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Collusion at the Non-Binding Minimum Wage: An Automatic Stabilizer?

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Abstract

This paper examines unemployment dynamics through the lens of a wage-posting model with two sectors and two types of workers. The model assumptions include collusion at a non-binding minimum wage, costly entry and intersectoral labor mobility. Model simulations demonstrate that collusion at a non-binding minimum wage induces entry into the low-wage sector. This dampens the overall negative employment impact of economic downturns. The excess of low-wage vacancies has shown not only to secure low unemployment rates for the low-skilled workers, but also to provide employment opportunities for the high-skilled when their industries substantially decline.

Journal of Economic Literature Classification: J30

Keywords: unemployment, search, minimum wage, collusion

1 Introduction

Performance of the US labor markets during the pre-recession decades suggests that they have enjoyed a prolonged period of noteworthy flexibility. Despite negative shocks of the dotcom bubble and the nine eleven attacks unemployment did not significantly increase, with rates not exceeding 6% (in 2003).

The eroding real minimum wage might have played a role, but this paper proposes to look beyond the traditional displacement effect of the minimum wage. In my previous research I argued that the minimum wage can become a focal point for tacit collusion if it happens to be below the perfectly competitive level. As a result, low-wage employers could enjoy extramarginal profits in the short run and we can observe above average rates of job creation in the collusive sectors in the long run. This microeconomic phenomenon may have a macroeconomic interpretation. Namely, it could be argued that abundant low-wage vacancies could play a role of an additional buffer that absorbs excess high-wage labor during economic downturns. In other words, collusion at the non-binding minimum wage by lowering wages of the low-skilled may contribute to a greater labor market stability for both the low and the high-skilled workers.

This paper takes on a search-theoretic approach to the phenomenon of collusion at the non-binding minimum wage, based on the model of Burdett and Mortensen (1998). It analyzes dynamics of unemployment, wages and mobility of workers in the two sectors. It also contrasts the equilibrium outcomes for economies without and with the minimum wage, both binding and non-binding. The use of the search model allows to examine the complex interactions between the different sectors of the economy that the micro model can not replicate.

The possibility of collusion by low-wage employers at the non-binding minimum wage can explain some puzzling empirical facts. As was mentioned, since potentially higher profits could be

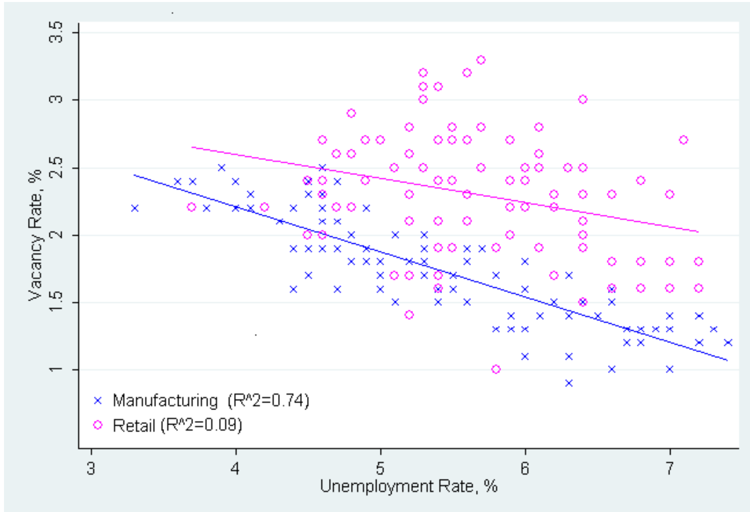


Figure 1: Unemployment and Vacancy Rates in Retail and Manufacturing Sectors, 2001-2008 (BLS: JOLTS data)

earned in collusive sectors, these sectors should experience a higher than average rate of entry and job creation. This, for example, can be illustrated with graphing of Beveridge curves in sectors that are potentially affected by collusion and sectors that are not. Figure 1 shows Beveridge curves for manufacturing and retail sectors. The latter having greater vacancy rates than the former, especially for the higher rates of unemployment. The expected inverse relationship between vacancy and unemployment rates is also significantly weaker in retail, where the minimum wage is arguably more relevant.

While one may view the availability of additional vacancies as a positive outcome of well-functioning markets, in case of collusion it is a reflection of an uneven sharing of the surplus created by the employment relationship. Moreover, as some results of this paper show, the availability of excess vacancies in the collusive sectors may lead to crowding out of ‘good’, higher paying jobs in the sectors that are not affected by collusion.

The entry and job creation driven by collusion in the low-wage sectors may also provide an

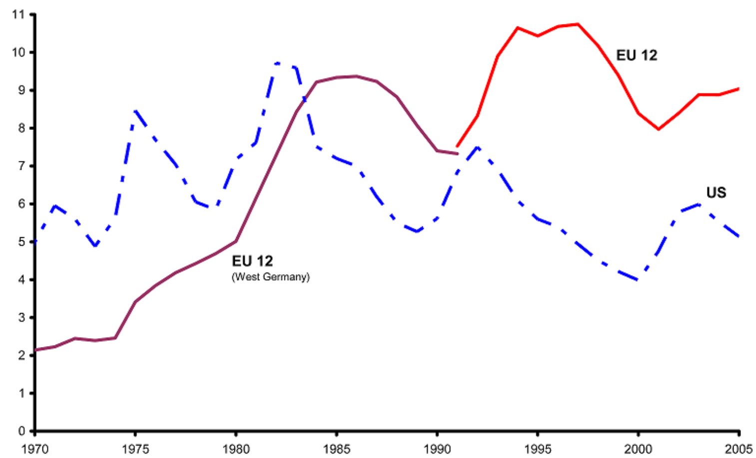


Figure 2: Unemployment Rate in Continental EU and in the US (Source: Bertola, 2006)

additional dimension to the discussion of diverging unemployment rates in the US and in Europe. Figure 2 (Bertola, 2006) reflects such a divergence in unemployment rates since mid-80s. While labor market rigidities, such as tighter firing rules and much greater degree of unionization in Europe, are the usually quoted explanations of the difference in unemployment rates, the non-binding minimum wage could also play a role. In some European countries, such as Belgium or France, the minimum wage is rather binding, contributing to greater structural unemployment. In other countries, such as in Germany, the absence of the minimum wage rules out the possibility of coordination at this focal point, resulting in higher, more competitive wages, smaller profits and smaller entry rates in the low-wage sector.

In addition to the positive effect of the collusive minimum wage on the overall job-creation and reduction in cyclical unemployment in the low-wage industries, the non-binding minimum could also mitigate the negative effects of demand shocks in the high-wage sectors. Displaced workers in these sectors may find temporary work in the low-wage sectors as a suitable alternative during economic downturns.

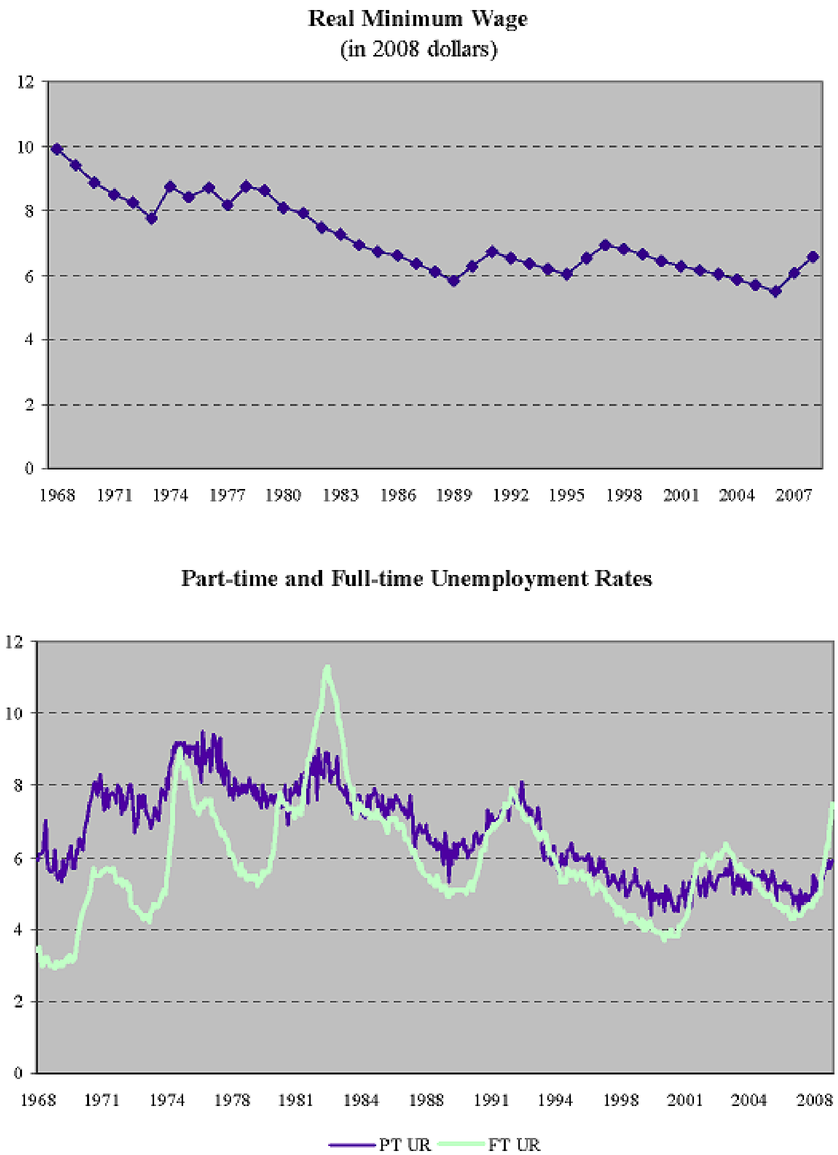


Figure 3: Real Minimum Wage and Unemployment Rates

Examine, for example, Figure 3 that depicts annual unemployment rates for the part-time (low-wage, affected by minimum wage) and the full-time (high-wage, not affected by minimum wage) workers along with real minimum wage rates in the US. While unemployment rates in the low-wage sector closely follow the pattern of the real minimum wage, it is also clear that the volatility in the full-time unemployment rate is significantly reduced when the minimum wage is low. Moreover, the relationship between the absolute value of the difference in full-time and part-time unemployment rates and the real minimum wage exhibit a strong positive correlation of 0.77[1]. This hints that the low-wage sector may be absorbing some fluctuations in unemployment in the high-wage sector.

The model built in the paper attempts to replicate the above dynamics using the framework of Burdett and Mortensen (1998). The model presented in the next section assumes wage-setting, two types of labor, high-skilled (HS) and low-skilled (LS)[2], and two types of employers, high-productivity(HP) and low-productivity(LP). The performance of the model is checked through a series of numerical simulations. Simulation results predict that unemployment rates are the lowest in economies with a non-binding minimum wage rather than in economies without the minimum wage or with the minimum wage that is binding.

2 The Model

2.1 Overview

The labor market is populated by M firms, indexed by j with a fraction v of them vacant, and N workers, indexed by i, with a fraction u of them unemployed.

[1]The correlation between part-time unemployment rate and the real minimum is estimated at 0.56, and the correlation between full-time unemployment rate and the real minimum at -0.019.

[2]Albrecht, van den Berg, and Vroman (2008) for instance consider low-skilled and medium-skilled, which could be also appropriate for our setting.

All workers are split in two types: N_1 low-skilled workers who can only be employed in the low-productivity sector and N_2 high-skilled workers, who can be employed both in the high and low-productivity sectors. In other words, low-skilled workers have limited upward mobility while high-skilled workers are perfectly mobile. Each worker supplies one unit of labor to the market inelastically and does not value leisure.

There are two types of firms, high-productivity firms that comprise the HP sector of size M_1, and low-productivity firms that comprise the LP sector of size M_2. Each firm has exactly one vacancy. Firms are heterogenous in productivity of labor[3]. The firm type and productivity is determined randomly at the time of entry. The entry occurs if the vacancy value exceeds the entry cost. The fixed pool of labor also limits the entry by restricting the overall amount of rents to be made by firms. These entry restrictions allow firms that are already in the market to earn positive profits.

In any period t a fraction $s_h(s_l)$ of existing HP(LP) worker-firm matches is exogenously destroyed. Firms become vacant and workers exit into unemployment. Unemployed workers return to the job market and search for the best wage offer that exceeds their reservation wage. High-skill workers also decide on the sector to search in, by weighting the probability of forming a match, average sectoral wages, as well as differences in the search costs in the two sectors.

While searching workers sample the wage offer distribution in a way similar to the lottery drawings, known as the 'urn-ball' matching. Every period an unemployed worker obtains wage quotes from two vacant employers [4]. After wage quotes are received, the worker applies to a firm

[3] Perhaps productivity is not the exact term that would correctly carry the meaning of labor contribution to the firm performance. An alternative term used in the literature is 'net revenue product', which reflects labor contribution that could be associated with changes in the stock of capital, as well as changes in revenue that a vacancy generates, which are not necessarily directly linked to the productivity of labor. See, for example, Bashkar and To (2003) for a more precise definition of the term.

[4] Double sampling is chosen for simplification, but can be generalized.

that offers a higher wage. While it creates an incentive for the firms to compete on wages, it also gives rise to the congestion externality – the increase in unemployment due to coordination failure, as a few applicants will apply to the same high-wage positions. The worker is not allowed to send applications in a mixed-strategy manner to both firms. If a worker receives identical wage quotes, he randomly selects one.

The search is costly for both workers and firms. Workers face a higher search cost if they look for jobs in the HP sector and smaller costs in the LP sector, which can be explained by greater accessibility of low-wage vacancy information: in food service and retail sectors, for example, a worker can learn about available vacancies during an occasional shopping trip or during lunch[5].

A vacant firm is assumed to observe the exact mix of productivities for all vacant firms and use this information for wage-setting. Vacant firms that are unable to fill the position revise offers in the subsequent period. Prior to search workers can observe average sector wages, as well as probabilities of forming a match. Though, only high-skilled workers, considering mobility, are able to utilize this information.

2.2 Collusion

Wages are determined unilaterally by firms. The ability of workers to obtain multiple wage quotes during a single search period gives a rise to wage dispersion. In this wage-posting environment the lower bound of the wage offer distribution is at worker's reservation wage, which usually allows for a gap between worker's marginal productivity and the wage rate that contributes to firms' positive profits. The existence of the gap may induce regulators to bring the lowest wage up to the productivity level by introducing minimum wage laws. This invariably reduces rents earned by

[5]Clearly, one can model the less costly search in the LP sector by assuming that a worker is able to sample more than two offers during each period. A by-product of this search routine is a greater congestion externality, and higher frictional unemployment, which is observed in the data.

all firms in the industry and forces them to look for alternative profit opportunities. One of such opportunities is colluding at the mandated minimum wage.

Collusion, as a cooperative outcome of a dynamic prisoners' dilemma game is possible when a non-cooperative outcome becomes unattractive to players facing future punishment for deviating. In my previous work (Shelkova, 2008) I provide a microeconomic explanation for the existence of the spike by suggesting that a non-binding minimum wage could become a focal point for tacit collusion by infinitely-lived low-wage employers. In the labor markets, where punishment is often delayed since firms participate in the job market for a limited time, the super-game cooperative equilibrium can be unattainable. However, firms may still seek cooperation through an alternative collusion enforcement mechanism, which makes cooperation attractive every period the firm is vacant[6]. In this paper collusion is self-enforced by market participants who agree to bear higher vacancy costs (collusion 'enforcement' costs) if they deviate from the designated collusive benchmark. In other words, collusion becomes possible due to modification of the prisoner's dilemma payoffs in which only two alternatives are available to employers – collude by offering the minimum wage, or compete by offering a higher wage.

The collusion enforcement costs can be motivated in several ways. First, since unemployed workers sort between the two observed wage quotes, minimum wage vacancies will receive the least number of applications. It means lesser costs of processing applications for colluders. Minimum wage jobs are also more likely to remain vacant the longest period of time, and workers that sampled them in the previous periods can carry this information over to the next period, such that an 'initial' firm's investment in advertising the minimum wage vacancy gets spread over the multiple periods reducing the per-period cost. Finally, minimum wage vacancies can be considered as more visible

[6]One can argue that in the low-wage labor markets high separation rates could be the enforcement mechanism that leads to the super-game type of collusion. I plan to investigate this possibility in the future.

than their higher wage counterparts, such that workers are more likely to sample them. This, in turn, forces higher wage firms to incur additional costs in order to make their vacancies as visible as their low-wage counterparts.

Search-theoretic papers that analyze the effects of the minimum wage generally categorize them into two groups. First, researchers may assume that the minimum wage is binding, i.e. it displaces the least productive employers contributing to greater unemployment. Second, researchers may assume that the minimum wage is non-binding (usually in wage-posting models), in which case it shifts the lower bound of the wage distribution upward, increasing wages, compressing the wage distribution but not affecting employment. In both cases the rents enjoyed by employers are reduced. By introducing collusion sustained due to the contemporaneous enforcement costs firms maybe able to restore profit levels enjoyed prior to the introduction of the minimum wage and even improve upon them by appropriating the share of rents previously enjoyed by workers. The minimum wage as a focal point for collusion becomes instrumental in facilitating it by providing a reference point in wage-setting.

In the environment where firms are productively heterogenous collusion at the minimum wage gives a rise to the minimum wage spike – a empirical phenomena observed in many economies with the minimum wage. Heterogeneity also allows for wage dispersion since it is likely that most productive employers will find it still optimal to deviate. However, even in the partially-cooperative outcome firms earn profits that are generally higher than otherwise received in a non-cooperative environment. The extra profits lead to entry by new firms until profits are leveled out with non-cooperative level profits. Still, since entry is usually not instantaneous, collusion remain attractive, at least in the short run.

In the paper we assume that the vacant firms can perfectly monitor the wage-setting decisions, and thus do not cheat: colluding firms face the lower probability of filling the vacancies and non-colluding firms face the higher probability of filling the vacancy but pay the enforcement costs in a disciplined manner.

2.3 Defining probabilities

The process of forming productive firm-worker match is identical in both HP and LP markets and is organized according to the so-called 'urn-ball' matching process. An unemployed worker samples wage offer distribution by being randomly matched with two vacant firms and requesting wage quotes[7]. Not all firms are necessarily being asked for a wage quote since the probability of matching is less than one as predicted by the urn-ball matching function (Butters, 1977; Burdett & Judd, 1983; Albrecht et al., 2003 & 2004, Mortensen 2003, and others). As a result, only matched firms have a chance of receiving job applications.

Each firm can be contacted by any worker. Thus, since each worker contacts and requests wage quotes from two firms the number of quotes requested from each firm should be within the range $[0, 2U]$ and is binomially distributed with the average probability of success $\frac{2U}{V}$. If V and U are large, which rules out the possibility of worker requesting two wage quotes from the same employer, and the fraction $\frac{2U}{V}$ is stable, the binomial distribution of the number of quotes received by a representative firm can be approximated by the Poisson distribution with mean $\frac{2}{\theta}$ (where $\theta = \frac{V}{U}$ is labor market tightness[8]).

Workers discriminate between the two employers by applying to a firm that offers a higher wage. Thus, firm's probability of filling a vacancy does not only depend on the probability of being sampled(defined above), but also on the value of its wage offer, which forces heterogenous employers

[7]The restriction on the number of quotes to two is not new to the literature (see Shapiro, 2004), and is done for computational simplicity.

[8]To simplify theoretical analysis we assume that U and V are large. For finite U, V see Albrecht et al. 2004.

to raise wages and results in the equilibrium wage dispersion.

If all firms follow an identical rule for wage determination, the probability of receiving an application will depend on the firm's rank $F(w)$ within the wage distribution. Thus, a single issued quote (in the environment where the worker samples two) will lead to the application with probability $F(w)$, i.e. the probability that a competing wage is lower and the worker returns to fill out the job application. Therefore, a firm that is being requested x wage quotes has the following probability of at least one worker returning to submit an application:

$$1 - (1 - F(w))^x \,.$$

Combining the probability of being sampled (the Poisson random variable) with the probability of receiving an application gives the following expression for the probability of filling a vacancy (similar to Mortensen, 2003:19):

$$\begin{gathered} p_w(\theta, F(w)) = \sum_{x=0}^{\infty} \left[1 - (1 - F(w))^x\right] \frac{\exp(-\frac{2}{\theta})(\frac{2}{\theta})^x}{x!} = \\ = 1 - \sum_{x=0}^{\infty} [1 - F(w)]^x \frac{\exp(-\frac{2}{\theta})(\frac{2}{\theta})^x}{x!} = 1 - \exp\left(-\frac{2F(w)}{\theta}\right). \end{gathered} \tag{1}$$

Now, consider a market with a fixed cluster of wage offers, such as the minimum wage spike. Denote ρ as a fraction vacancies that offers minimum wages. Let us define probability of receiving a job application by a firm offering minimum wage. As before, it is a combination of two probabilities: the probability that a firm is being sampled, and the probability that an applicant returns. The average number of wage quotes requested that defines the probability of being sampled is determined in the same way as before, though the probability of receiving an application is slightly different.

A firm that offers a minimum wage and was sampled by a worker faces the probability equal to ρ that a competitive wage quote is also a minimum wage, only in this case the firm has a positive probability of worker returning. Since a worker who obtained two identical wage quotes randomly chooses between them the firm's single quote will lead to an application with probability $\rho/2$. Then, a firm with x quotes requested has the following probability of at least one worker returning to submit an application:

$$1 - \left(1 - \frac{\rho}{2}\right)^x.$$

Combining the probability of being sampled with the probability of receiving an application results in the following probability of filling a minimum wage vacancy:

$$p_m(\theta, \rho) = \sum_{x=0}^{\infty} \left[1 - \left(1 - \frac{\rho}{2}\right)^x\right] \frac{\exp(-\frac{2}{\theta})(\frac{2}{\theta})^x}{x!} == 1 - \exp\left(-\frac{\rho}{\theta}\right). \tag{2}$$

While a firm that receives an application will form a guaranteed match, a worker who submits an application will not necessarily do so. This happens due to the congestion externality, as more than one worker can sample and apply to the same vacancy. The probability of a successful match for a representative worker is:

$$q(\overline{p}, \theta) = \min\left\{\frac{\sum_{i=1}^{V} p_w^j(\theta, F(w_j))}{U}, 1\right\} = \min\left\{\frac{\overline{p}V}{U}, 1\right\} = \min\{\overline{p}\theta, 1\}. \tag{3}$$

2.4 Firms

General Set-Up

A representative vacant firm has the following vacancy value:

$$V = \frac{1}{1+r}\left[-c + pJ + (1-p)V\right],$$

where r is the interest rate used for discounting, $p = [p_l, p_h]$ is the probability of forming a match in either LP or HP sectors. Vacant firms face vacancy cost c, which could be cost of advertising, processing applications, or actual hiring costs (e.g., costs of preparing a contract etc.). In the simulation to follow I set this cost as a fraction of firm's productivity.

A representative occupied firm has the following value:

$$J = \frac{1}{1+r}\left[y - w + sV + (1-s)J\right],$$

where y is productivity and $s = [s_l, s_h]$ is the job destruction rate in LP/HP sector.

Solving the system of equations simultaneously get the following value functions:

$$V^0 = \frac{p(y-w) - c(r+s)}{r(1+r)(r+s+p)} - \frac{C}{1+r} \tag{4}$$

$$V = \frac{p(y-w) - c(r+s)}{r(r+p+s)}, \tag{5}$$

$$J = \frac{(y-w)(p+r) - cs}{r(r+p+s)}. \tag{6}$$

A firm considering market entry assesses a life-time value of job creation:

$$V^0 = \frac{1}{1+r}[-C+V], \tag{7}$$

where C is the entry cost. In the following simulations it is also set as a multiple of firm's productivity. Potential entrants randomly draw productivity type and associated entry/vacancy costs.

Wage Determination

Employers in both sectors determine wages unilaterally (i.e. post) as in Mortensen (2003). In the paper I adopt a simplifying assumption that each unemployed worker draws two wage offers. The exception is made for one worker who who draws only one wage offer and one empty offer[9]. This assumption is necessary for establishing a lower bound of the wage offer distribution which is equal to worker common reservation wage. The wage offer distribution has no gaps – each firm in our set-up is the equivalent of the firm 'type' in Mortensen's environment, where firms of different productivity types set wages and densely populate the support, ruling out the possibility of deviation (i.e., for the equilibrium to be Nash).

When setting wage firms balance a higher probability of filling the vacancy associated with a higher wage and lower per period payoff with a lower probability of filling a vacancy associated with a lower wage and higher per period payoff. Thus, firm's wage offer (or, as in the Mortensen's, the upper support for the productivity type) is found by equating:

$$V(y_j, w_j, p(\theta, F(w_j))) = V(y_j, w_{j-1}, p(\theta, F(w_{j-1}))).$$

[9]This assumption can be modified by increasing the number of workers drawing a single wage offer to be more reflective of the environment where some workers (perhaps who are better at search) are able to observe multiple wages, while others observe one or none.

This yields the optimal wage offer rule:

$$w_j^* = y_j - \left(\frac{(y_j - w_{j-1})p_{j-1}a + c(r+s)(1-a)}{p_j} \right), \tag{8}$$

where $a = \frac{p_j+r+s}{p_{j-1}+r+s} > 1$ (since $p_j > p_{j-1}$).

Such wage-setting by heterogenous employers leads to equilibrium wage dispersion. No group of firms will offer identical wages, since deviation by an infinitesimally small amount will result in a higher payoff.

Minimum Wage and Wage-Setting in the Low-Productivity Sector

Since the lower bound of the wage offer distribution is tied to the worker reservation wage and all other wages are determined by referencing the next lower wage, the resulting wages will be below productivity. In such cases the government may decide to intervene by placing wage restrictions in the form of a minimum wage.

Suppose, government imposes a minimum wage floor $m > \underline{w}$. It is assumed that the minimum wage has different effects on high- and low-productivity sectors. In the LP sector it will become the new lower bound of the wage offer distribution, and it will also lead to a modification of firms' wage-setting behavior. Namely, it is assumed that the minimum wage becomes a convenient reference point for employer collusion. As firms are able to perfectly monitor each other's wage-setting, a deviation from the collusive wage is associated with incurring an additional search cost, the collusion enforcement costs κ. Therefore, a LP firm is placed into a binary choice mode with respect to wage-setting, with the following Bellman equations describing values of minimum wage and a higher wage vacancy:

$$V_m = \frac{1}{1+r}\left[-c + p_m J_m + (1-p_m)V_m\right],$$

if firm offers the minimum wage m, and:

$$V_w = \frac{1}{1+r}\left[-c - \kappa + p_w J_w + (1-p_w)V_w\right],$$

if firm offers a higher wage w. Probabilities of forming a match p_m and p_w are defined earlier.

The associated occupied firm's Bellman equations are:

$$J_m = \frac{1}{1+r}\left[y - m + s_l \max\{V_m, V_w\} + (1-s_l)J_m\right],$$

$$J_w = \frac{1}{1+r}\left[y - w + s_l \max\{V_m, V_w\} + (1-s_l)J_w\right].$$

Depending on the value of collusion enforcement costs and due to productive heterogeneity, some firms will find it optimal to set wages at the minimum while others will offer a higher wage. For vacant firms that post minimum wage offers the Bellman equations can be re-written in the following way:

$$rV_m = -c + p_m(J_m - V_m); \tag{9}$$

$$rJ_m = y - m + s_l(V_m - J_m). \tag{10}$$

Firms that post higher wage offers have the following Bellman equations:

$$rV_w = -c - \kappa + p_w(J_w - V_w); \tag{11}$$

$$rJ_w = y - w + s_l(V_w - J_w). \tag{12}$$

Solving the system of Bellman equations for a non-colluding firm ($V_w > V_m$), the following vacancy value is obtained:

$$V_w = \frac{(y-w)p_w - (c+\kappa)(r+s_l)}{r(p_w + r + s_l)}.$$

Similarly, firms offering minimum wages ($V_m > V_w$) have the following vacancy value:

$$V_m = \frac{(y-m)p_m - c(r+s_l)}{r(p_m + r + s_l)}.$$

Thus, a representative low-productivity firm has the following wage schedule:

$$w = \begin{cases} m & \text{if } V_m \geq V_w; \\ w^* & \text{otherwise.} \end{cases}$$

The equality of V_m and V_w determines the boundary productivity $\widehat{y}$ that splits all vacant LP firms into colluders and non-colluders.

High Productivity Firms

High-productivity firms follow the same general rule when determining wages as do low-productivity firms, however collusion does not take place in this sector. In equilibrium the least productive HP firm sets its wage at worker's common reservation wage.

Since high-productivity workers are free to choose between high- and low-skill jobs, in equilibrium wages in the two markets should be converging or equal, suggesting an implicit relationship between $(\overline{w}, q_l)$ and $(\overline{W}, q_h)$:

$$h(\overline{W}, q_h) = g(\overline{w}, q_l),$$

which is a solution to value-equalizing $U_l = U_h$ for HP workers (where q_l and q_h are worker probabilities for forming a match in low and high productivity sectors). This equality does not hold when strong demand for high-skilled workers leads to high wages, whereas low-productivity workers are unable to participate in this sector.

Entry and Exit

The model allows entry, which occurs if the value of creating a vacancy V^0 in (7)is positive, such that discounted vacancy value V equals or exceeds the cost of vacancy creation C. Potential entrants are able to observe values enjoyed by existing firms. It is anticipated that in case of a partial (or a complete) collusion vacancy values would exceed entry costs, thus inducing entry. The entry continues until the value of creating a job (V^0) for a marginal representative entrant is zero (i.e. each additional entry is associated with negative value).

Reservation entry cost for a representative firm with productivity y is (no collusion):

$$C^* = \frac{(y - w) - c(r + s)}{r(r + p + s)}. \tag{13}$$

Vacant firms exit the market if the vacancy value V becomes negative:

$$V = \frac{p(y - w) - c(r + s)}{r(r + p + s)} < 0,$$

which is the same as (13), suggesting that exit takes place when the cost of job creation is below the cost of maintaining an existing position.

Firms that are currently occupied exit only in the case value associated with the position becomes negative (since entry cost is sunk):

$$J = \frac{(y-w)(r+p) - sc}{r(r+p+c)} < 0,$$

but in case of costly entry this situation is unlikely.

2.5 Workers

High-Skilled Workers

Without loss of generality it is assumed that unemployed workers are eligible for unemployment insurance (UI) benefits b only for one time period (in the US this period is usually 6 months, extended during recessions, but is finite). When the period of eligibility ends, workers move into the pool of uninsured unemployment and receive zero benefits.

Unemployed high-skilled workers have two choices: to search for jobs in the LP job market or to participate in the HP job market. However, expiration of UI benefits for the insured unemployed, as well as differences in the search costs in the two sectors force them to evaluate the two alternatives carefully.

The Bellman equation for insured unemployed workers is:

$$U_l^b = \frac{1}{1+r}\left[-\zeta_l + b + q_l E_l + (1-q_l)\max\{U_l^n, U_h^n\}\right],$$

where U_l^b is the value of unemployment in the LP sector (superscript l); U_l^n and U_h^n are the values of uninsured unemployment in LP and HP sectors; E_l is the value of having a job in the LP sector;

q_l is the probability of forming a match in the LP sector; and ζ_l is the search cost in the LP market.

Following is the Bellman equation for a worker that receives benefits and chooses to search in the HP sector:

$$U_h^b = \frac{1}{1+r}\left[-\zeta_h + b + q_h E_h + (1-q_h)\max\{U_l^n, U_h^n\}\right],$$

where U_h^b is the value of unemployment in the HP sector (superscript h), E_h is the value of having a job in the HP sector; q_h is the probability of forming a match in the HP sector; and ζ_h is the search cost in the HP market.

Uninsured high-skilled unemployed workers do not receive unemployment benefits and characterized by the following Bellman equations:

$$U_l^n = \frac{1}{1+r}\left[-\zeta_l + q_l E_l + (1-q_l)\max\{U_l^n, U_h^n\}\right],$$

$$U_h^n = \frac{1}{1+r}\left[-\zeta_l + q_h E_h + (1-q_h)\max\{U_l^n, U_h^n\}\right].$$

When employed, high-skilled workers have the following Bellman equations:

$$E_h = \frac{1}{1+r}\left[W + s_h \max\{U_l^b, U_h^b\} + (1-s_h)E_h\right],$$

$$E_l = \frac{1}{1+r}\left[w + s_l \max\{U_l^b, U_h^b\} + (1-s_l)E_l\right],$$

where W and w are wages received in HP and LP sectors, respectively.

As mentioned, every period an unemployed high-skilled worker chooses a sector where to search for jobs. If an insured worker prefers HP sector, it implies that the value of participation in the HP market is also higher for this worker if he were uninsured ($U_h^b > U_l^b \Rightarrow U_h^n > U_l^n$). Symmetrically, if a worker prefers LP market it implies that the value of participation in the LP market is higher for this particular worker if he were uninsured ($U_l^b > U_h^b \Rightarrow U_l^n > U_h^n$). It simplifies computations by reducing the number of cases to two. Thus, for an unemployed worker who prefers high-productivity job market the Bellman equations are:

$$rU_h^b = -\zeta_h + b + q_h(E_h - U_h^n) + (1 - q_h)(U_h^n - U_h^b),$$

$$rU_h^n = -\zeta_h + q_h(E_h - U_h^n),$$

$$rE_h = W + s_h(U_h^b - E_h),$$

$$rE_l = w + s_l(U_h^b - E_l).$$

For an unemployed worker who prefers low-productivity market the Bellman equations are:

$$rU_l^b = -\zeta_l + b + q_l(E_l - U_l^b) + (1 - q_l)(U_l^n - U_l^b),$$

$$rU_l^n = -\zeta_l + q_l(E_l - U_h^n),$$

$$rE_h = W + s_h(U_l^b - E_h),$$

$$rE_l = w + s_l(U_l^b - E_l).$$

In equilibrium unemployed workers are either indifferent between the two markets or prefer the HP market: $U_h^b \geq U_l^b$ for workers who receive benefits, and $U_h^n \geq U_l^n$ for others.

Sector choice by high-skilled workers

This section outline sector choice by HS unemployed workers. Several assumptions are made with regards to this decision. Namely, it is assumed that every period workers observe: last period wage offers, vacancies and matching outcomes in both sectors. They also observe current unemployment rates.

Suppose, x is the number of HS workers choosing to search in the HP sector. Then, in combination with the equilibrium condition which states that workers are indifferent between the two sectors, the probabilities of forming a match are:

$$q_l = \overline{p_l}\frac{V_1}{U-x} \text{ \& } q_h = \overline{p_h}\frac{V_2}{x},$$

where V_1, V_2 are the number of vacancies in the two sectors, U is the total number of unemployed and $\overline{p_l}, \overline{p_h}$ are the firm's equilibrium probabilities of hiring. Note that if market conditions are favorable for HS workers and due to mobility restrictions of LS workers, in equilibrium x may exceed the actual number of HS unemployed workers. If x is below the actual number of unemployed HS workers U_h, then $U_h - x$ workers will search for the LP jobs with a fraction of those who switch $\phi = \frac{U_h - x}{U_h}$.

Offer acceptance

Another decision made by the high-skilled unemployed workers is whether to accept an extended wage offer. A reservation wage condition provides an insight into this decision.

Unemployed HS workers searching in HP sector when deciding whether to accept an offer, compare next period values of being employed and paid W to the value of being unemployed and receive no benefits. Thus, their reservation wage is found by equating $E_h = U_h^n$. For workers who search in the LP sector reservation wage solves $E_l = U_l^n$. Therefore, reservation wages W_r and w_r

for the two types of workers are:

$$W_r = -\zeta_h - b\frac{s_h}{1+r},$$

$$w_r = -\zeta_l - b\frac{s_l}{1+r}.$$

These reservation wages indicate that as long as workers do not value leisure and the search cost and the UI benefits are non-negative, they will accept any extended wage offer. Thus, the voluntary unemployment does not exist in the model environment. The unemployment can only arise as a result of search frictions or due to inadequate labor demand.

Low-Skilled Workers

Low-skill workers are restricted to participation in low-productivity job market only. Thus, their Bellman equations are:

$$U_l^b = \frac{1}{1+r}\left[-\zeta_l + b + q_l E_l + (1-q_l)U_l^n\right],$$

$$U_l^n = \frac{1}{1+r}\left[-\zeta_l + q_l E_l + (1-q_l)U_l^n\right],$$

$$E_l = \frac{1}{1+r}\left[w + s_l U_l^b + (1-s_l)E_l\right].$$

Low-skilled unemployed workers regardless of their unemployed status (insured and uninsured) accept offers that satisfy reservation wage property $U_l^n = E_l$, with reservation wage given by:

$$w_r = -\zeta_l - b\frac{s_l}{1+r}.$$

2.6 Equilibrium

The wage-posting equilibrium is a vector:

$$\{M_1, M_2, \{w_j\}_{j=1}^{M_1-V_1}, \{W_j\}_{j=1}^{M_2-V_2}, \{w_j^o\}_{j=1}^{V_1}, \{W_j^o\}_{j=1}^{V_2}, u_l, u_h, \theta_l, \theta_h, \rho^o, \rho, \phi\}$$

that consists of:

- number of HP firms M_1 and LP firms M_2;
- distribution of wages and wage offers in the LP sector $\{w_j\}_{j=1}^{M_1-V_1}$ and $\{w_j^o\}_{j=1}^{V_1}$;
- distribution of wages and wage offers in the HP sector $\{W_j\}_{j=1}^{M_2-V_2}$ and $\{W_j^o\}_{j=1}^{V_2}$;
- unemployment rates for low-skilled and high-skilled workers u_l and u_h;
- labor market tightness in the two sectors θ_l and $theta_h$;
- fraction of vacant LP firms offering minimum wage ρ^o;
- fraction of occupied LP firms paying minimum wage ρ;
- fraction of high-skilled workers who search for the LP sector jobs ϕ.

In equilibrium:

- firms set wages to maximize vacancy value;
- there is no entry or exit of firms;
- high-skilled unemployed workers either strictly prefer or are indifferent between search unemployment in HP and LP sectors, thus no intersectoral mobility takes place.

3 Numerical Experiments

This section presents a series of numerical experiments that illustrate potential effects of collusion on labor market outcomes. The goal is to compare the outcomes for the model economies with the minimum wage at different levels, as well as for the economies without the minimum wage.

3.1 The Choice of Parameter Values

The simulation period is a year. The interest rate set at a standard $r = 0.05$. Annual job destruction rates for durable manufacturing and services are chosen to proxy job destruction rates in the two sectors, equal to 11.1% and 19.7% respectively (Davis et al., 2008).

To set minimum wage levels I consult the data on real minimums in 1968-2008 (see Appendix), which varied during this period from \$5.50 to \$9.90 (in 2008 dollars, adjusted by CPI-U). In simulations the minimum wage takes on values \$6, \$8 and \$10.

To assign the number of workers to the two groups I chose to follow the division of labor force in the part- and the full-time workers. Over the past forty years an average of 78% of workers were part of the full-time labor force. In simulations, I keep the fraction of the HS workers constant at 75%.

To get the core simulation targets for wages, I consult compensation statistics for full- and part-time workers (BLS Employment Cost Index, 1993-2008). The available data reveals that the ratio of total compensation for the two types of workers is relatively stable, with full-time workers earning about 2.1 times the hourly compensation of part-timers. The stability of relative wages suggests that the movement of the labor force between the two sectors most likely occurs due to the difference in expected, not earned, wages. In other words, mobility is due to differences in probabilities of finding a job. The model probability of finding a job, in turn, depends on the labor

Table 1: Baseline Parameters

	HP/HS	LP/LS
Number of firms, $M_1\&M_2$	1,500	540
Productivity distribution, $Y_1\&Y_2$	$N(35,10)$	$N(20,10)$
Firm vacancy cost, c	$0.02Y_1$	$0.02Y_2$
Entry cost, C	$3.2Y_1$	$3.9Y_2$
Job destruction rate, $s_l\&s_h$	0.111	0.197
Number of workers, $N_1\&N_2$	1,500	500
Worker search cost, ζ	10.00	1.00
Minimum wage, m	6.00	
Enforcement cost, κ	1.00	
UI benefits, b	5.00	
Interest rate, r	0.05	

market tightness θ. Thus, the high-skilled unemployed workers will consider low-wage jobs if the number of HP vacancies has reduced. In the context of the model, firms will exit the market if the value of a vacancy or a filled position becomes negative. Several possibilities for such decrease are considered next. Apart from parameters discussed above, all other parameters of the model are chosen either arbitrarily or to reflect the statistics.

I anchor the simulations to the data for 1995. In this first benchmark economy the number of firms exactly matches the number of workers of appropriate skill level. Table 1 lists the choice of parameter values. Table 2 compares simulation results to the data for 1995. As can be seen from the table, the results match the data rather closely. There is a slight difference between simulated and actual unemployment rates, but still the unemployment of low-skilled workers exceeds the unemployment of the high-skilled, as suggested by the data.

Note that the unemployment rates that were obtained in simulations could not be directly compared to unemployment statistics, since the model unemployment actually denotes an annual probability of becoming unemployed. I obtain comparable estimates by using information on average unemployment duration, which in 1968-2008 was equal to 14.5 weeks. Thus, to obtain a 'stock' (not a 'flow', as in the model) unemployment rate I multiply the estimated annual probability of becoming unemployed by average unemployment duration (in weeks) and divide their product by 52 weeks. These converted unemployment rates are reported in the results tables.

3.2 The Experiments

The goal of the numerical experiments is to explore labor market outcomes of the economies in the downturn. A decrease in economic activity is modeled through the effects on the high productivity sector. Namely, a reduction in productivity, firm displacement due to rising entry cost and a reduction in productivity, and due to the rising job destruction rates. Simulation results are presented in Tables 3–5. The first rows of each set of simulations represent an economy without the minimum wage. Each subsequent row represents an economy with the minimum wage and collusion enforcement.

Productivity Decline in the HP Sector

The first section of Table 3 presents simulation results with declining HP-sector productivity, though with stable numbers of sector vacancies in the economy without the minimum wage. As Y_2 was allowed to decline, in order to obtain identical firm populations the cost of entry were adjusted accordingly.

Table 2: Benchmark Economy (2008 $)

	Actual, 1995	Simulation
Average Wage, FT/HS	27.47	27.78
Average Wage, PT/LS	12.69	13.14
Unemployment, FT/HS	5.48	4.56
Unemployment, PT/LS	6.05	5.64
Unemployment	5.59	4.83
Real Minimum Wage	6.00	6.00

As can be seen from the table, only substantial decline in HP productivity to an average of 20 leads to a reduction in firm count and raises unemployment rates of the high-skilled workers. Since wages in the HP sector remain higher than wages in the LP sector, as well as because separation rates are still significantly lower, high-skilled unemployed workers do not feel compelled to switch the search sector.

In this environment, where the initial numbers of vacancies are sufficient for both types of workers, economies with the minimum wage perform better. The average converted unemployment rate under various minimum wage levels is 4.9%, while the rate in the economies without the minimum average to about 5.04%.

HP Firm Displacement Due to Costly Entry

The next set of experiments illustrates a different scenario: HP firms are displaced by a reduction in productivity (from 35 to 27.5) and a simultaneous rise in entry costs. From the benchmark quantity of 1500, HP firm count declines to 1290 and 1140. (original targets of 200-drop could not be achieved precisely).

This set of simulations clearly demonstrates the willingness of HS workers to seek employment in the LP sector during economic downturns associated with shrinking of the HP sector. The fraction of HS workers who switch exceeds 11% in the economies with the minimum wage, and 17% in the economies without the minimum. However, the incentives to switch in the form of wages and probability of finding a job are not high enough to substantially reduce the unemployment rate of high-skilled workers.

Note that modeling the exit of HP firms explicitly allows to obtain the more recent unemployment pattern when the unemployment rates of full-time workers exceeded the rates of part-time

Table 3: Simulation Results (1)

	m	M_1	M_2	ρ	u	u_l	u_h	ϕ	w_l	w_h	w
Decline in HP-firm productivity											
Y_2 N (35,10)											
$C_l = 3.9$	-	540	1500	0.000	5.05	6.52	4.55	0.000	14.25	27.45	24.37
$C_h = 3.2$	6	630	1500	0.074	4.83	5.64	4.56	0.000	13.14	27.78	24.25
	8	630	1500	0.098	4.86	5.77	4.56	0.000	13.25	27.90	24.38
	10	628	1500	0.132	4.85	5.71	4.56	0.000	13.68	28.03	24.58
Y_2 N(27.5,10)											
$C_l = 3.9$	-	540	1500	0.000	5.06	6.60	4.54	0.000	14.30	20.43	19.00
$C_h = 3.8$	6	649	1500	0.079	4.85	5.61	4.59	0.000	13.13	20.80	18.94
	8	659	1500	0.105	4.82	5.65	4.55	0.000	13.39	20.94	19.12
	10	659	1500	0.140	4.84	5.59	4.59	0.000	13.75	21.05	19.29
Y_2 N(20,10)											
$C_l = 4.9$	-	515	1560	0.000	5.01	7.20	4.28	0.050	13.03	13.54	13.42
$C_h = 4.5$	6	569	1336	0.059	4.93	6.16	4.52	0.005	12.45	14.73	14.14
	8	569	1336	0.079	4.99	6.28	4.56	0.009	12.71	14.93	14.36
	10	568	1112	0.107	5.10	6.31	4.70	0.010	13.23	16.87	15.81
HP-firm displacement due to rising entry costs											
Y_2 N(27.5,10)											
$C_l = 3.9$	-	540	1500	0.000	5.06	6.60	4.54	0.000	14.30	20.43	19.00
$C_h = 3.8$	6	649	1500	0.079	4.85	5.61	4.59	0.000	13.13	20.80	18.94
	8	659	1500	0.105	4.82	5.65	4.55	0.000	13.39	20.94	19.12
	10	659	1500	0.140	4.84	5.59	4.59	0.000	13.75	21.05	19.29
Y_2 N(27.5,10)											
$C_l = 5.1$	-	524	1290	0.000	6.82	7.14	6.71	0.044	13.22	17.37	16.30
$C_h = 6.4$	6	580	1290	0.057	6.65	6.16	6.81	0.008	12.70	18.15	16.74
	8	580	1290	0.077	6.64	6.15	6.80	0.008	12.94	18.52	17.07
	10	579	1290	0.111	6.63	6.14	6.79	0.011	13.28	18.84	17.39
Y_2 N(27.5,10)											
$C_l = 7.7$	-	510	1132	0.000	8.49	8.21	8.58	0.176	11.42	15.73	14.48
$C_h = 7.9$	6	510	1140	0.022	8.44	8.00	8.59	0.112	11.45	16.87	15.33
	8	510	1140	0.031	8.44	7.94	8.60	0.113	11.85	17.36	15.79
	10	510	1140	0.054	8.43	7.94	8.59	0.112	12.29	17.86	16.27

Table 4: Simulation Results (2)

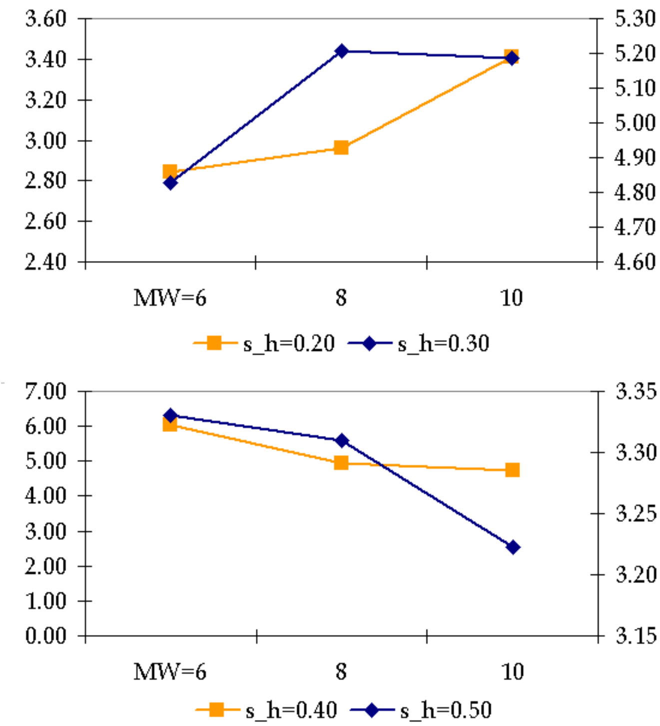
	m	M_1	M_2	ρ	u	u_l	u_h	ϕ	w_l	w_h	w
Effects of increased HP-firm job destruction rates Y_2 N (35,10), $C_l = 3.9$, $C_h = 3.2$											
$s_h = 0.111$	-	540	1500	0.000	5.05	6.52	4.55	0.000	14.25	27.45	24.37
	6	630	1500	0.074	4.83	5.64	4.56	0.000	13.14	27.78	24.25
	8	630	1500	0.098	4.86	5.77	4.56	0.000	13.25	27.90	24.38
	10	628	1500	0.132	4.85	5.71	4.56	0.000	13.68	28.03	24.58
$s_h = 0.20$	-	540	1350	0.000	8.00	6.48	8.50	0.000	14.31	27.77	24.15
	6	654	1350	0.084	7.78	5.65	8.49	0.000	13.10	28.06	23.93
	8	660	1350	0.107	7.76	5.54	8.50	0.000	13.42	28.18	24.08
	10	659	1149	0.140	8.12	5.57	8.98	0.000	13.83	30.66	25.50
$s_h = 0.30$	-	540	1126	0.000	9.42	6.54	10.38	0.000	14.34	31.83	26.13
	6	660	1125	0.087	9.16	5.54	10.37	0.000	12.85	32.07	25.62
	8	660	912	0.112	9.46	5.56	10.76	0.000	13.09	32.51	25.17
	10	660	902	0.151	9.53	5.64	10.82	0.000	13.46	32.70	25.40
$s_h = 0.40$	-	540	902	0.000	10.37	6.58	11.64	0.003	14.23	33.15	25.67
	6	654	902	0.084	10.15	5.63	11.66	0.000	12.95	33.39	25.15
	8	856	685	0.099	9.09	5.37	10.33	0.080	13.17	33.36	22.37
	10	869	678	0.128	8.96	5.40	10.15	0.095	13.50	33.55	22.35
$s_h = 0.50$	-	1248	327	0.000	7.64	4.97	8.54	0.504	14.48	34.75	17.97
	6	1399	327	0.057	6.98	4.48	7.81	0.424	13.53	34.90	17.29
	8	1407	327	0.072	6.95	4.46	7.77	0.429	13.67	35.11	17.38
	10	1407	327	0.098	6.85	4.44	7.66	0.434	13.94	35.24	17.64

workers during recession. In each case the overall unemployment is lower in the economies with the minimum wage, mainly due to a reduction is LS unemployment.

Increases in the HP Job Destruction Rates

Modeling deteriorating economic conditions through an increase in job destruction rates produces results that are, perhaps, the closest to the data. The job destruction rate in the HP sector is raised from the initial 0.111 to 0.2, 0.3, 0.4 and 0.5. Such high rates of destruction maybe associated with structural changes (see Davis et al. 2008 for a review of job destruction annual rates in different industries).

Figure 4: Difference Between HS and LS Unemployment Rates



Simulation outcomes are presented in Table 4. Higher job destruction rates in the HP sector displace high-productivity firms and significantly raise unemployment in this sector. Wages, however, do not drop significantly in the low-productivity sector and even mildly increase in the high-productivity sector. This outcome is consistent with the empirical observation of 'sticky wages'.

As results demonstrate, unless job destruction rates in the HP sector are significantly higher than the rates in the LP sector, HS workers do not consider switching sectors. For example, at $s_h = 0.40$ and $m = 10$, 9.5% of HS workers search for LP jobs. However, raising the rate to 0.50 induces as many as 40% of workers consider the switch.

Higher job destruction rates that are, perhaps, associated with increased job insecurity force employers to raise wages, which by reducing vacancy values induces the exit. Low-productivity sector firms benefit from such displacement – they now enjoy a significantly larger pool of workers and higher matching rates. This induces the entry into the LP sector. Related to the above, for large values of job destruction (at $s_h = 0.50$ in my case) overall unemployment rates actually drop to 6.98/7.64% from the highs of 10.15/10.37% (under $s_h = 0.40$), for the economies with ($6) and without the minimum wage.

Note that the economies with high job destruction rates but without the minimum wage are worse off in terms of the employment outcomes. Their unemployment rates are almost always above the rates in the economies with collusive minimum wages. Additionally, as you can see from the Table 4, when destruction rates are sufficiently high, the unemployment rate of high-skill workers begins to decline as the minimum wage becomes more binding.

The results of this set of simulations have also shown that the gap between the HS and LS unemployment rates can be higher when the minimum wage is more binding and the HP job destruction rates are only mildly increased (see Figure 4). This resonates with the empirical observation of converging unemployment rates of the part- and full-time workers discussed in the introduction.

Collusion Enforcement

In addition to the 'slack economic conditions' scenarios, labor market outcomes under different collusion enforcement regimes are also considered. In the above simulations the enforcement costs were set at one. Table 5 displays simulation results with higher enforcement costs.

Greater enforcement lead to higher levels of collusion by low-wage employers (results on ρ). Though the effect on the overall unemployment is non-linear (higher unemployment under medium enforcement costs $\kappa = 2$), unemployment rates in the economies with collusive minimum wages are always lower. Unemployment of the low-skilled workers is the lowest under the highest minimum

Table 5: Simulation Results (3)

	m	M_1	M_2	ρ	u	u_l	u_h	ϕ	w_l	w_h	w
					$Y_2N(27.5, 10)$, $C_l = 5.1$, $C_h = 6.4$						
$\kappa = 1$	-	524	1290	0.000	6.82	7.14	6.71	0.044	13.22	17.37	16.30
	6	580	1290	0.057	6.65	6.16	6.81	0.008	12.70	18.15	16.74
	8	580	1290	0.077	6.64	6.15	6.80	0.008	12.94	18.52	17.07
	10	579	1290	0.111	6.63	6.14	6.79	0.011	13.28	18.84	17.39
$\kappa = 2$	-	660	1194	0.000	6.97	6.44	7.15	0.193	13.42	17.20	15.97
	6	732	1194	0.129	6.97	5.68	7.40	0.083	11.62	17.32	15.55
	8	757	1194	0.161	6.86	5.62	7.28	0.095	12.00	17.70	15.90
	10	757	1194	0.202	6.80	5.64	7.18	0.105	12.51	18.16	16.34
$\kappa = 3$	-	660	1200	0.000	6.86	6.42	7.01	0.186	13.44	17.22	16.00
	6	783	1245	0.321	6.81	5.36	7.29	0.034	9.70	17.44	15.31
	8	783	1249	0.386	6.79	5.44	7.24	0.034	10.37	17.81	15.78
	10	783	1249	0.461	6.73	5.41	7.17	0.039	11.35	18.19	16.29

wage and strongest collusion enforcement.

Interestingly, under each enforcement cost value unemployment level drops as the minimum wage becomes more binding. This suggests that by carefully ‘managing’ the enforcement and minimum wage levels one can achieve an ‘acceptable’ level of utility for workers.

Varying Unemployment Insurance Benefits

The last series of simulation outlines the effects of different UI benefit levels on unemployment of two types of workers. The results are presented in Table 6. Two scenarios are considered. The first describes an economy with lower HP-firm productivity (mean of 27.5) and normal level of job destruction ($s_h = 0.111$). The second describes an economy with normal productivity (mean of 35) and increased job destruction ($s_h = 0.40$).

For the first model economy the lowest unemployment benefits (b=1) translate into the lowest unemployment for LS workers. Medium size benefits reduce vacancy values for LP firms, which exit the market. As benefits rise even higher, the inflow of HP workers reignites entry into the LP market, which actually improves the outcomes for the low-skilled. HS workers, in turn, enjoy the lowest unemployment under medium size benefits. Minimum wages seems to benefit this model economy with reduced productivity in the HP sector, though the effect propagates mainly through job creation in the LP sector.

For the second model economy, the medium benefits translate into the highest unemployment rates, both for the economy with the minimum and without. Minimum wages seem to benefit this model economy with an increased job destruction rates both in the HP and the LP sectors.

This set of simulations illustrates the importance of understanding the nature of a recession. In case of major structural shifts that are associated with high job destruction rates in high-productivity sectors, the benefits can be either high or low, with large fraction of high-skill workers seeking temporary employment in the low-productivity sector. If the recession is driven by a temporary reduction in demand that leads to a lower marginal revenue product, simulations suggest that the smaller UI benefits might be a more appropriate solution.

4 Conclusion

The aim of this paper was to investigate employment trends of economies with a minimum wage that serves as a reference point for collusion, and in particular to study the possibility of reduction in unemployment rates during economic downturns. It was shown that collusive minimum wages could mitigate negative shocks affecting the high-productivity sectors. There are two avenues for such mitigation, first is the overall increased job creation due to collusion in the low-productivity sector, and second is the additional job creation due to switching of high-skilled workers to the low-productivity sector.

Thus, the model results showed that unemployment rates are lower in the economies with

Table 6: Simulation Results (4)

	m	M_1	M_2	ρ	u	u_l	u_h	ϕ	w_l	w_h	w
$s_h = 0.111$, $Y_2N(27.5, 10)$,$C_l = 5.1$, $C_h = 6.4$											
b=1	-	660	1217	0.000	6.79	6.37	6.93	0.166	13.72	17.37	16.21
	6	660	1218	0.047	6.91	6.05	7.19	0.093	12.91	17.63	16.21
	8	660	1218	0.061	6.92	6.12	7.19	0.095	13.10	17.91	16.46
	10	660	1218	0.084	6.88	6.09	7.14	0.098	13.39	18.25	16.78
b=5	-	524	1290	0.000	6.82	7.14	6.71	0.044	13.22	17.37	16.30
	6	580	1290	0.057	6.65	6.16	6.81	0.008	12.70	18.15	16.74
	8	580	1290	0.077	6.64	6.15	6.80	0.008	12.94	18.52	17.07
	10	579	1290	0.111	6.63	6.14	6.79	0.011	13.28	18.84	17.39
b=10	-	689	1182	0.000	6.94	6.41	7.12	0.224	13.44	17.31	16.01
	6	689	1193	0.038	6.89	6.17	7.12	0.145	12.78	17.74	16.14
	8	689	1193	0.051	6.87	6.11	7.12	0.144	12.95	18.02	16.38
	10	689	1193	0.070	6.91	6.18	7.15	0.149	13.29	18.34	16.70
$s_h = 0.40$, $Y_2N(35, 10)$, $C_l = 3.9$, $C_h = 3.2$											
b=1	-	849	499	0.000	7.32	4.12	8.39	0.253	14.30	32.94	20.80
	6	906	499	0.060	7.14	3.75	8.27	0.196	13.60	33.08	20.65
	8	920	499	0.074	7.08	3.76	8.19	0.205	13.76	33.24	20.73
	10	920	499	0.097	7.03	3.77	8.12	0.210	13.98	33.42	20.87
b=5	-	540	902	0.000	10.37	6.58	11.64	0.003	14.23	33.15	25.67
	6	654	902	0.084	10.15	5.63	11.66	0.000	12.95	33.39	25.15
	8	856	685	0.099	9.09	5.37	10.33	0.080	13.17	33.36	22.37
	10	869	678	0.128	8.96	5.40	10.15	0.095	13.50	33.55	22.35
b=10	-	862	499	0.000	7.43	4.22	8.50	0.244	14.28	32.81	20.73
	6	958	499	0.062	7.43	4.12	8.53	0.194	13.46	32.96	20.34
	8	966	499	0.075	7.34	4.08	8.42	0.204	13.64	33.12	20.41
	10	966	499	0.094	7.28	4.08	8.35	0.214	13.89	33.29	20.57

collusive minimum wage as opposed to economies without the minimum wage, as well as in the economies where the minimum wage is more binding.

The model has also produced experimental evidence that is consistent with neoclassical predictions. Namely, that the higher minimum wage leads to greater unemployment, though the model assumptions were very far from classical, including assumptions of wage-posting and collusion. In a way, the paper warns an empirical researcher who might conclude that the wages are determined in the competitive market place where minimum wage binds.

Overall, the constructed model could be helpful in understanding both employment and wage dynamics in the markets where collusion is possible. For economies, where the goal of full and stable employment is emphasized, the collusive minimum wage can provide an additional stabilizing effect during economic downturns. This, however, is achieved at the expense of lower earnings. A policy-maker should also consider the effects that a temporary relocation of the educated workforce to the low-wage sectors, beneficial in the short run, has on the human capital of these workers. If the human capital deteriorates and the upward mobility of the high-skilled workers is reduced, the temporarily created low-wage jobs may become permanent, leading to a change in industrial structure of the economy in the long run.

References

Albrecht, J., Tan, S., Gautier, P., & Vroman, S. (2004). Matching with Multiple Applications Revisited. *Economics Letters*, *84*, 311–314.

Albrecht, J., van den Berg, G., & Vroman, S. (2008). The Aggregate Labor Market Effects of the Swedish Knowledge Lift Program. Working paper 2008-1, IFAU.

Bashkar, V., & To, T. (2003). Oligopsony and the distribution of wages. *European Economic Review*, *47*, 371–399.

Bertola, G. (2006). *The Economics of the European Union* (3 edition)., chap. Europe's Unemployment Problems. Oxford University Press.

Burdett, K., & Mortensen, D. (1998). Wage Differentials, Employer Size and Unemployment. *International Economic Review*, *39*(2), 257–273.

Butters, G. (1977). Equilibirum Distribution of Sales and Advertising Prices. *The Review of Economic Studies*, *44*(3), 465–491.

Davis, S., Faberman, J., Haltiwanger, J., Jarmin, R., & Miranda, J. (2008). Business Volatility, Job Destruction and Unemployment. *NBER WP 14300*.

Mortensen, D. (2003). *Wage Dispersion.* MIT: Zeuthen Lecture Book Series.

Shapiro, J. (2004). Income Taxation in a Frictional Labor Market. *Journal of Public Economics*, *88*, 465–479.

Shelkova, N. (2008). Low-Wage Labor Markets and the Power of Suggestion. University of Connecticut, Working Paper 2008-33.

Appendix: Real Minimum Wage, Unemployment and Hourly Compensation

	Real MW, 2008 $	UR	FT UR	PT UR	% FT LF	Comp. FT	Comp. PT
1968	9.90	3.56	3.13	6.03	0.83		
1969	9.40	3.49	3.12	5.74	0.82		
1970	8.87	4.98	4.63	6.92	0.81		
1971	8.51	5.95	5.61	7.81	0.79		
1972	8.24	5.60	5.19	7.69	0.80		
1973	7.75	4.86	4.43	7.19	0.80		
1974	8.73	5.64	5.23	7.72	0.79	Not avail.	
1975	8.40	8.48	8.37	9.00	0.76		
1976	8.70	7.70	7.48	8.83	0.77		
1977	8.17	7.05	6.73	8.58	0.77		
1978	8.75	6.07	5.68	7.93	0.78		
1979	8.60	5.85	5.47	7.72	0.79		
1980	8.10	7.18	7.09	7.56	0.77		
1981	7.93	7.62	7.56	7.94	0.77		
1982	7.47	9.71	9.98	8.47	0.74		
1983	7.24	9.60	9.91	8.15	0.74		
1984	6.94	7.51	7.56	7.43	0.76		
1985	6.71	7.19	7.13	7.54	0.77		
1986	6.58	7.00	6.91	7.43	0.77		
1987	6.35	6.18	6.03	6.90	0.78		
1988	6.10	5.49	5.32	6.36	0.78		
1989	5.82	5.26	5.07	6.18	0.79		
1990	6.26	5.62	5.45	6.36	0.78		
1991	6.72	6.85	6.81	6.98	0.77		
1992	6.52	7.49	7.51	7.49	0.76		
1993	6.33	6.91	6.86	7.18	0.77	27.63	13.41
1994	6.17	6.10	6.11	5.98	0.76	28.01	12.78
1995	6.00	5.59	5.48	6.05	0.77	27.47	12.69
1996	6.52	5.41	5.30	5.84	0.77	27.46	12.61
1997	6.91	4.94	4.82	5.47	0.78	27.32	12.88
1998	6.80	4.50	4.34	5.27	0.79	27.67	13.22
1999	6.66	4.22	4.07	4.95	0.79	27.85	13.18
2000	6.44	3.97	3.83	4.78	0.80	28.28	13.44
2001	6.26	4.74	4.68	5.10	0.79	28.64	14.17
2002	6.16	5.78	5.89	5.23	0.78	29.75	14.60
2003	6.03	5.99	6.11	5.47	0.77	30.12	14.62
2004	5.87	5.54	5.56	5.30	0.78	30.68	14.55
2005	5.68	5.08	5.01	5.41	0.78	30.67	14.60
2006	5.50	4.62	4.53	5.08	0.79	30.88	14.68
2007	6.07	4.63	4.55	4.92	0.79	30.75	15.00
2008	6.55	5.81	5.87	5.52	0.78	30.65	14.98