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A Cross-Country Comparison of the Minimum Wage

by

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תקציר

השוואה בין-לאומית של שכר המינימום

מאמר זה משווה את אפקטיביות שכר המינימום במדינות שונות בעזרת מודל של חיפוש בשיווי משקל. שכר מינימום מוגדר כאפקטיבי אם הוא גבוה **משכר הסף** – השכר הנמוך ביותר שתמורתו עובדים מוכנים לעבוד גם בהעדר שכר מינימום – או גבוה מערך התפוקה של העובדים בחלק מהפירמות במשק, כך שאכיפתו תביא לסגירתן; במקרה האחרון, שכר הסף החדש יכול להיקבע מעל לשכר המינימום. שכר מינימום אפקטיבי משנה אפוא את שיווי המשקל בשוק העבודה.

המאמר מראה שהשוואות אמפיריות של שכר המינימום, המבוססות של שיעורו יחסית לממוצע, לשכר החציוני או לתפוקה לעובד, וכן שיטות המבוססות על ניתוח התפלגות השכר בפועל, כגון אמידת שיעורם של העובדים המשתכרים שכר זה, אינן תקפות, ועלולות להוביל למסקנות מוטעות. זאת משום שרמה גבוהה של שכר המינימום יחסית לשכר הממוצע או החציוני אינה מעידה בהכרח ששכר המינימום אכן אפקטיבי; גם אם שיעור המועסקים בשכר המינימום נמוך, לא ניתן לקבוע כי הוא אינו אפקטיבי, משום שייתכן כי הביא לסגירתן של פירמות שהתפוקה לעובד הייתה נמוכה. מכאן ששיטה אמפירית טהורה, כלומר שיטה הנסמכת על ניתוח נתונים בלבד, אינה יכולה לקבוע חד-משמעית אם שכר המינימום הוא אפקטיבי; רק ניתוח באמצעות מודל כלכלי יכול לספק תשובה על שאלה זו.

שכר הסף של העובדים מחושב בעזרת כיול של מודל חיפוש, המביא בחשבון הטרוגניות של עובדים ופירמות, במספר מדינות אירופיות ובארצות-הברית. הכיול מבוסס על מאמר שאמד את הפרמטרים המבניים של מודל החיפוש למדינות אלו באותה שיטה, ובאמצעות בסיסי נתונים דומים, וכן על התאמת מאפייני התעסוקה של עובדים מיומנים ולא מיומנים במודל לאלו הנצפים בפועל.

מתברר שתוצאות השוואה המבוססת על עקרון האפקטיביות, בעזרת מודל, הן אכן תוצאות שונות מתוצאותיהן של השוואות אמפיריות. לדוגמה: בהולנד שכר המינימום גבוה יחסית לתפוקה של עובדים לא-מיומנים, אך כיוון ששכר הסף של העובדים גבוה עוד יותר – בין השאר, עקב תשלומי העברה גבוהים למובטלים – הוא אינו אפקטיבי. לעומת זאת בארצות הברית, שבה שכר המינימום יחסית לשכר הממוצע הוא הנמוך ביותר בין כל מדינות ההשוואה, נמצא כי שכר המינימום אפקטיבי מאוד, וזאת משום ששכר הסף של העובדים הלא-מיומנים בארצות הברית נמוך ממנו במידה ניכרת, כתוצאה ממדיניות של תשלומי העברה נמוכים למובטלים, אך גם מפני הקצב הגבוה של הצעות העבודה למועסקים בארצות הברית, אשר דומה ואף גבוה מקצב ההצעות למובטלים. שכר המינימום שם, על אף האפקטיביות שלו, נמוך בהרבה מהתפוקה של העובדים הלא-מיומנים, כך שניתן להעלות אותו במידה משמעותית ללא השפעה שלילית על התעסוקה. בצרפת נמצא ששכר המינימום משפיע ישירות על צד הייצור.

המסקנה העיקרית מדוגמאות אלו היא שאת מדיניות שכר המינימום לא ניתן להעריך כשלעצמה, אלא בהקשר רחב יותר, המביא בחשבון את מאפייני שוק העבודה ואת מדיניות תשלומי ההעברה למובטלים.

אמנם לא ניתן לערוך השוואה תקפה של ישראל למדינות אחרות, בשל מגבלת נתונים, אך ניתן ליישם את העקרונות המוצגים בעבודה גם להערכת המדיניות הרצויה של שכר המינימום בישראל.

A Cross-Country Comparison of the Minimum Wage

Amit Friedman

Abstract

This paper compares the minimum wage in different countries and evaluates its effectiveness by using a calibrated equilibrium labor search model. The main result is that the conclusions from comparisons and tests, which are based on empirical grounds, are sometimes reversed when examined within the model. I show, that under reasonable assumptions, the minimum wage in the U.S., which is low, and therefore perceived to be ineffective, is in fact more effective than the one in some European countries. The minimum wage in the U.S. is above the reservation wage of low-skilled workers, yet, it is substantially lower than labor productivity; I find that adopting the recent proposal to raise the Federal minimum wage by 40 percent will reduce the monopsonistic power of firms without having an adverse effect on employment of low-skilled workers.

1 Introduction

This paper compares the minimum wage levels in five countries: the U.S., the U.K., France, Germany and the Netherlands. The comparison is based on the notion of *effectiveness*, that is, the extent to which the minimum wage affects labor market outcomes. The methodology is to calibrate an equilibrium labor search model with heterogenous workers and firms, and to compare the *reservation wage,* that is, the lowest wage offer workers accept, to the minimum wage. An effective minimum wage is either higher than the reservation wage, or higher than some of the possible employer-employee match values in the economy.

There are three main methods that are used in the literature in order to conduct cross-country comparisons of the minimum wage and to evaluate its effectiveness. The first is based on macroeconomic aggregates such as the Kaitz index - the ratio of the minimum wage, weighted for its coverage, to the average wage (Cahuc and Zylberberg (2005)). The second is based on individuals' wage data, as recorded in cross-sections or panels: the percentage of employees who are paid the minimum wage (Dolado et al. (1996)), or spikes in the empirical wage density function at the minimum wage or its neighborhood are used to measure the pressure it applies on the wage distribution; the absence of such spikes is interpreted as evidence for an ineffective minimum wage, while a compressed wage density near the minimum wage is interpreted as evidence for its effectiveness (DiNardo et al. (1996)).The third approach utilizes changes in the minimum wage to identify its effect on labor market outcomes (Card and Krueger (1995)).

I argue that from the perspective of labor search theory, all the empirical methods described above are insufficient, in the sense that they are unable to determine if the minimum wage is effective. The first method does not take into account that the minimum wage may be effective even if it is relatively low, because the reservation wage is even lower. The second method does not take into account that the minimum wage can be effective even if is below observed wages, because it affected the production function directly, while a compressed density near the minimum wage can be caused by the reservation wage or by the distribution of labor productivity. The third method does not take into account the possibility of multiple equilibria in the labor market, which prevent the identification of a minimum wage change, as proved formally by van den Berg (2003). The case of multiplicity suggests that the minimum wage effectiveness can not be assessed even by designed experiments.

I use an on-the-job equilibrium labor search model of the Burdett-Mortensen (1998) type, which is extended for heterogeneous firms, (van den Berg (2003)), and extend it for heterogeneous workers, in order to

conduct a cross country comparison which is based on labor search theory. Equilibrium labor search models are natural candidates for analyzing policies such as the minimum wage, because as general equilibrium models they are not subjected to the Lucas critique as argued by Eckstein and van den Berg (2003). In addition, because labor search theory suggests that the entire wage distribution lies bellow the marginal product of labor, they can replicate the well-known phenomenon - a minimum wage raise may result in actual wage raise for some workers, without any adverse effects on employment, a stylized fact that standard competitive labor theory is unable to match, at least without modifications. The model is calibrated based on data for the early 90's, but the results are still relevant today for most countries, because the minimum wage policy has not changed drastically since then, with the exception of the U.K., where the minimum wage had been abolished and was re-introduced in the late 90's.

The main result is that the conclusions from standard comparisons, which are based on empirical grounds, are sometimes reversed when analyzed with an equilibrium search model. For example, I show, that under reasonable assumptions, the minimum wage in the US, which is relatively low, is more effective than the one in some European countries. This conclusion is in contradiction with the common conclusion in the literature as presented in Cahuc and Zylberberg (2005), who conclude that it is set higher, and plays a more important role in Europe, based on the Kaitz index and the percentage of minimum wage earners.

The minimum wage in the U.S. is very effective because it is much higher than the reservation wage of low-skilled workers. If this is the case, the minimum wage is expected to compress the "counter-factual" wage density function and create a spike around the minimum wage, a prediction which is in line with the empirical wage density function, even when corrected for other factors that may shift it (see DiNardo et.al (1996)).

The minimum wage in the U.S. is, however, substantially lower than labor productivity; this finding supports the view that a moderate minimum wage raise will raise actual wages without having adverse effects on employment, and highlights the minimum wage importance in reducing wage inequality in the U.S.. The estimated reduction of the monopsonostic power of firms due to the minimum wage law is 20 to 25 percent; I find that adopting the recent call made by more than 650 top economists[1], including five winners of the Nobel Prize for economics, to raise the Federal minimum wage from 5.15 $ to 7.25 $ per hour, will

[1] In the Economic Policy Institute on 11.10.2006 (quoted from Santa Cruz Sentinel / Associated Press).

reduce the monopsonistic power of firms on low-skilled workers by 50 to 60 percent, without any adverse consequences for employment.

In European countries the minimum wage was found to be lower than the reservation wage. In France and in the Netherlands, however, the results are not conclusive; the minimum wage is very close to the reservation wage on one hand, and its level relative to labor productivity is high on the other. Especially in France, it is possible that the total labor cost of a minimum wage worker is higher than the value of match between low skilled workers and low productivity firms, given the high tax wedge there. If this is the case, the minimum wage is expected to affect the production function directly, without creating a spike in the wage density function, a prediction which is in-line with the empirical wage density function in France (see Abowd et .al (1999)). In Germany, the minimum wage was found to be ineffective at all.

The analysis has some implications for economic efficiency. I find that in an economy with imperfections, the fact that low productivity firms survive in equilibrium and employ a substantial fraction of the workforce is a major source for output loss. This loss, which is caused by the imperfect information workers receive on job offers on-the-job, is on par with the overrated loss due to unemployment. The U.S. and the Netherlands were found to be the most efficient economies in terms of total output loss due to labor market frictions.

2 The model

The model is an extended version of the basic wage posting model by Burdett and Mortensen (1998). It is an on-the job search model with high and low productivity firms, and high and low skill workers. The value of a firm-worker match is given by the interaction of the firm productivity level and the worker's skill level. In the model, firms offer wages, and workers, both unemployed and on-the-job, get wage offers randomly at the rate which is a structural parameter of the economy. Firms make "take it or leave it" offers to workers; there is no bargaining.

This basic framework is extended for exogenous worker heterogeneity, as in Bowlus and Eckstein (2002), and firm heterogeneity, as in van den Berg (2003). The result is a "2 by 2" model with high and low-productivity firms and high and low-skilled workers. The workers' skill level is fully observed by firms, so firm offers are conditional on worker type. The model is detailed in Friedman (2005).

2.1 Firms and workers

There are high and low productivity firms p_h and p_l, and skilled and unskilled workers, e_h and e_l. The share of high skilled workers and their

relative skill level (e_h/e_l), as well as the share of high productivity firms and their relative technological level (p_h/p_l), are exogenous.

The value of the employer-employee match is a function of the skill level of the worker and the technological level of the firm, as in Postel-Vinay and Robin (2002), and is given by:

$$m_{i,j} = f(e_i, p_j) = e_i * p_j \tag{1}$$

Skilled and unskilled workers, when unemployed, receive job offers that are drawn randomly from a conditional wage distribution $F_i(w)$, at rates λ_h^0 and λ_l^0, respectively, and at rates λ_h^1 and λ_l^1 when employed. These rates are a function of the number of active firms in the market. A common, constant, exogenous separation rate δ returns the workers to unemployment. In this setting, the optimal behavior of workers is given by a reservation wage when unemployed, while employed workers accept wage offers that are higher than their current wage. Unemployed workers benefits are equal to b.

The skill level is assumed to be observed by firms, hence, firms wage offers are conditioned on the skill level of the worker they meet and the job market is separable.

2.2 Equilibria

The model is solved by applying the BM equilibrium definition:

Equilibrium: for each sector , that is for skilled and unskilled workers, an equilibrium is characterized by a triplet which is composed of a wage offer distribution, a reservation wage, and a firm profit-flow, $(F_i(w_i), \phi_i, \Pi^j)$ such that the following conditions hold:

1. The system is at steady state;

2. The reservation wage is optimal, that is, it maximizes workers' utility function;

3. Firms with the same productivity level make equal profits.

The optimal behavior of workers is to accept a job offer when unemployed if the offered wage is above a reservation wage. The optimal reservation wage is different in equilibria A and B due to the differences in the wage offer distribution function $F_i(w_i)$, however, in both cases the reservation wage has the general form of:

$$\phi_i = b_i + (\lambda_i^0 - \lambda_i^1) \int_{\phi_i}^{w_i^{\max}} \frac{1 - F_i(w_i)}{\delta + \lambda_i^1 (1 - F_i(w_i))} dw_i \tag{2}$$

where $F_i(w_i)$ is the endogenous wage offer distribution, which depends on the equilibrium type. Thus, the reservation wage equals un-

employment benefits plus the option value of labor search.

It can be shown that the reservation wage is increasing in λ_i^0 and decreasing in λ_i^1. In addition, as the value of the integral is positive, we can see immediately that the reservation wage is higher than the benefits (b_i) in case $\lambda_i^0 > \lambda_i^1$, and the reservation wage is lower than outside benefits if $\lambda_i^0 > \lambda_i^1$; In case $\lambda_i^0 = \lambda_i^1$ The option value is zero as the worker receives job offers when unemployed at the same rate as when employed. These cases show that in order to assess whether the minimum wage is "effective" the relative levels of the minimum wage and outside benefits are necessary but insufficient, and it is necessary to take into account labor market frictions.

There are several candidate equilibria in each sector, that is, in the low skilled and high skilled sectors. Van den Berg (2003) solved this problem and presented the analytical conditions for each type of equilibrium to hold. I apply his solution, which holds for identical workers, separately for each sector. The equilibrium is determined by the vector of structural parameters $(\lambda_h^0, \lambda_l^0, \lambda_h^1, \lambda_l^1, \delta, b, e_l, e_h, p_l, p_h)$.

A. High productivity as well as low productivity firms are active if $\phi_i \leq m_{il}$.

The wage offer distribution for low productivity firms is

$$F_{il}(w) = \frac{\delta + \lambda_i^1}{\lambda_i^1}\left(1 - \sqrt{\frac{m_{il} - w_i}{m_{il} - \phi_i}}\right) \qquad w_i \in \left[\phi_i, \overline{w_i^l}\right] \tag{3}$$

where $F_{il}(\overline{w_{il}}) = 1 - q$ and for high tech firms,

$$F_i^h(w) = \frac{\delta + \lambda_i^1}{\lambda_i^1}\left(1 - \frac{\delta + \lambda_i^1 q}{\delta + \lambda_i^1}\sqrt{\frac{m_i^h - w_i}{m_i^h - \phi_i}}\right) \qquad w_i \in \left[\overline{w_i^l}, \widehat{w}_i\right] \tag{4}$$

where $F_{il}(\widehat{w}_i) = 1$. By substituting these in (2) the explicit solution for the reservation wage becomes:

$$\phi_i = \frac{(\delta + \lambda_1)^2 b + (\lambda_0 - \lambda_1)\lambda_1 (c m_{il} + (1 - c) m_{ih})}{(\delta + \lambda_1)^2 + (\lambda_0 - \lambda_1)\lambda_1} \tag{5}$$

where $c = \left[(\delta + \lambda_i^1)q / \left(\delta + \lambda_i^1 q\right)\right]^2$,and the explicit condition for equilibrium A, in terns of the structural parameters is given by:

$$\left(\left(\lambda_i^0 - \lambda_i^1\right)\lambda_i^1 (m_{ih} - m_{il})\right) c \leq \left(\delta + \lambda_i^1\right)^2 (m_{il} - b) \tag{6}$$

.

B. Only high productivity firms are active if $\phi_i > m_{il}$. In this case, the wage offer distribution is given by the standard BM (1998) model:

$$F_i^h(w_i) = \frac{\delta + \lambda_i^1}{\lambda_i^1}\left(1 - \sqrt{\frac{m_i^h - w_i}{m_i^h - \phi_i}}\right) \tag{7}$$

by substituting in (2) the explicit solution for the reservation wage becomes:

$$\phi_i = \frac{(\delta + \lambda_1)^2 b + (\lambda_0 - \lambda_1)\lambda_1 m_{ih}}{(\delta + \lambda_1)^2 + (\lambda_0 - \lambda_1)\lambda_1} \tag{8}$$

and the explicit condition for equilibrium B, in terms of the structural parameters is given by:

$$\left(\lambda_i^0 - \lambda_i^1\right)\lambda_i^1(m_{ih} - m_{il}) > \left(\delta + \lambda_i^1\right)^2 (m_{il} - b) \tag{9}$$

C. Multiplicity, where both types of equilibria can be realized in case both conditions hold.

D. A "no-trade" equilibrium: high productivity as well as low productivity firms are inactive.

Note that unlike competitive labor-markets, where low productivity firms can not survive in equilibrium, in noncompetitive labor-markets, under some conditions, low productivity firms are able to survive; The ability of low productivity firms to "survive" in equilibrium depends on the amount of labor market frictions, on the technological differences, and on the presence of institutional arrangements such as the minimum wage.

2.3 The Minimum Wage

The minimum wage does not appear directly in the model. The effectiveness of the minimum can be assessed by comparing it to equilibrium properties. An "effective" minimum wage is defined below:

Definition 1 *The minimum wage is effective in case it is higher than the reservation wage $\phi_i < MW$, or it is higher than the value of a possible employer-employee match $m_{i,j} < MW$.*

Because the reservation wage is endogenous, it can be higher than the minimum wage in the last case. As a consequence, increasing the minimum wage may result in a higher reservation wage. Thus, although there is no bargaining in the wage setting process, the effect on wages is equivalent to higher bargaining power.

"Effectiveness" means that labor market outcomes would have changed if the minimum wage had not been implemented; However, abolishing

the minimum wage without a noticeable change in labor market outcomes does not imply that the minimum wage was ineffective, because the minimum wage can "select" the equilibrium type in case of multiplicity (see VDB (2003)). For this reason, the minimum wage can be effective even in case we do not observe workers who earn the minimum wage.

This definition ignores the tax wedge. In case such a wedge exists, the (net)minimum wage is effective in case it is higher than the net reservation wage, and in case $m_{i,j} < MW(1+\tau)$ where τ stands for the total income tax wedge (income tax, payroll tax, social security etc.).

2.4 Labor market facts

In order to calibrate the model, we need to divide the labor market between high and low-skilled workers. I use the upper secondary education level as a dividing line between low skilled and high skilled workers. Thus, workers with post secondary- non tertiary education (OECD definitions: level 6, ISCED level 4) or higher are classified as high skilled workers. Table 1 presents the labor market facts according to this division.

Table 1: Labor market facts
1992 Data. Source: OECD, Education at a Glance and authors' calculations

	US	UK	DE	FR	NL
1. High skilled share (%)	35.7	22.6	26.2	19.6	26.2
2. Relative wage (%)	69.2	84.5	44.5	54.1	48.4
3. High skilled unemployment (%)	3.3	3.5	4.1	4.5	3.9
4. Low skilled unemployment (%)	8.4	9.7	6.9	9.8	6.2
5. High skilled participation (%)	88.0	87.7	88.3	87.8	85.5
6. Low skilled participation (%)	75.2	75.1	72.2	72.9	65.5

The first line in table 1 shows that the definition of high skilled workers is parsimonious: most workers under this definition are low-skilled. The second line presents the relative wage of high skilled workers compared to low-skilled; The next two lines present the unemployment rate for each worker type: the unemployment rate of high skilled workers is about half than the one for low-skill workers. In a job search model, this implies that either the job offer rate for low skilled is much lower, or the return to unemployment rate of these workers is much higher.

2.5 Calibration

I calibrate the model for five economies - U.S., U.K., Germany, France and the Netherlands. The labor market structural parameters are based

on an empirical cross-country comparison by Ridder and van den Berg (2003), who used data for 1990-1991. The main advantage of using their results is that they applied the same methodology, which is based on aggregate data, for each country, thus, the structural parameter values they estimated are comparable. These values hold for homogeneous workers and firms, while the model presented here assumes worker and firm heterogeneity. Hence, additional identifying assumptions are needed in order to account for worker and firm heterogeneity. In order to do so, I use the below set of identifying assumptions:

1. The separation rate δ is equal for both types
2. The unemployment benefit b is equal for both types
3. I calibrate λ_l^0 and λ_h^0 such that the unemployment rate, of each type, equals the observed rate. This is done by using the steady state condition for unemployment:

$$u_i = \frac{\delta}{\delta + \lambda_i^0} \tag{10}$$

4. The proportion of the rates of receiving on-the-job new wage-offers λ_l^1 and λ_h^1 equals the proportion of receiving offers while unemployed, and the average rate in the population equals the estimates of Ridder and Van Den Berg (2003)[2]. The last four lines in table 2 present the job offer rates for each worker type, based on the identifying assumptions above.

Table 2: Structural labor market parameters
1991 data. Source: Ridder and Van Den Berg (2003) and authors' calculations

Parameter description		US	UK	DE	FR	NL
1. Job offer rate for unemployed	λ_0	0.47	0.15	0.10	0.09	0.13
2. Job offer rate on-the-job	λ_1	0.61	0.12	0.03	0.04	0.07
3. Return to unemployment rate	$\delta(*10)$	0.30	0.09	0.04	0.08	0.07
4. Relative unemployment benefits	$\frac{b}{p}$	0.27	0.32	0.36	0.44	0.48
5. Relative minimum wage	$\frac{MW}{P}$	0.35	0.39	0.38	0.63	0.57
6. Job offer rate for unemployed	λ_0^l	0.34	0.11	0.05	0.07	0.11
7. Job offer rate on-the-job	λ_1^l	0.38	0.08	0.02	0.03	0.06
8. Job offer rate for unemployed	λ_0^h	0.91	0.34	0.08	0.17	0.49
9. Job offer rate on-the-job	λ_1^h	1.02	0.24	0.04	0.07	0.09

Table 2 shows that labor market in the U.S. is very different from

[2]In case that high skilled and low skilled workers receive offers in different rates, the mean rate of job offers is given by the weighted average of rates in the population. Note however that the number of job offers in the population is not distributed exponentially (Amari and Misra (1997)).

European labor markets. Specifically, the parameter estimates mean that:

1. Flows in the US are 5-20 fold higher than Europe.

2. In European countries, the job offer rate for unemployed is about double than the rate on-the-job. Only in the US $\lambda_1 > \lambda_0$. This result implies that the reservation wage in the U.S. is lower than outside benefits, as the option value of job search increases when the worker is employed. In addition, it immediately follows that the minimum wage in the U.S. was effective, since it is higher than unemployment benefits. In European countries unemployment benefits are lower than the minimum wage, and the relative level of the minimum wage is higher, but since $\lambda_1 < \lambda_0$, it is not clear if it is effective. In order to answer this we have to solve for the reservation wage.

In order to complete the calibration, I search for quadruples $(e_l, e_{h,} p_l, p_h)$, so that the relative wage in equilibrium equals the observed relative wage in each economy, and the average worker productivity relative to unemployment benefits is in line with the observed one (the inverse of line 4 in table 2). The staedy-state conditions on flows imply that actual wage CDF $G(w)$ is given by:

$$G(w)\left(\delta + \lambda^1 (1 - F(w))\right) = F(w)\delta \tag{11}$$

hence, the empirical (observed) wage distribution, in case equilibrium A is realized, is given by:

$$G_i(w) = \frac{\delta}{\lambda_i^1}\left(\sqrt{\frac{m_{il} - \phi_i}{m_{il} - w_i}} - 1\right) \qquad w_i \in \left[\phi_i, \overline{w_i^l}\right] \tag{12}$$

$$G_i(w) = \frac{\delta}{\lambda_i^1}\left(\frac{1 + \lambda_i^1/\delta}{1 + q\lambda_i^1/\delta}\sqrt{\frac{m_{ih} - \overline{w_i}}{m_{ih} - w_i}} - 1\right) \qquad w_i \in \left[\overline{w_i^l}, \overline{w_i^h}\right] \tag{13}$$

These allow to solve explicitly the expected wage $E(G_i(w))$, which is geven by:

$$E(G_i(w)) = \frac{\delta}{\delta + \lambda^1}\phi_i + \frac{\lambda_1}{\delta + \lambda^1}\left((cm_{il} + (1-c)m_{ih})\right)$$

In case equilibrium B is realized, the empirical (observed) wage distribution is given by:

$$G_i(w_i) = \frac{\delta F_i(w_i)}{\delta + \lambda_i^1 (1 - F_i(w_i))} \tag{14}$$

and $E(G_i(w))$ is given by:

$$E\left(G_i(w)\right) = \frac{\delta}{\delta + \lambda^1}\phi_i + \frac{\lambda_1}{\delta + \lambda^1}\left(m_{ih}\right) \tag{15}$$

Specifically, I normalize $(e_l = 1, p_l = 1)$ and check firm technological advantage (p_h/p_l) within the range 10 to 100 percent. Higher values are "uninteresting" in the sense that low technology firms can not survive, given the structural parameters. In addition, I check the result for different compositions of firms (q): from 10 percent low productivity firms to 90 percent. For each set of parameters, the relative skill (e_h/e_l) is set such that the relative wage in equilibrium equals the observed wage.

3 Results

The simulation results, based on different parameter values, are presented in Tables 3-6. The main results are that the minimum wage in the U.S. is probably much more effective than meets the eye; the U.S. economy is the most efficient and France the most inefficient in terms of output loss due to labor market frictions. Below, I summarize the results concerning minimum wage effectiveness, economic efficiency, monopsonistic power. In the next sunsection I derive some policy implications.

The minimum wage effectiveness. The minimum wage in the U.S. is very effective: in all simulations the minimum wage is substantially higher than the reservation wage. This is a result of a combination of low unemployment benefits and a unique information structure. The information structure in the U.S. implies that the option value of search while unemployed is *negative.* The negative option value reduces the reservation wage below unemployment benefits, so the reservation wage of both low-skilled and high skilled workers is much lower than the minimum wage [3]. Note that for all parameter values $\phi_l < MW_{US} < m_{ll}$, therefore, it should compress the "counterfactual" wage density function and create a spike around the minimum wage. This prediction is in line with the findings of DiNardo, Fortin and Lemieux (1996), who found the such a spike actually exists[4]. For all parameter values, the minimum wage was substantially lower than m_{ll}, and this means that it did not affect production directly. This finding supports the view that a moder-

[3]Note that theoretically, the reservation wage can be zero or even negative. The fact that workers agree to participate in on-the-job trainings without getting paid can be interpreted as a zero reservation wage.

[4]They found that the minimum wage effect was still evident at 1988, after a decade of wage freeze policy by the Reagan administration eroded it in real terms by 32 percent. The minimum wage was raised in 1990 and 1991, by 10 percent in real terms. The spike is higher for women, especially for high-school dropouts with 20 years or less of experience, and they show that it is caused by the minimum wage, and not by other factors.

ate minimum wage raise will raise actual wages without having adverse effects on employment.

In European countries, for all parameter values, the minimum wage was found to be lower than the reservation wage. This result holds for all equilibrium types, including the multiple equilibria case which is common in European countries. However in France, the minimum wage is very close to the reservation wage, thus, it might be effective, given the high tax wedge there (see the subsection on the tax wedge). Yet, the empirical wage distribution in France does not present such a clear-cut spike near the minimum wage (see Aboud et. al. (1999)), and this implies that even if it is effective it probably affects production directly: as the total labor costs to the firm when employing a minimum wage worker are higher than his productivity.

In Germany, where the minimum wage is substantially lower than the reservation wage of low skilled workers, the minimum wage is very ineffective. The main reason is that unemployment benefits in Germany are very high relative to the minimum wage; in addition, the option value of labor search is positive, so the reservation wage is higher than the minimum wage for all parameter values that were checked.

A note on taxation. The model ignores the different tax wedge among the five countries. Generally, the existence of a tax wedge changes equilibrium outcomes; A positive tax rate reduces offered wages throughout the job offer distribution, thus the reservation wage is also lower[5].The tax wedge in France was substantially higher than in other countries. The ratio of total cost of compensation to the total wage bill was: US: 1.23, UK: 1.15, DE: 1.22, NL: 1.16 and FR: 1.39[6]. The total tax wedge in France was about 65 percent[7]. This high tax wedge means that the minimum wage in France was probably effective.

To conclude, the effectiveness of the minimum wage in the U.S. is probably higher than in other countries, although its level relative to the average productivity is the lowest among all 5 countries[8].

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[5]The exact solution for a job search model with a linear tax rate is left to future work.

[6]Source: National accounts of OECD countries, Main aggregates, 2005 (1992 data).

[7]The statutory monthly (gross) minimum wage was 5459 FF (net wage of 4548 FF). The monthly total compensation cost, including payroll taxes, was 7528 FF (see Aboud et. al. (1999), 1991 data, appendix A.).

[8]This finding is closely related to Flinns' (2002) who showed that wage inequality in the U.S., which is perceived to be high, is not actually higher than wage inequality in Italy, when measured by the wage offer distribution which is estimated by an equilibrium search model.

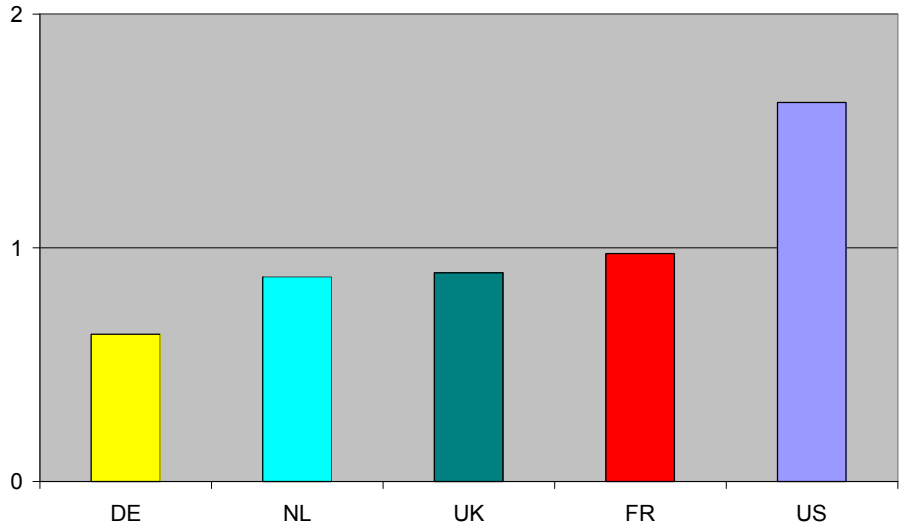

Figure 1: Minimum wage effectiveness: minimum wage to reservation wage of low-skilled workers, $p^h = 1.1 \quad q = 0.5$

Efficiency. The total efficiency of each economy is measured by the total output loss due to labor market frictions. It is computed by comparing actual output in equilibrium, that is $\sum m_{i,j}$, to potential output, which is defined as the output level that would have been produced had the economy been competitive, that is, with no frictions in the labor market. There are two sources of inefficiencies in the model: the first and well known is unemployment, the second, which is mostly ignored, is the result of the fact that a substantial share of the workforce is employed in low-productivity firms. For example, if 90 percent of firms are low-productivity firms , in the U.S. they will employ only 20.9 percent of high skilled workers. In France, these firms will employ 46.5 percent of high skilled workers. The reason for this difference is the fact that the rate at which job offers are received on-the-job in the U.S. is high, so the endogenous quit rate from low-productivity firms is high, hence, their size in equilibrium is small.

The comparison shows that the U.S. economy is the most efficient, and France is the most inefficient economy due to total labor market frictions. Figure 2 shows that the second source for output loss - inefficient production - is the major one in most countries. For example, unemployment in France accounts for only 33 percent of output loss, while the fact that low productivity firms employ about half of the workforce accounts for remaining 67 percent. The fact that this is a major source for inefficiency helps to explain the difference between the economic per-

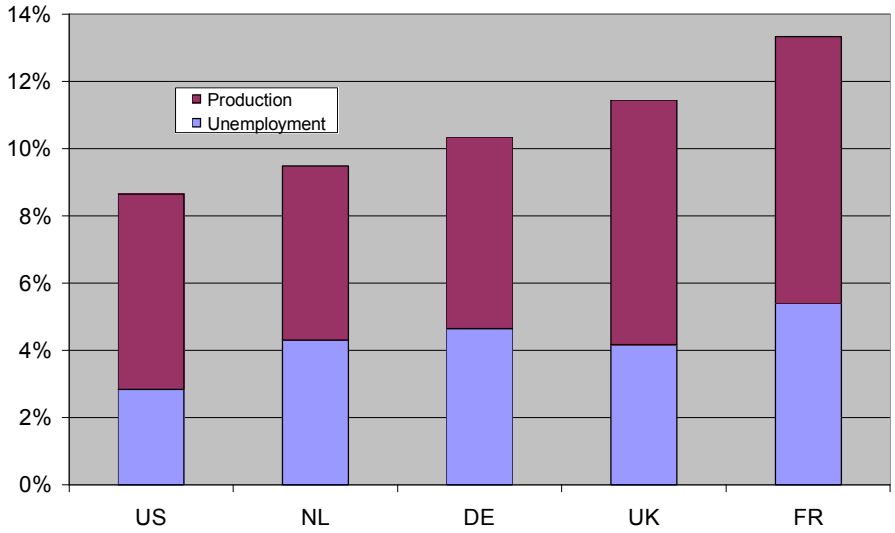

Figure 2: Total output loss due to labor market frictions, $p^h = 1.1$ $q = 0.1$

formance of the U.S. relative to other countries, especially in terms of output per hour.

Monopsonistic power. The monopsonistic power of firms is measured by the ratio of mean wage to the value of the employer-employee match. The results for a segmented labor market, which are analyzed here, show that although unemployment benefits affect mostly low-skilled workers, the monopsonistic power of firms against low-skilled workers is higher than against high skilled workers. Firms' mark-up on low skilled workers is between 4 to 10 percent, while firms' mark-up on high skilled workers is between 2 and 4 percent. The reason is that most of the protection against exploitation stems from the option to receive a higher job offer, and for high skilled workers, the probability for receiving offers on-the-job is significantly higher[9]. This result makes a good argument for the existence of minimum wage laws.

Because the minimum wage in the U.S. is found to be effective, it is possible to quantify its influence on the monopsonistic power of firms. If the minimum were abolished, the monopsonistic power of firms against

[9] As claimed by Ridder and Van den Berg (2003), the monopsonistic power of firms in all countries is relatively low, and it will not be significantly higher if minimum wages and unemployment benefits are zero. They quantify it to be below 5 percent; Most of the protection workers have from being exploited stems from the option to make job-to-job transitions.

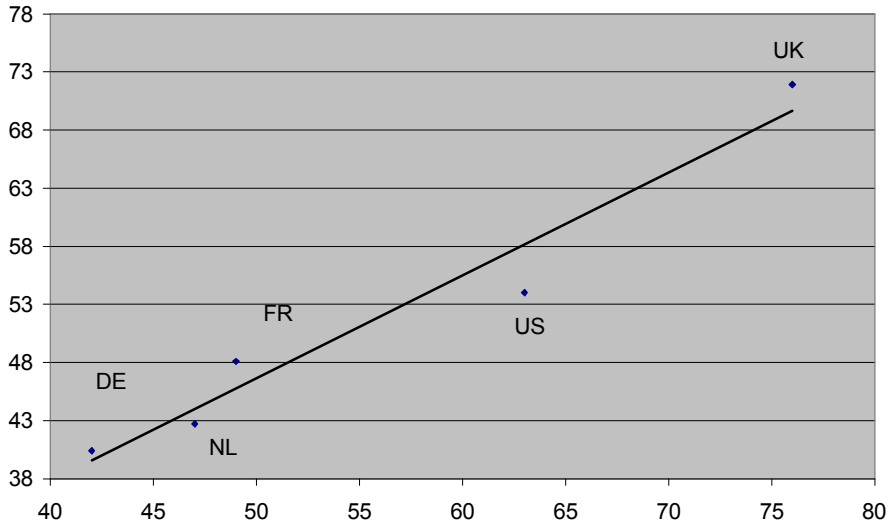

Figure 3: Skill premium corrected for quality, $p^h = 1.1 \quad q = 0.5$

low skilled workers would reach 6.5 percent; with the minimum wage, the monopsonistic power is 5.1 percent only. Thus, the minimum wage reduces the monopsonistic power by approximately 25 percent.

The skill premium. I compute the skill premium based on the estimated mean of the wage offers distribution[10]. Generally, the skill premium is lower than the relative wage, a result which is in-line with the results of Ridder and van den Berg (1998) - the skill premium based on the wage offer distribution, is lower than the estimates based on cross-section estimates. Figure 3 shows the skill premium in each country against relative labor productivity. In countries above the regression line, like France and the U.K., high-skilled workers are relatively expensive, while American and Dutch high-skilled workers are relatively cheap. Thus, the U.S. and the Netherlands have a comparative advantage in producing goods or services which are human capital intensive.

[10]Eckstein and Wolpin (1995) proved that the relative wage is a biased measure of the skill premium, as it is based only on accepted wage offers. They argued that the "true" skill premium should be estimated based on the wage offer distribution rather than the distribution of actual wages.

Table 3: 10 % productivity difference, 50 % of firms are low-productivity firms

$e^l = 1, \quad p^l = 1, \; p^h = 1.1 \quad q = 0.5$

$e^h_{US} = 1.63, \; e^h_{UK} = 1.76, \; e^h_{DE} = 1.42, \; e^h_{FR} = 1.49, \; e^h_{NL} = 1.47$

	US	UK	DE	FR	NL
Low Skilled workers					
1. Equilibrium type	A	A	A	A	A
2. Reservation wage	0.29	0.56	0.73	0.77	0.80
3. Average wage	1.03	1.01	1.03	1.01	1.05
4. Average Productivity	1.09	1.09	1.09	1.08	1.09
5. Workers in p^l firms (%)	7.0	11.5	12.1	16.6	10.4
High Skilled workers					
6. Equilibrium type	A	A	A	A	A
7. Reservation wage	0.20	0.81	0.98	1.08	1.05
8. Average wage	1.74	1.87	1.49	1.56	1.56
9. Average Productivity	1.78	1.92	1.54	1.61	1.60
10. Workers in p^l firms (%)	2.9	4.6	7.7	8.8	6.9
Relative and minimum wage					
11. Minimum wage	0.47	0.50	0.46	0.75	0.70
12. Relative wage (%)	69.2	84.5	44.5	54.1	48.4
13. Skill Premium (%)	54.0	71.9	40.4	48.1	42.7

Table 4: 50 % productivity difference, 50 % of firms are low-productivity firms

$e^l = 1, \quad p^l = 1, p^h = 1.5 \quad q = 0.5$

$e^h_{US} = 1.60, e^h_{UK} = 1.70, e^h_{NL} = 1.50$

	US	UK	DE	FR	NL
Low Skilled workers					
Equilibrium type	A	A	C	C	B
Reservation wage	0.39	0.74			1.11
Average wage	1.35	1.31			1.45
Average Productivity	1.46	1.44			1.50
Workers in p^l firms (%)	7.0	11.5			0.0
High Skilled workers					
Equilibrium type	A	A	A	C	A
Reservation wage	0.27	1.05			1.43
Average wage	2.29	2.41			2.10
Average Productivity	2.34	2.46			2.18
Workers in p^l firms (%)	2.9	4.6			6.9
Relative and minimum wage					
Minimum wage	0.63	0.66			0.96
Relative wage (%)	69.2	84.5			48.4
Skill Premium (%)	50.3	67.3			26.0

Table 5: 100 % productivity difference, 50 % of firms are low-productivity firms

$s^l = 1, \quad p^l = 1, p^h = 2 \quad q = 0.5$

$s^h_{US} = 1.58, s^h_{DE} = 1.41, s^h_{FR} = 1.47, s^h_{NL} = 1.47$

	US	UK	DE	FR	NL
Low Skilled workers					
Equilibrium type	A	C	B	B	B
Reservation wage	0.51		1.36	1.43	1.48
Average wage	1.76		1.91	1.89	1.94
Average Productivity	1.93		2.00	2.00	2.00
Workers in p^l firms (%)	7.0		0.0	0.0	0.0
High Skilled workers					
Equilibrium type	A	A	B	B	B
Reservation wage	0.36		1.80	1.98	1.94
Average wage	2.98		2.73	2.85	2.87
Average Productivity	3.04		2.82	2.95	2.95
Workers in p^l firms (%)			0.0	0.0	0.0
Relative and minimum wage					
Minimum wage	0.83		0.84	1.38	1.28
Relative wage (%)	69.2		44.5	54.1	48.4
Skill Premium (%)	47.7		39.6	46.7	43.0

Table 6: 10 % productivity difference, 90 % of firms are low-productivity firms

$s^l = 1, \quad p^l = 1, \; p^h = 1.1 \quad q = 0.1$

$s^h_{US} = 1.60, s^h_{UK} = 1.73, s^h_{DE} = 1.41, s^h_{FR} = 1.48, s^h_{NL} = 1.46$

	US	UK	DE	FR	NL
Low Skilled workers					
Equilibrium type	A	A	A	A	A
Reservation wage	0.28	0.54	0.70	0.73	0.77
Average wage	0.98	0.96	0.98	0.96	0.99
Average Productivity	1.06	1.05	1.04	1.03	1.05
Workers in p^l firms (%)	40.4	53.8	55.3	64.1	51.1
High Skilled workers					
Equilibrium type	A	A	A	A	A
Reservation wage	0.20	0.77	0.93	1.03	1.00
Average wage	1.66	1.77	1.41	1.48	1.48
Average Productivity	1.70	1.81	1.47	1.53	1.53
Workers in p^l firms (%)	20.9	30.1	43.0	46.5	40.2
Relative and minimum wage					
Minimum wage	0.46	0.48	0.44	0.72	0.67
Relative wage (%)	69.2	84.5	44.5	54.1	48.4
Skill Premium (%)	51.4	69.9	39.9	47.8	42.2

3.1 Policy implications

The simulation results show that minimum wage raise in the U.S. and Germany will not result in an adverse effect on employment: in the U.S., although the minimum wage was found to be effective, it is far below labor productivity, and in Germany the minimum wage is far below the reservation wage and therefore ineffective. As to France and the Netherlands, the results are less clear. In both countries, the reservation wage is high relative to labor productivity; given the tax wedge, which is not accounted for in the analysis, a minimum wage raise might result in the shut down of low productivity firms and in substantial job loss in the short run.

The minimum wage in the U.S. is substantially lower than labor productivity; this finding supports the view that a moderate minimum wage raise will raise actual wages without having adverse effects on employment, and highlights the minimum wage importance in reducing wage inequality in the U.S.. Note that wage disperssion in the U.S. is the highest among all five countries for two reasons: the reservation wage is low, because job offers are made more often on-the-job, and the maximum wage relative to labor productivity is high because the absolute

rate of job offers on-the-job is high.

The estimated reduction of the monopsonostic power of firms due to the minimum wage law is 20 to 25 percent; I find that adopting the recent call made by more than 650 top economists[11], including five winners of the Nobel Prize for economics, to raise the Federal minimum wage from 5.15 $ to 7.25 $ per hour, will reduce the monopsonistic power of firms against low-skilled workers by 50 to 60 percent, without any adverse consequences for employment.

The main conclusion is that the minimum wage policy can not be "detached" from other labor market policies, such as outside benefits, and ignore labor market fundamentals, such as frictions. While the ratio between unemployment benefits and the minimum wage has received the attention of policy makers, it seems that labor market frictions and their interaction with unemployment benefits, have been ignored by them when deciding on the minimum wage.

The minimum wage policy may have important implications for the long-run. Minimum wages reduce the monopsony power of firms on the one hand, but might cause low-productivity firms to cease production on the other hand, so its total effect on the skill premium is ambiguous. In case workers make a rational decision whether to invest in human capital, based on the wage premium they expect, and their ability, the minimum wage may have a positive or a negative effect on long-run growth (see Friedman (2005)). For this reason, assessing its effectiveness and identifying the channel through which it is effective, is important. The long-run implications on economic growth of the results of this paper will be addressed in the future.

[11] In the Economic Policy Institute on 11.10.2006 (quoted from Santa Cruz Sentinel / Associated Press).

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