unproductive sector is not able to compensate for higher earnings when finding a job in the unproductive sector. Consequently, wage costs always increase and job creation unambiguously falls in the productive sector. What are the overall effects on employment? While economy-wide unemployment increases whenever job creation in the unproductive sector decreases, the effects on unemployment are ambiguous whenever job creation in the unproductive sector increases (due to more inflows from the productive sector and more outflows to the unproductive sector). This implies that a minimum wage targeting the unproductive sector in a two-sector search economy harms productive employment while its effects on unproductive employment are ambiguous. It seems especially noteworthy that even if aggregated employment rises, this is, in our model, at the cost of lower productive employment.

At first sight, this seems to worsen welfare. To analyze this issue, we follow Pissarides (2000) by taking aggregated production minus search costs as a welfare measure in order to investigate this conjecture. Our welfare measure for the two-sector search model is in the spirit of the well-known Hosios condition (Hosios, 1990), which states that social optimum is reached whenever the bargaining power of workers equals the matching elasticity. Given the labor market structure and search frictions in our model, job creation in the productive sector in a competitive equilibrium tends to be too high from a welfare point of view as individual firms in the productive sector do not take into account the effects of their vacancy posting on social costs, i.e. rising aggregate search costs. This even holds when the bargaining power of workers equals the matching elasticity. Hence, the imposition of higher wage costs in the productive sector (via the introduction of a minimum wage in the unproductive sector) may improve welfare as aggregate search costs fall due to a lower job creation rate in the productive sector. Still, a minimum wage by itself will not be able to generate a first-best outcome, since it can only insure *ceteris paribus* optimal job creation either in the productive or unproductive sector. In the equilibrium with a minimum wage, there will be – compared to the Hosios conditions applicable in our framework – still too (little) much job creation in the (un)productive sector because of suboptimal (superoptimal) wage costs in the (un)productive sector whenever the minimum wage is chosen according to the optimality condition in the unproductive (productive) sector because of the spillover effects. Hence, in such a model with search frictions and the existence of a minimum wage, the first-best outcome can only be reached by either additionally subsidizing unproductive labor or taxing productive work, depending on whether the minimum wage is chosen such as it yields optimal job creation in the productive or unproductive sector *ceteris paribus*.

The contribution of our paper is twofold. First, we are to the best of our knowledge the first to document a minimum-wage-induced spillover effect in a matching framework. We show that minimum wages may have negative employment repercussions on sectors that are not targeted by minimum wages. Three other recent studies also stress the importance of spillover effects. Lechthaler and Snower (2008) show that minimum wages may discourage firms from adequately training low-skilled workers, potentially resulting in a "low-skill trap". Dolado et al. (2007) argue that positive spillover effects of targeted employment protection legislation reforms on non-targeted workers may be economically relevant. Finally, Falk et al. (2006) find evidence in favor of a wage spillover effect due to the introduction of a minimum wage. Second, we propose an alternative setup to augment the conventional matching framework by an additional sector, which might prove useful for other research questions.

The rest of the paper is organized as follows. Section 2 describes the basic model. Section 3 pictures the competitive equilibrium, whereas section 4 describes the equilibrium with minimum wages. In section 5, we analyze the effects of minimum wages on job creation and employment, while section 6 conducts a welfare assessment. Section 7 concludes. A mathematical appendix is added.

2 The Basic Setup

Our model is an extension of Mortensen and Pissarides (1994, 1999, 2003) in continuous time. We assume that workers are risk neutral, live infinitely, and discount the future at rate r. Worker population is normalized to one. Labor market frictions are captured by a matching function, assuming that a match between an unemployed worker and a vacancy is only realized if the joint surplus from the match exceeds the sum of the values for both parties staying unmatched. This joint surplus is then split via Nash bargaining. There is free entry of vacancies, so that in equilibrium, the value of maintaining a vacancy equals zero. Matches are subject to idiosyncratic shocks, in which case they are dissolved. Hence, the rate of job destruction is assumed to be exogenous. Since we abstract from, for instance, dismissal costs, this assumption does not qualitatively change our results (see Pissarides, 2000).

We extend the Mortensen and Pissarides (1994, 1999, 2003) framework by allowing for a two-sector economy where sectors differ in their productivity. Such productivity differences between two sectors reverting to a pool of homogenous workers can be motivated by structural differences within an economy. For instance, Fuchs-Schündeln and Izem (2007) show that skill differences between East and West German workers are negligible in contrast to differences in job characteristics. Furthermore, it is a well-established fact in the growth literature that two sectors with identical labor productivity might exhibit different total factor productivities because one sector employs labor more efficiently than the other sector.[5] Hence, workers with a priori the same productivity will be more (less) productive in relative terms if they are employed in the sector with higher (lower) productivity. This implies that workers may be (i) unemployed (labelled by U), (ii) employed in the productive sector E or (iii) employed in the unproductive sector L. Unemployment is the residual state in the sense that workers whose employment in either the productive or unproductive sector ends due to an idiosyncratic shock flow back into unemployment. We will see that, as a result of search frictions, both sectors simultaneously exist, which also implies that wages in the productive sector are higher than those in the unproductive sector. In a fully competitive labor market, the wage differential would not exist (see e.g. Acemoglu, 2001).

[5]The aim our theoretical framework is not to model these sectoral productivity differences, but to analyze potential consequences of their existence.

The labor market flows are graphically represented by Figure 1, where λ is the job destruction rate. We assume equal exogenous job destruction across sectors for simplicity without harming our results qualitatively. $\theta_j q(\theta_j)$ is the rate at which unemployed workers will find a job in sector $j = E, L$. The job finding rates result from a Cobb-Douglas matching function $M_j = v_j^{\eta} s_j^{(1-\eta)}$, where v_j is the number of vacancies in sector j, s_j the number of workers searching for a sector j job, and $0 < \eta < 1$ is the elasticity of the matching function.[6] The assumption that both sectors have exactly the same matching function is for simplicity and highlights the fact that differences in the matching matching technology are not the source of the results. Defining labor market tightness as $\theta_j = v_j/s_j$ yields $q(\theta_j) = M_j/v_j = \theta_j^{-\eta}$ as the rate at which a vacancy in j will be filled, with $q'(\theta_j) = -\eta\theta_j^{(-\eta-1)} < 0$. A searching worker will find a job in sector j at rate $\theta_j q(\theta_j) = M_j/s_j = \theta_j^{(1-\eta)}$, with $[\theta_j q(\theta_j)]' = (1-\eta)\theta_j^{-\eta} = (1-\eta)q(\theta_j) > 0$. It will become clear soon that, whenever an unemployed worker is simultaneously offered a job in the productive and the unproductive sector, he will join the productive sector as the wages paid there are higher. Further, any worker in the unproductive sector getting a job offer in the productive sector will change jobs for the same reason, while the opposite never holds. This labor market structure is similar to the modelling of two sectors by Albrecht et al. (2006). The flow equilibria are then given by equalizing flows into and out of sectors E, L and unemployment U, respectively. In the following, we describe the value functions of employers and workers in more detail and derive equilibrium. It is important to note that our results derived below do not change qualitatively once we assume job destruction rates between sectors to differ, or that the rate of finding jobs in sector E differs depending on whether searchers are in state U or L, respectively. Hence, we assume equality for mathematical simplicity.

Let V_j be the present discounted value of a vacancy in sector j and J_j that of a filled job. It is straightforward that V_j can then be expressed by the Bellman equation

$$rV_j = -k + q(\theta_j)[J_j - V_j], \tag{1}$$

[6]Petrolongo and Pissarides (2001) have shown that a Cobb-Douglas matching function is a good approximation to picture the stylized facts of labor markets. Therefore, the loss of generality assuming a Cobb-Douglas matching function can be justified by the consistency of such a function with empirical facts. Furthermore, it simplifies the analysis later on. Whereas Boersma and van Ours (1999) propose that $\eta \approx \frac{1}{2}$, Flinn (2006) finds that $\eta < \frac{1}{2}$.

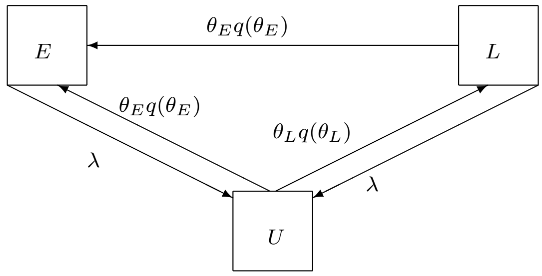

Figure 1: Labor Market Flows

where k denotes the per period search costs and

$$rJ_j = (1+\delta\gamma_j)y - w_j + \lambda[V_j - J_j] + (1-\gamma_j)\theta_E q(\theta_E)[V_L - J_L], \tag{2}$$

where w_j represents the wage payment. A vacancy costs k per period and earns $[J_j - V_j]$ at rate $q(\theta_j)$. The value of a match to an employer with productivity $(1+\delta\gamma_j)y$ is what is left once the wage is paid, $((1+\delta\gamma_j)y - w_j)$, plus the capital loss in the case the job is destroyed, $[V_j - J_j]$, which occurs at rate λ. We assume $\delta > 0$, $\gamma_E = 1$ and $\gamma_L = 0$ to capture sectors E and L within one equation. In sector L jobs, workers may additionally find employment in E, in which case the worker leaves the firm and the job is closed. That occurs at rate $\theta_E q(\theta_E)$ captured by the last term on the right-hand side of equation (2).

Further, we assume free market entry and profit maximization of firms. Then, we know that, in the steady-state equilibrium, the value of a vacancy must be zero, $V_E = V_L = 0$. This and equations (1) and (2) yield

$$J_j = \frac{(1+\delta\gamma_j)y - w_j}{r + \lambda + (1-\gamma_j)\theta_E q(\theta_E)} = \frac{k}{q(\theta_j)}. \tag{3}$$

Equation (3) states that, in equilibrium, the expected present value of a job in each sector must equal the average search costs (note that $1/q(\theta_j)$ is the average search duration for a vacancy in j).

The present discounted value of income for an unemployed worker U consists of the expected income gain when finding a job in sector L plus the expected income gain from finding a job in sector E. For simplicity, we abstract from any non-labor income. Formally, this present value can be written as

$$rU = \theta_L q(\theta_L)[W_L - U] + \theta_E q(\theta_E)[W_E - U], \tag{4}$$

where W_j is given by

$$rW_j = w_j + \lambda[U - W_j] + (1-\gamma_j)\theta_E q(\theta_E)[W_E - W_L]. \tag{5}$$

Remember that $j = L, E$, $\gamma_E = 1$ and $\gamma_L = 0$. The worker earns w_j per period and faces the capital loss $[U - W_j]$ at rate λ in the case of job destruction. Whenever a worker employed in L finds a job in E, he gains $[W_E - W_L]$ which occurs at rate $\theta_E q(\theta_E)$.

If we define e as the fraction of workers employed in sector E, l as the fraction of workers employed in sector L and u as the fraction of unemployed workers, we can calculate the steady-state equilibrium fractions as[7]

$$e = \frac{\theta_E q(\theta_E)}{\lambda + \theta_E q(\theta_E)}, \tag{6}$$

$$l = \frac{\lambda \theta_L q(\theta_L)}{[\lambda + \theta_E q(\theta_E)][\lambda + \theta_L q(\theta_L) + \theta_E q(\theta_E)]}, \tag{7}$$

and

$$u = \frac{\lambda}{\lambda + \theta_L q(\theta_L) + \theta_E q(\theta_E)}. \tag{8}$$

Note that these fractions perfectly correspond to the standard fractions in which only one sector is active. To see this, simply set $\theta_L = 0$. These fractions allow us to state that $s_L = u$ workers search for sector L jobs and $s_E = u + l = (1 - e)$ workers search for a job in sector E as those employed in sector L also look for employment in E.

3 The Competitive Equilibrium

Given the present-value functions for firms and workers, we now have to determine how the positive rent of a match is divided between the worker and the firm. Following Pissarides (2000), we assume that wages are determined by a Nash bargaining procedure where $0 \leq \beta < 1$ is the bargaining power of workers.[8] The sharing rule is then given by $\beta J_j = (1 - \beta)[W_j - U]$. Using equations (2) and (5), wages turn out to be given by

$$w_j = \beta(1 + \delta\gamma_j)y + (1 - \beta)\left\{rU - (1 - \gamma_j)\theta_E q(\theta_E)[W_E - U]\right\}. \tag{9}$$

[7]Figure 1 describes the inflow and outflow of workers into and out of the different possible situations. From there, we know that e evolves according to $\dot{e} = (1 - e - l) \cdot \theta_E q(\theta_E) + l \cdot \theta_E q(\theta_E) - e \cdot \lambda$ and l according to $\dot{l} = (1 - e - l) \cdot \theta_L q(\theta_L) - l \cdot \lambda - l \cdot \theta_E q(\theta_E)$, where the dotted variables indicate changes over time. As changes over time are zero in the steady state, we can solve the preceding equations for e and l. Bearing in mind that $u = (1 - e - l)$, because the population size is normalized to one, allows us to derive equations (6) to (8).

[8]It could be reasonable to assume bargaining power of workers to be different in both sectors, for example assuming $\phi = \beta + \epsilon \neq \beta$ to be the bargaining power of workers in sector E and β the one in L. Again, this does not alter our results qualitatively, and hence we abstract from this issue.

This states that wages must, in general, be at least as high as the outside option of being unemployed, rU, and increase with increasing bargaining power β, which determines the fraction of a match surplus obtained by the worker. Because workers employed in L have a chance of finding employment in E, firms are able to squeeze the wage payment (which sector L employees will accept according to the bargaining power represented by the last term on the right-hand-side of equation (9)). It is straightforward to see that wages for those workers employed in sector E exceed wages of those employed in L, $w_E > w_L$ because of, first, the chance of sector L employees of finding employment in sector E and, second, because of the productivity difference $\delta > 0$. Using equations (3) and (4) as well as the sharing rule from the wage bargaining procedure to eliminate rU, competitive wages turn out to be

$$w_j = \beta \left\{ (1 + \delta\gamma_j)y + k \left[\theta_L + \gamma_j \theta_E \right] \right\}. \tag{10}$$

Substituting these wages into equation (3), the equilibrium job creation conditions are given by

$$(1 - \beta)y = \beta k \theta_L + [r + \lambda + \theta_E q(\theta_E)] \frac{k}{q(\theta_L)} \tag{11}$$

as the job creation condition for sector L (hereinafter JC_L) and

$$(1 - \beta)(1 + \delta)y = \beta k [\theta_L + \theta_E] + (r + \lambda) \frac{k}{q(\theta_E)} \tag{12}$$

as the job creation condition for sector E (hereinafter JC_E). Simultaneously solving equations (11) and (12) determines the equilibrium values of market tightness in sectors L and E. Note that equations (11) and (12) both generate downward sloping curves in a θ_L/θ_E space which may cause existence and stability problems regarding the equilibrium.

Proposition 1. *There always exists a unique and stable equilibrium in which both sectors L and E are simultaneously active as long as* $\delta \geq 0$.

Proof. See Appendix A. □

Given θ_L and θ_E from solving equations (11) and (12), we are able to determine the steady-state fractions of workers employed in E, L and being unemployed, U, by equations (6), (7), and (8), respectively.

4 Equilibrium with a Minimum Wage

Assume now that there exists a government which considers wages paid in sector L "not to be fair" for whatever exogenously given reason (e.g. some not explicitly modelled election campaigns, distributional considerations, an 'equal work-equal pay' attitude, etc.) while it agrees with the wage payments in sector E. In order to correct for the "unfair" wage payments in sector L, the government imposes a minimum wage $m \in [w_L, w_E]$ to lower the wage gap.[9]

In the presence of a minimum wage, the firms' "asset pricing" function in sector L, equation (2), re-writes to

$$rJ_L^m = y - m + \lambda[V_L - J_L^m] + \theta_E q(\theta_E)[V_L - J_L^m], \tag{13}$$

where the superscript ^{m} indicates the presence of a minimum wage, while the employed sector L workers' present value of income is, referring to equation (5), represented by

$$rW_L^m = m + \lambda[U - W_L^m] + \theta_E q(\theta_E)[W_E - W_L^m]. \tag{14}$$

Note that, in principle, nothing changes for sector E firms and employed sector E workers *ceteris paribus*, because the minimum wage is assumed to be equal to or below the wage bargained there. Further, market tightness in L and E is given from the individual worker's and firm's perspective. This implies that, for given θ_L and θ_E, sector L workers gain $r[W_L^m - W_L] = m - w_L = m - \beta[y + k\theta_L]$, where we define $a = m - \beta[y + k\theta_L]$ as the mark-up on the competitive wage induced by the minimum wage, i.e. the additional payment exceeding the market wage.

As, in the presence of a binding minimum wage (i.e. $m > w_L$), workers employed in sector L attain higher wage payments, this feeds back on the utility of unemployment. The present value of income for unemployed workers in the presence of a minimum wage can thus be expressed by $rU^m = \theta_E q(\theta_E)[W_E - U^m] + \theta_L q(\theta_L)[W_L^m - U^m]$. Using the present value of income for unemployed workers in the absence of a minimum wage, equation (4), and the utility difference of being employed in sector L, $[W_L^m - W_L]$, equation (14) minus equation (5), the utility difference of unemployment can be expressed

[9]Note that we do not mean to make any judgment regarding fairness issues and are simply interested in the steady-state employment and welfare effects of imposing some sort of minimum wage in one sector of a two-sector economy exogenously.

as

$$r[U^m - U] = \frac{\theta_L q(\theta_L)}{r + \theta_L q(\theta_L)} \cdot a = \frac{\theta_L q(\theta_L)}{r + \theta_L q(\theta_L)} \cdot [m - \overbrace{\beta[y + k\theta_L]}^{=w_L}], \tag{15}$$

which is greater than zero as long as $a > 0$ (i.e. the minimum wage is binding) for given market tightness in E and L.

Hence, even though sector E is not directly influenced by the minimum wage in L, the potentially increased utility of unemployment, as represented by equation (15), generates feedback. To see this, remember how wages are bargained. We know that the wage is a fraction of the match-specific payoff (depending on the bargaining power of workers) plus the utility of unemployment. As the latter changes in the presence of a minimum wage, so does the wage bargained in sector E, which now yields $w_E^m = \beta(1+\delta)y + (1-\beta)U^m$ (see equation (9)). Using equation (15) and $rU^m = rU + r[U^m - U]$ to eliminate rU^m, we get

$$w_E^m = \beta[(1+\delta)y + k(\theta_L + \theta_E)] + (1-\beta)\frac{\theta_L q(\theta_L)}{r + \theta_L q(\theta_L)} \cdot a. \tag{16}$$

As long as there is no binding minimum wage (i.e. $a = 0$), the wage bargained in sector E is the competitive one. Using the minimum wage and $a = m - \beta[y + k\theta_L]$, we can express the job creation condition for sector L in the presence of a minimum wage (hereinafter JC_L^m) as

$$\begin{aligned} & (1-\beta)y = \beta k\theta_L^m + [r + \lambda + \theta_E^m q(\theta_E^m)]\frac{k}{q(\theta_L^m)} + a \\ \iff \quad & y - m = [r + \lambda + \theta_E^m q(\theta_E^m)]\frac{k}{q(\theta_L^m)}. \end{aligned} \tag{17}$$

Substitution of equation (16) into equation (2) gives the job creation condition for sector E in the presence of a minimum wage (hereinafter JC_E^m) as

$$\begin{aligned} & (1-\beta)(1+\delta)y = \beta k[\theta_L^m + \theta_E^m] + (r+\lambda)\frac{k}{q(\theta_E^m)} + \\ & (1-\beta)\frac{\theta_L^m q(\theta_L^m)}{r + \theta_L^m q(\theta_L^m)} \cdot a \\ \iff \quad & (1-\beta)\left[(1+\delta)y - \frac{\theta_L^m q(\theta_L^m)}{r + \theta_L^m q(\theta_L^m)}(m - \beta y)\right] = \\ & \beta k\left[\frac{r + \beta\theta_L^m q(\theta_L^m)}{r + \theta_L^m q(\theta_L^m)}\theta_L^m + \theta_E^m\right] + (r+\lambda)\frac{k}{q(\theta_E^m)}, \end{aligned} \tag{18}$$

where the superscript ^{m} on the equilibrium values indicates that this is the situation in the presence of a minimum wage. Simultaneously solving equations

(17) and (18) determines the equilibrium values for market tightness in sectors L and E in the presence of a minimum wage θ_L^m and θ_E^m. For $a = 0$ (i.e. there exists no binding minimum wage), the equilibrium boils down to the competitive equilibrium. It is furthermore a straightforward matter to show and handy to remember that, for a minimum wage equal to sector L wage payments, i.e. $m = w_L$, the equilibrium values for market tightness in sectors L and E will be the same, i.e. $\theta_L = \theta_L^m$ and $\theta_E = \theta_E^m$.[10]

Proposition 2. *There always exists a unique and stable equilibrium in which both sectors L and E are active in the presence of a minimum wage as long as* $\delta \geq 0$ *and* $y > m$.

Proof. See Appendix B. □

Again, given θ_L^m and θ_E^m from solving equations (17) and (18), we are now able to determine the fractions of workers employed in E, L and being unemployed, U, in the presence of a minimum wage m by equations (6), (7), and (8), respectively.

5 Comparing Equilibria

In order to analyze the employment effects of an increase of the minimum wage $m \in [w_L, y[$ (see Proposition 2), we totally differentiate equations (17) and (18), which yields

$$-[r + \lambda + \theta_E^m q(\theta_E^m)] \frac{\eta k}{\theta_L^m q(\theta_L^m)} d\theta_L^m - (1-\eta) k \frac{q(\theta_E^m)}{q(\theta_L^m)} d\theta_E^m = dm \tag{19}$$

and

$$\begin{aligned} - &\left(\beta k \frac{r + \beta \theta_L^m q(\theta_L^m)}{r + \theta_L^m q(\theta_L^m)} + (1-\beta)(1-\eta) \frac{a \cdot r \cdot q(\theta_L^m)}{[r + \theta_L^m q(\theta_L^m)]^2} \right) d\theta_L^m \\ - &\left((r+\lambda) \frac{\eta k}{\theta_E^m q(\theta_E^m)} + \beta k \right) d\theta_E^m = (1-\beta) \frac{\theta_L^m q(\theta_L^m)}{[r + \theta_L^m q(\theta_L^m)]} dm, \end{aligned} \tag{20}$$

respectively. We have made use of the fact that $da = dm - \beta k d\theta_L$ and the Cobb-Douglas matching function which implies $0 < \eta = -\frac{\theta_j q'(\theta_j)}{q(\theta_j)} < 1$.

From equation (19) we see that, as already indicated above, market tightness θ_L *ceteris paribus* decreases with increasing market tightness θ_E because

[10] For this to hold, the job creation conditions for sectors L and E in the absence and in the presence of a minimum wage have to be the same. After subtracting equation (11) from equation (17) and equation (12) from equation (18), we find that this is unambiguously the case for $m = \beta[y + k\theta_L] = w_L$.

a higher probability of finding a job in E for workers reduces the average duration of a job in L and, thus, reduces the incentive for job creation there. Further, a higher minimum wage m increases labor costs and, therefore, also reduces the incentive for job creation in L.

Equation (20) states that job creation in E (represented by market tightness θ_E) decreases with increasing market tightness θ_L and the minimum wage m *ceteris paribus*. This is because both increase the workers' outside option (θ_L because of the higher probability of finding a job in L and m because of higher payments whenever a job in L is found) which increases wage costs in sector E, see equation (16). This reduces the incentives for job creation.

To calculate the final effects of an increase in the minimum wage on job creation in L and E, we have to combine all these effects. In doing so, we find, after rearranging equations (19) and (20) that (calculations can be retraced in Appendix D)

$$\frac{d\theta_L^m}{dm} = \frac{(1-\eta)(1-\beta)k\frac{\theta_L^m q(\theta_E^m)}{[r+\theta_L^m q(\theta_L^m)]} - \beta k - (r+\lambda)\frac{k\eta}{\theta_E^m q(\theta_E^m)}}{|\hat{J}|} \tag{21}$$

and

$$\begin{aligned}\frac{d\theta_E^m}{dm} = \quad & -\frac{\beta[r+\beta\theta_L^m q(\theta_L^m)] + (1-\beta)\theta_L^m q(\theta_L^m)\eta}{\theta_L^m[r+\theta_L^m q(\theta_L^m)]\cdot|\hat{J}|}y \\ & +\frac{[r+\beta\theta_L^m q(\theta_L^m)] + (1-\beta)\theta_L^m q(\theta_L^m)\eta}{\theta_L^m[r+\theta_L^m q(\theta_L^m)]\cdot|\hat{J}|}m \\ & -\frac{r\left[1-(1-\beta)(1-\eta)\frac{\theta_L^m q(\theta_L^m)}{[r+\theta_L^m q(\theta_L^m)]}\right] + \beta\theta_L^m q(\theta_L^m)}{\theta_L^m[r+\theta_L^m q(\theta_L^m)]\cdot|\hat{J}|}a < 0,\end{aligned} \tag{22}$$

where $|\hat{J}| > 0$ as shown in Appendices B and C. Note that, referring to equation (22), we know that

$$0 < \frac{[r+\beta\theta_L^m q(\theta_L^m)] + (1-\beta)\theta_L^m q(\theta_L^m)\eta}{\beta[r+\beta\theta_L^m q(\theta_L^m)] + (1-\beta)\theta_L^m q(\theta_L^m)\eta} < 1, \tag{23}$$

while $\frac{y}{m} > 1$ is a necessary condition in order for both sectors to exist (see Proposition 2). Thus, from equations (21) and (22), we see that an increase in the minimum wage in sector L decreases job creation in sector E as long as $y > m$ while its effects on job creation in sector L itself are ambiguous. This implies that a minimum wage in the unproductive sector may indeed yield higher job creation in this sector compared to a situation without minimum wages (nevertheless, the opposite may also hold true). However, the minimum wage unambiguously reduces job creation in the *productive* sector which is indeed not directly influenced by it.[11] From an intuitive point of view, this may seem odd at first sight and certainly warrants some explanation.

As we already know, the increase of the minimum wage increases wage costs in L, which reduces job creation in L *ceteris paribus*. Further, it augments the workers' outside option *ceteris paribus* and thus increases labor costs in sector E which reduces the incentive for job creation in E. This reduced job creation in E decreases the likelihood that employees in L will find employment in E and thus leave sector L. Hence, the firms' discounting in sector L is decreased which *ceteris paribus* increases the incentive for job creation in L. Regarding sector E, the potential decrease in job creation in sector L, however, is not able to compensate for the increase in expected wage costs, which implies that the workers' outside option and thus wage costs in E will unambiguously increase even though sector E is not directly affected by the minimum wage. Therefore, job creation in E unambiguously falls (see equation (22)). Whether job creation in L ultimately rises or falls depends crucially on whether higher wage costs or reduced discounting dominate (see equation (21), where the first term of the denominator on the right-hand side represents the reduced discounting effect and the second term the higher wage effect).

To be more precise, let's rearrange the numerator on the right-hand side of equation (21) to find that job creation in the unproductive sector rises if

$$\underbrace{\frac{(1-\eta)k\frac{q(\theta_E)}{q(\theta_L)}}{-\beta k-(r+\lambda)\frac{k\eta}{\theta_E q(\theta_E)}}}_{=\frac{d\theta_E}{dm}_{|JC_E}} \cdot \underbrace{(1-\beta)\frac{\theta_L q(\theta_L)}{r+\theta_L q(\theta_L)}}_{=d\theta_E|_{JC_L}} > 1, \tag{24}$$

where $\frac{d\theta_E}{dm}_{|JC_E}$ indicates by how much job creation in E decreases *ceteris paribus* due to an increase in the minimum wage (see equation (20)). This has to be multiplied by how much this decrease in θ_E *ceteris paribus* affects the incentive for job creation in sector L resulting from a change in discounting, $d\theta_E|_{JC_L}$ (see equation (19)). Thus, $\frac{d\theta_E}{dm}_{|JC_E} \cdot d\theta_E|_{JC_L} > 0$ is the indirect effect of the introduction of a minimum wage for sector L on job creation in sector L (resulting from reduced job creation in E and, hence, changes in average job duration). If this indirect effect dominates the direct effect of an increase in minimum wages, i.e. $-1 \cdot dm$ (see equation (19)), job creation in L rises. Otherwise, it falls. To put it differently, *only if the reduction in the risk of*

[11] Note that equations (21) and (22) also hold true for the introduction of a minimum wage, which initially implies $a = 0$.

losing a sector L worker to sector E because of less productive job creation is high enough and, thus, sufficiently prolongs the expected duration of a sector L job, higher wage costs can be overcompensated and job creation in L can rise. Whether or not this is the case, of course, depends on the parametric specification of the model and will ultimately be an empirical question.

Our results imply that the introduction of a minimum wage unambiguously decreases employment in the productive sector E as θ_E falls (see equations (22) and (6)). If the fall in θ_E is not large enough to compensate for the higher wage payments in L (i.e. condition (24) does not hold), job creation in sector L also falls. This implies less job creation in sectors L and E, which unambiguously generates higher unemployment (see equation (8)). The effects on sector L employment are then ambiguous (see equation (7)) because, while the job finding rate in sector L for unemployed workers has fallen, the pool of unemployment has increased. On the contrary, if the reduction in θ_E is large enough to generate additional job creation in L (i.e. condition (24) holds), this unambiguously increases employment l due to higher job creation in L and less job creation in E (see equation (7)), whereas, the effects on unemployment are ambiguous (see equation (8)).

Hence, we find that a minimum wage may increase the overall level of employment. But even if overall employment rises, however, this comes at the cost of lower levels of productive and higher levels of unproductive employment.

6 Welfare Implications

The above findings, of course, make it necessary to assess some welfare implications of minimum wages in our setup. Regarding welfare, we follow Pissarides (2000) and take the present value of production (minus search costs) as a welfare measure which is given by

$$\Omega = \int_0^\infty e^{-rt}[(1+\delta)y\cdot e + y\cdot l - k\theta_L\cdot \underbrace{(1-e-l)}_{=u} - k\theta_E\cdot(1-e)]dt, \qquad (25)$$

where $(1+\delta)y\cdot e$ equals the current level of production in the productive sector, $y\cdot l$ is the current level of production in the unproductive sector, $k\theta_L(1-e-l)+k\theta_E(1-e)$ constitutes total search costs and t represents time. Wages are not taken into account separately as they only determine how current production is distributed among workers and firms. Employment e and l evolve over time according to (see also Figure 1 and footnote 7)

$$\dot{e} = \frac{de}{dt} = (1 - e)\theta_E q(\theta_E) - e \cdot \lambda \tag{26}$$

and

$$\dot{l} = \frac{dl}{dt} = (1 - e - l) \cdot \theta_L q(\theta_L) - l \cdot \lambda - l \cdot \theta_E q(\theta_E). \tag{27}$$

By maximizing equation (25) subject to (26) and (27) and some rearranging, we can describe the socially optimal values of market tightness θ_L and market tightness θ_E by the following two equations (calculations are, in principle, in perfect analogy to Pissarides, 2000, p. 189 and are therefore not repeated here).

$$(1 - \eta)y = \eta k \theta_L^* + [r + \lambda + \theta_E^* q(\theta_E^*)] \frac{k}{q(\theta_L^*)} \tag{28}$$

as the optimal job creation condition in sector L (hereinafter JC_L^*) and

$$(1-\eta)(1+\delta)y = \eta k(\theta_L^* + \theta_E^*) + (r+\lambda)\frac{k}{q(\theta_E^*)} + k\theta_L^* \frac{[r + \lambda + \theta_E^* q(\theta_E^*)]}{[\lambda + \theta_L^* q(\theta_L^*) + \theta_E^* q(\theta_E^*)]} \tag{29}$$

as the optimal job creation condition in sector E (hereinafter JC_E^*), where the superscript * indicates that these are the welfare-optimal values. Again, it can be shown in analogy to the proofs of Propositions 1 and 2 that the JC_E curve's θ_L-axis intercept is higher than the one of the JC_L^* curve as long as $\delta \geq 0$, and that the JC_E^* curve intersects the θ_E-axis while the JC_L^* curve never does. Therefore, the curves intersect. Thus, these two equations determine the socially optimal levels of market tightness θ_L^* and θ_E^*. For the competitive market to reach a first-best allocation, market tightness θ_L and θ_E, given by equations (11) and (12), have to equal market tightness θ_L^* and θ_E^*, given by equations (28) and (29). As we directly see, this will generally not be the case which implies that the competitive equilibrium is likely to be inefficient.

The result that the market equilibrium is, generally, inefficient is not new in a model with search frictions. In the standard one sector economy, the well-known Hosios condition states that matching efficiency η must equal the workers' bargaining power β in order to achieve an efficient solution (see Hosios, 1990 and Pissarides, 2000). By comparing equation (11) with equation (28) and equation (12) with equation (29), we see that this *ceteris paribus* generates an "optimal" job creation condition for sector L. However, even then, in the market equilibrium, there is still too much job creation in the productive sector E (formally captured by a different last term on the rhs of equation (29)). Correspondingly, there will be too little job creation in L in the competitive equilibrium because $d\theta_L/d\theta_E < 0$. This implies that the Hosios condition by itself (namely, $\beta = \eta$) is not sufficient to generate an efficient market outcome in a two-sector search economy.

The reason for this is as follows. Due to the productivity advantage $\delta > 0$, firms are too eager to create jobs in the productive sector from a social planner's perspective as they fail to internalize the congestion externality caused by individual vacancy posting in E. Too many vacancies, however, expand search duration and, thus, increase search costs for the entire economy. Thus, from a welfare point of view, there is a trade-off between a higher level of production (caused by the increase in the number of sector E jobs) and higher search costs (caused by the congestion externality). This even holds whenever the bargaining power of workers β coincidentally equals the matching elasticity η as implied by the standard Hosios condition. To put it differently, in the optimal equilibrium (given by equations (28) and (29)) compared to the competitive market equilibrium (given by equations (11) and (12)), the productivity loss from a decline in the number of productive jobs is compensated for by lower search costs and growth of unproductive jobs. Hence, the social planner would chose fewer productive and more unproductive jobs rather than end up in the competitive equilibrium. Therefore, the Hosios condition must be modified in a two-sector search model as labor costs in sector E are too low even when $\eta = \beta$ (see equations (28) and (29)).

This implies that a minimum wage in L, even though it is comes the cost of less productive employment, may be welfare-enhancing because it may exactly do what a social planner would do, i.e. generate higher labor costs and, thus, fewer jobs in E and – potentially – more jobs in L (i.e. if condition (24) holds). However, comparing the optimality conditions with the equilibrium conditions in the presence of a minimum wage, i.e. equation (28) with equation (17) and (29) with equation (18), we find that the social optimal solution cannot be reached by choosing a minimum wage alone. By subtracting equation (28) from equation (17), we find that the mark-up a should be chosen as to compensate for the difference between matching elasticity and bargaining power,

$$a_L^* = (\eta - \beta)[y + k\theta_L] \;\Leftrightarrow\; m = \eta[y + k\theta_L]. \tag{30}$$

The subtraction of equation (29) from equation (18), however, yields

$$a_E^* \;=\; \frac{(\eta - \beta)}{(1 - \beta)} \cdot \frac{r + \theta_L q(\theta_L)}{\theta_L q(\theta_L)}[(1 + \delta)y + k(\theta_L + \theta_E)]$$

$$+\frac{k}{q(\theta_L)} \cdot \frac{[r + \lambda + \theta_E q(\theta_E)]}{[\lambda + \theta_L q(\theta_L) + \theta_E q(\theta_E)]}[r + \theta_L q(\theta_L)],$$

which unambiguously exceeds the previous "optimal" minimum wage ($a_L^* < a_E^*$). This implies that there is no *one* minimum wage to achieve the optimal equilibrium solution. Even if the minimum wage is chosen such that one of the two optimality conditions, i.e. equations (28) or (29), holds, the other one is not fulfilled and the outcome under minimum wages will still be inefficient compared to the optimum. Nevertheless, we can basically learn three things that are important for choosing an adequate minimum wage.

First, if the bargaining power of workers falls short of the matching elasticity, i.e. $\beta < \eta$, a binding minimum wage – if accordingly chosen (i.e. $a \approx a_L^*$) – is likely to improve welfare as it may drive the equilibrium closer to the optimality condition for sector L . This result is in the spirit of findings for monopsony models or models with monopsonistic competition (and relatively few competitors on the labor demand side). Minimum wages may be welfare-improving if they are able to decrease the "abuse" of power by those who demand labor.

Second, if the bargaining power of workers exceeds the matching elasticity, i.e $\beta > \eta$, labor costs for unproductive work – already too high measured in terms of the optimality condition – will be increased further, while the condition for optimal productive work, i.e. a_E^*, can theoretically be fulfilled. In this case, however, the government must implement additional measures to compensate for the labor costs in the unproductive sector. From the perspective of these two points, a minimum wage itself only seems to make sense as long as the bargaining power of workers is small (relative to the matching elasticity). Otherwise, the introduction of a minimum wage would, according to our framework, cost productive labor (see section 5) and also decrease welfare whenever no other measures are taken by the government to compensate for this loss.

Third, to make this point very clear, a minimum wage optimally chosen for either the unproductive or productive sector (according to the two previous equations for a_L^* or a_E^*) must additionally be supplemented by either subsidizing unproductive labor (if the minimum wage is chosen to generate the optimal productive job creation condition, $a = a_E^*$) to not make labor costs for unproductive work too high, or by taxing productive labor (if the minimum wage is chosen to generate optimal job creation in the unproductive sector, $a = a_L^*$)

in order to compensate for the congestion externality caused by the fact that, from an individual perspective, it is still more attractive to create jobs in the more productive sector.

7 Conclusions

We have presented a two-sector search model that extends the matching framework of Mortensen and Pissarides (1994, 1999, 2003) and Pissarides (2000) by introducing an additional sector. The economy consists of a productive and an unproductive sector, but following a modified approach of Albrecht et al. (2006), both sectors revert to the same pool of homogeneous workers. In the competitive equilibrium, wages paid in the productive sector are higher than those paid in the unproductive sector as in Acemoglu (2001). We assume that, in order to compensate for this wage gap, the government decides to introduce a minimum wage in the unproductive sector which is smaller than (or, at most, equal to) the competitive wage bargained in the productive sector.

Our first main result is that the minimum wage unambiguously reduces job creation and employment only in the *productive* sector, while its employment effect on the unproductive sector is ambiguous. This result stems from the fact that a minimum wage in the unproductive sector *ceteris paribus* increases the unemployed workers' outside option, as any employment in the unproductive sector now yields a higher wage. An increasing outside option improves their bargaining position and ability to demand higher wages in the productive sector, leaving firms less willing to hire. However, if productive job creation falls, the chances of unproductive employees of finding employment in the productive sector will fall as well, and the average duration of jobs increases in the unproductive sector. On the one hand, this may trigger more job creation; on the other hand, however, higher wage costs decrease the incentive for job creation in the unproductive sector. Ultimately, the employment effect in the unproductive sector depends on which of these effects dominates. What are the consequences of a minimum-wage-induced increase in the outside option for the productive sector? We find that even a decrease in job creation in the unproductive sector is not able to compensate for higher earnings from a job found in the unproductive sector. Consequently, wage costs of employees always increase and job creation unambiguously falls in the productive sector. What are the overall effects on employment? While economy-wide unemployment increases whenever job creation in the unproductive sector decreases, the effects on unemployment are ambiguous whenever job creation in the unproductive sector increases (due to more inflows from the productive sector and more outflows to the unproductive sector). This implies that a minimum wage in a two-sector search economy harms productive employment, while its effects on the unproductive sector are ambiguous. It is especially noteworthy that, even if aggregated employment rises, this comes at a cost to productive employment.

At first sight, this seems to worsen welfare. However, following Pissarides (2000) and taking aggregated production minus search costs as a welfare measure, we are able to calculate an analogue to the well-known Hosios condition in the two-sector search economy. In the conventional matching model, the Hosios condition states that social optimum is reached whenever the bargaining power of workers equals the matching elasticity. We draw the following conclusions with respect to welfare from our model. A minimum wage that exceeds the competitive wage in the unproductive sector of a two-sector search economy is most likely welfare-improving if the bargaining power of workers is sufficiently low (i.e. it falls short of the matching elasticity). Nevertheless, a single minimum wage cannot yield the first-best solution because there may still be too much job creation in the productive sector (thus making search costs are high) from a welfare perspective. Hence, the government must additionally impose taxes in the productive sector to increase labor costs or, when choosing the minimum wage that makes labor costs in the productive sector sufficiently high, subsidize employment in the unproductive sector. The minimum wage alone is not able to achieve social optimum. However, all this can only be achieved at the cost of less productive employment. We would like to underline once more that these welfare implications crucially depend on the parameters on bargaining power and the matching elasticity. Policymakers that take the introduction of a minimum wage into consideration should carefully seek empirical estimates for these parameters. Flinn (2006), for example, finds that the workers' bargaining power exceeds the matching elasticity (although not by much) in the United States. Irrespective of the exact estimates, policymakers have to bear in mind that a minimum wage in the unproductive sector will unambiguously reduce employment in the productive sector.

There are, however, some limitations in the analysis presented above. The conventional monopsonistic competition assumes that, first, minimum wages create incentives for innovation or education which, in turn, increase (aggregated) productivity (see Lechthaler and Snower, 2008, as a recent example). If that were the case in our model, the incentive to reduce job creation in the unproductive sector would decline. Second, one should carefully examine the role of competitive wage setting. The above analysis is conducted for individual wage bargaining. However, we know that wage setting plays a role for labor market outcomes concerning taxation (see e.g. Sinko, 2007), employment protection and/or experience rating (see e.g. Baumann and Stähler, 2008, and Stähler, 2008). Therefore, the wage setting structure may also play a role whenever we consider a two-sector economy in which competitive wages are set by, for example, unions. We leave these issues for further research because – as simple as the model may be – the effects and results in the present paper have, to the best of our knowledge, not been analyzed before. Further, we offer an alternative way to introduce sectoral differences into matching models that may also be useful for addressing other questions.

Mathematical Appendix

A Proof of Proposition 1

From totally differentiating equation (11) we know that the JC_L curve is downward sloping in a θ_L/θ_E space and, from equation (11) itself, that, as θ_L approaches zero, θ_E approaches infinity. The JC_E curve is also downward sloping in a θ_L/θ_E space. However, for $\theta_L = 0$, there exists a positive level of θ_E beyond which θ_L would turn negative. This implies that, as long as the θ_L-axis intercept of the JC_E curve is above the one of the JC_L curve, the curves must intersect and, thus, there will exist an equilibrium. Assuming $\theta_E = 0$ for a moment and dividing the left- and right-hand sides of equations (12) by those of equation (11), we see that this yields

$$\frac{\theta_{L|JC_E}}{\theta_{L|JC_L} + (r+\lambda)\theta^{\eta}_{L|JC_L}} = (1+\delta), \tag{31}$$

where $\theta_{L|JC_E}$ is the axis intercept of the JC_E curve and $\theta_{L|JC_L}$ that of the JC_L curve, respectively. We see that as long as $\delta > 0$, i.e. as long as there is a productivity advantage in sector E as presumed, the JC_E's axis intercept must be larger than the one of the JC_L (because the right-hand side is greater one which implies that, for the left-hand side to be that, too, $\theta_{L|JC_E} > \theta_{L|JC_L}$ has to hold). Note that the same holds for $\delta = 0$.

Regarding stability, we know that the determinant of the Jacobian ($\tilde{J}$) of the system of equations (11) and (12) is given by (calculations can be retraced in Appendix C)

$$\begin{aligned} |\tilde{J}| \;\; = \;\; & \left\{[r+\lambda+\theta_E q(\theta_E)]\frac{k\eta}{\theta_L q(\theta_L)} + \beta k\right\} \cdot \left\{[r+\lambda]\frac{k\eta}{\theta_E q(\theta_E)} + \beta k\right\} \\ & -k^2\beta(1-\eta)\frac{q(\theta_E)}{q(\theta_L)}, \end{aligned} \tag{32}$$

which has, in principle, an ambiguous sign. We know, however, that both curves are monotonically falling. As the JC_E curve's θ_L-axis intercept in a θ_L/θ_E space is larger than the one of the JC_L curve, and as the JC_E curve turns negative for some positive level of θ_E, while the JC_L curve does not, the JC_E curve must be steeper than the JC_L curve in equilibrium (i.e. when both curves intersect). This implies that $|\tilde{J}| > 0$ for the equilibrium values of θ_L and θ_E (see Appendix C for more formal details). Still, the equilibrium is stable as

$$tr\,\tilde{J} = -[r+\lambda+\theta_E q(\theta_E)]\frac{k\eta}{\theta_L q(\theta_L)} - [r+\lambda]\frac{k\eta}{\theta_E q(\theta_E)} - 2\beta k < 0, \tag{33}$$

which implies that the equilibrium is a stable node. Thus, the equilibrium unambiguously exists and is unique and stable as long as $\delta \geq 0$.

B Proof of Proposition 2

From equation (17) we see that, as long as $y > m$, it is worth opening a vacancy in L. Otherwise, the minimum wage would exceed marginal worker's productivity and, thus, sector L would be destroyed (i.e $\theta_L = 0$). Hence, the maximum minimum wage for both sectors to simultaneously exist is restricted by y.

Further, as in the competitive equilibrium, the JC_L^m curve is downward sloping in an θ_L/θ_E space. θ_E approaches infinity as θ_L approaches zero (i.e. the JC_L^m curve always takes positive values). From the JC_E^m curve, equation (18), it is straightforward to see that there is a positive level of θ_E on the downward sloping JC_E^m curve for which θ_L turns negative. Again, the θ_L-axis intercept of the JC_E^m curve in a θ_L/θ_E space is above the one of the JC_L^m curve for $\delta \geq 0$. This becomes obvious by assuming $\theta_E^m = 0$ and dividing both sides of equations (18) by both sides of equation (17), which yields

$$\frac{\beta k \theta^m_{L|JC_E} + (1-\beta)\frac{\theta^{m(1-\eta)}_{L|JC_E}}{r+\theta^{m(1-\eta)}_{L|JC_E}} \cdot a}{\beta k \theta^m_{L|JC_L} + (r+\lambda)\theta^{m\eta}_{L|JC_L} + a} = (1+\delta) \geq 1. \tag{34}$$

Because $0 < \frac{\theta_L^m q(\theta_L^m)}{r+\theta_L^m q(\theta_L^m)} < 1$ and $0 < \beta < 1$, $\theta^m_{L|JC_E} > \theta^m_{L|JC_L}$ as long as $\delta \geq 0$. Hence, both curves intersect. The determinant of the Jacobian of the system of equations (17) and (18) is given by

$$\begin{aligned} |\hat{J}| \;=\; & \left\{[r+\lambda+\theta_E^m q(\theta_E^m)]\frac{\eta k}{\theta_L^m q(\theta_L^m)}\right\}\left\{[r+\lambda]\frac{k\eta}{\theta_E^m q(\theta_E^m)} + \beta k\right\} \\ & -(1-\eta)k\frac{q(\theta_E^m)}{q(\theta_L^m)}\left\{\beta k \frac{r+\beta\theta_L^m q(\theta_L^m)}{r+\theta_L^m q(\theta_L^m)}\right. \\ & \left. +(1-\beta)(1-\eta)\frac{a\cdot r\cdot q(\theta_L^m)}{[r+\theta_L^m q(\theta_L^m)]^2}\right\}, \end{aligned} \tag{35}$$

which has, in equilibrium, a positive sign ($|\hat{J}| > 0$) for the same reasons as in the competitive equilibrium (again, see Appendix C for more details). Nevertheless, the equilibrium is a stable node because

$$tr\, \hat{J} = -[r+\lambda+\theta_E^m q(\theta_E^m)]\frac{k\eta}{\theta_L^m q(\theta_L^m)} - [r+\lambda]\frac{k\eta}{\theta_E^m q(\theta_E^m)} - \beta k < 0. \tag{36}$$

C Stability of Equilibrium

Totally differentiating the equilibrium conditions of the competitive outcome, equations (11) and (12), yields

$$-\left\{[r+\lambda+\theta_E q(\theta_E)]\frac{k\eta}{\theta_L q(\theta_L)}+\beta k\right\}d\theta_L-(1-\eta)k\frac{q(\theta_E)}{q(\theta_L)}d\theta_E=-dexo \quad (37)$$

and

$$-\beta k d\theta_L-\left\{[r+\lambda]\frac{k\eta}{\theta_E q(\theta_E)}+\beta k\right\}d\theta_E=-dexo, \quad (38)$$

where use has been made of the fact that $0<\eta=-\frac{\theta_j q'(\theta_j)}{q(\theta_j)}<1$ and $dexo$ captures all the differentials in the exogenously given parameters. It is then a straightforward matter to calculate the Jacobian of the system of equations $|\tilde{J}|$ and the trace of the system of equations $tr\,\tilde{J}$ given by equations (32) and (33), respectively.

We know that $|\tilde{J}|>0$ must hold in equilibrium because, as the JC_E curve's θ_L-axis intercept is larger than the one of the JC_L curve, and because the JC_E curves turns negative for a positive level of θ_E in the θ_L/θ_E space while the JC_L curve does not, the JC_E curve must be steeper than the JC_L curve (at least until but most likely beyond the θ_E-axis intercept). We know that

$$Slope\,JC_L=\frac{d\theta_L}{d\theta_E}=-\frac{\overbrace{(1-\eta)k\frac{q(\theta_E)}{q(\theta_L)}}^{AA}}{\underbrace{\left\{[r+\lambda+\theta_E q(\theta_E)]\frac{k\eta}{\theta_L q(\theta_L)}+\beta k\right\}}_{=BB}}<0 \quad (39)$$

and

$$Slope\,JC_E=\frac{d\theta_L}{d\theta_E}=-\frac{\overbrace{\left\{[r+\lambda]\frac{k\eta}{\theta_E q(\theta_E)}+\beta k\right\}}^{=CC}}{\underbrace{\beta kd}_{=DD}}<0. \quad (40)$$

For the JC_E curve to be steeper, $-\frac{CC}{DD}<-\frac{AA}{BB}$, which implies $\frac{CC}{DD}>\frac{AA}{BB}$, must hold. Multiplying out gives $|\tilde{J}|=BB\cdot CC-AA\cdot DD>0$ (see equation (32)).

Regarding the situation with a binding minimum wage, the totally differentiated equilibrium conditions in the presence of a minimum wage, equations (17) and (18), are given by equations (19) and (20), respectively. From these equations, it is straightforward to calculate the determinant of the Jacobian of this system of equations as given in equation (35) while the corresponding trace is given by equation (36). The same formal argument regarding the slope's of the JC_L and JC_E curves can be made in order to find $|\hat{J}| > 0$. It is easy to see that the qualitative properties are the same as under the competitive equilibrium and, thus, the equilibrium is stable.

D Comparative Statics under Minimum Wages

Using equations (19) and (20), we know that, writing in matrix form and rearranging, $d\theta_L^m$ and $d\theta_E^m$ can be expressed as

$$\begin{pmatrix} d\theta_L^m \\ d\theta_E^m \end{pmatrix} = \frac{1}{|\hat{J}|} \cdot \begin{pmatrix} -\left\{[r+\lambda]\frac{k\eta}{\theta_E^m q(\theta_E^m)} + \beta k\right\} & (1-\eta)k\frac{q(\theta_E^m)}{q(\theta_L^m)} \\ \left\{\beta k \frac{r+\beta\theta_L^m q(\theta_L^m)}{r+\theta_L^m q(\theta_L^m)} + (1-\beta)(1-\eta)\frac{a\cdot r\cdot q(\theta_L^m)}{[r+\theta_L^m q(\theta_L^m)]^2}\right\} & -\left\{[r+\lambda+\theta_E^m q(\theta_E^m)]\frac{\eta k}{\theta_L^m q(\theta_L^m)}\right\} \end{pmatrix} \times$$

$$\times \begin{pmatrix} 1 \\ (1-\beta)\frac{\theta_L^m q(\theta_L^m)}{r+\theta_L^m q(\theta_L^m)} \end{pmatrix} dm,$$

where $|\hat{J}|$ is given by equation (35). Multiplying out yields equation (21) for $d\theta_L^m/dm$ and

$$\begin{aligned} \frac{d\theta_E^m}{dm} = & \left[\theta_L^m[r+\theta_L^m q(\theta_L^m)]\cdot|\hat{J}|\right]^{-1}\left[-\theta_L^m q(\theta_L^m)[r+\lambda+\theta_E^m q(\theta_E^m)](1-\beta)\frac{\eta k}{q(\theta_L^m)}\right. \\ & \left. +\beta k\theta_L^m[r+\beta\theta_L^m q(\theta_L^m)] + (1-\beta)(1-\eta)\frac{a\cdot r\cdot\theta_L^m q(\theta_L^m)}{[r+\theta_L^m q(\theta_L^m)]}\right]. \end{aligned} \tag{41}$$

We can use $m = \beta[y + k\theta_L^m] + a$ to substitute $\beta k\theta_L^m$ and equation (17) to substitute $[r+\lambda+\theta_E^m q(\theta_E^m)]\frac{k}{q(\theta_L^m)} = [y-m]$ which yields

$$\begin{aligned} \frac{d\theta_E^m}{dm} = & -\frac{(1-\beta)\theta_L^m q(\theta_L^m)\eta[y-m] + [r+\beta\theta_L^m q(\theta_L^m)][\beta y - m + a]}{\theta_L^m[r+\theta_L^m q(\theta_L^m)]\cdot|\hat{J}|} \\ & +\frac{(1-\beta)(1-\eta)\frac{a\cdot r\cdot\theta_L^m q(\theta_L^m)}{[r+\theta_L^m q(\theta_L^m)]}}{\theta_L^m[r+\theta_L^m q(\theta_L^m)]\cdot|\hat{J}|}. \end{aligned} \tag{42}$$

Rearranging gives equation (22).

References

Acemoglu, D. [2001], “Good Jobs versus Bad Jobs,” *Journal of Labor Economics*, 19, pp. 1-21.

Addison, J. T., M. L. Blackburn and C. D. Cotti [2009], “Do Minimum Wages Raise Employment? Evidence from the U.S. Retail-Trade Sector,” *Labour Economics*, forthcoming (accepted manuscript), doi: 10.1016/j.labeco.2008.12.007.

Albrecht, J. and B. Axell [1984], “An Equilibrium Model of Search Employment,” *Journal of Political Economy*, 92, 824–840.

Albrecht, J., L. Navarro and S. Vroman [2006], ”The Effects of Labor Market Policies in an Economy with an Informal Sector,” IZA Discussion Paper No. 2141, Bonn.

Baumann, F. and N. Stähler [2008], “Union Power As a Reason for Europe Not to Introduce Experience Rating?,” *Journal of Institutional and Theoretical Economics*, 164, pp. 568–585.

Bhaskar, V. and T. To [1999], “Minimum Wages for Ronald McDonald Monopsonies: A Theory of Monopsonistic Competition,” *Economic Journal*, 109, pp. 190–203.

Bhaskar, V. and T. To [2001], “Reply: Minimum Wages for Ronald McDonald Monopsonies: A Theory of Monopsonistic Competition,” mimeo.

Bhaskar, V., A. Manning and T. To [2002], “Oligopsony and Monopsonistic Competition in Labor Markets,” *Journal of Economic Perspectives*, 16, pp. 155–174.

Boal, W. and M. Ransom [1997], “Monopsony in the Labor Market,” *Journal of Economic Literature*, 35, pp. 86–112.

Broersma, L. and J. C. van Ours [1999], “Job Searchers, Job Matches and the Elasticity of Matching,” *Labour Economics*, 6, 77–93.

Burdett, K. and D. Mortensen [1998], “Wage Differentials, Employer Size, and Unemployment,” *International Economic Review*, 39, pp. 257-273.

Cahuc, P. and A. Zylberberg [2004], “Labor Economics,” MIT Press.

Card, D. and A. Krueger [1995], “Myth and Measurement: The New Economics of the Minimum Wage,” Princeton, NJ: Princeton University Press.

Dolado, J., M. Jansen and J.J. Serrano [2007], “A Positive Analysis of Targeted Employment Protection Legislation," *The B.E. Journal of Macroeconomics*, 7, Article 14.

Economist [2006], "A Lesson from Tony Blair: Germany's Labour Market," May 13, US Edition, Source: LexisNexis.

Falk, A., E. Fehr and C. Zehnder [2006], "Fairness Perceptions and Reservation Wages - The Behavioral Effects of Minimum Wage Laws," *The Quarterly Journal of Economics*, 121, 1347–1381.

Flinn, C.J. [2006], "Minimum Wage Effects on Labor Market Outcomes Under Search, Matching, and Endogenous Contact Rates," *Econometrica*, 74, 1013–1062.

FT [2008], "Germany Risks Crisis, Says Chief of Bosch," Financial Times, April 28, European Edition, Source: LexisNexis.

Fuchs-Schündeln, N. and R. Izem [2007], "Explaining the Low Labor Productivity in East Germany: A Spatial Analysis," *Working Paper*, No. 1307, Kiel Institute for World Economics, Kiel.

Hosios, A. J. [1990], "On the Efficiency of Matching and Related Models of Search Unemployment," *Review of Economic Studies*, 57, 279–298.

Ifo [2008], "Mindestlohn: Für und Wider," Ifo Schnelldienst No. 6/2008, Institut für Wirtschaftsforschung an der Universität München.

Jones, S.R.G. [1987], "Minimum Wage Legislation in a Dual Labor Market," *European Economic Review*, 31, pp. 1229–1246.

König, M. and J. Möller, [2007] "Mindestlohneffekte des Entsendegesetzes? Eine Mikrodatenanalyse für die deutsche Bauwirtschaft," IAB Discussion Paper No. 30/2007.

Lechthaler, W. and D. J. Snower [2008], "Minimum Wages and Training," *Labour Economics*, 15, pp. 1223–1237.

Manning, A. [2003], "Monopsony in Motion: Imperfect Competition in Labor Markets," Princeton University Press.

Mortensen, D.T. and C. Pissarides [1994], "Job Creation and Job Destruction in the Theory of Unemployment," *Review of Economic Studies*, 61, pp. 397–415.

Mortensen, D. T. and C. Pissarides [1999], "New Developments in Models of Search in the Labor Market," pp. 2567–2627 in: O. Ashenfelter and D. Card (eds), *Handbook of Labor Economics*, Vol. 3B, Elsevier, Amsterdam.

Mortensen, D. T. and C. Pissarides [2003], "Taxes, Subsidies, and Equilibrium Labour Market Outcomes," pp. 44–73 in: E. S. Phelps (edt), *Designing Inclusion: Tools to Raise Low-End Pay and Employment in Private Enterprise*, Cambridge University Press, Cambridge.

Neumark D. and W. Wascher [2007], "Minimum Wages and Employment," *Foundations and Trends in Microeconomics*, 3, pp. 1–182.

Petrolongo, B. and C. Pissarides [2001], "Looking into the Black Box: A Survey of the Matching Function," *Journal of Economic Literature*, 39, pp. 390–431.

Pissarides, C. [2000], "*Equilibrium Unemployment Theory*," MIT Press, second edition, Cambridge, MA.

Sinko, P. [2007], "Labour Taxation, Job Creation and Job Destruction – Focusing on the Role of Wage Setting," *International Tax and Public Finance*, 14, pp. 583–604.

Spiegel Online [2008], "Mindestlohn-Kompromiss: Scholz feiert Durchbruch für Prestigeprojekt," download: July 16, 2008.

Stähler, N. [2008], "Unemployment and Employment Protection in a Unionized Economy with Search Frictions," *Labour*, 22, pp. 271–289.

Stigler, G. [1946], "The Economics of Minimum Wage Legislation," *American Economic Review*, 36, pp. 358–265.

Todaro, M. [1969], "A Model of Labor Migration and Urban Unemployment in Less Developed Countries," *American Economic Review*, 59, pp. 138–148.

Walsh, F. [2003], "Comment on 'Minimum Wages for Ronald McDonald Monopsonies: A Theory of Monopsonistic Competition'," *Economic Journal*, 113, pp. 718–722.

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