Matching, Sorting and Wages

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Abstract

We develop an empirical search-matching model with productivity shocks so as to analyze policy interventions in a labour market with heterogeneous agents. To achieve this we develop an equilibrium model of wage determination and employment, which is consistent with key empirical facts. As such our model extends the current literature on equilibrium wage determination with matching and provides a bridge between some of the most prominent macro models and microeconometric research. The model incorporates long-term contracts, on-the-job search and counter-offers, and a vacancy creation and destruction process linked to productivity shocks. Importantly, the model allows for the possibility of assortative matching between workers and jobs, a feature that had been ruled out by assumption in the empirical equilibrium search literature to date.

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1 Introduction

Understanding the impact of labour market regulation is both important and complex. It is important because such regulations are pervasive and take the form of anything from firing restrictions to minimum wages all around the world. It is complex because regulations affect the equilibrium in the labour market, changing the wage structure, employment and the type of jobs that are available. The typical justification of such regulations are labour market imperfections and frictions: within a competitive framework any such regulation would be welfare reducing, would typically reduce employment and would increase wages. For a complete empirical understanding of the relative merits of such regulation we need a framework which at the same time allows for the possibility that some regulation is optimal, but does does not necessarily lead to that conclusion. Our aim is to develop and estimate a search-matching model with productivity shocks so as to analyze policy interventions in a labour market with heterogeneous agents. To achieve this we need an equilibrium model of wage determination and employment, which is consistent with key empirical facts. As such our model extends the current literature on equilibrium wage determination with matching and provides a bridge between some of the most prominent macro models and microeconometric research.

The empirical work on wage dynamics has offered important insights on how wages evolve over time for individuals. Some of this work has emphasised the stochastic evolution of wages\(^1\), while other work has considered carefully wage growth over the lifecycle including the role of experience, tenure and job mobility.\(^2\) Most of this work is essentially reduced form, in that there is little explanation of how the stochastic components arise or how wages are determined and the match surplus, if it exists, gets shared between workers and firms. As a result these empirical studies offer rich descriptions of wages, but do not allow us to assess the impact of policies in all but the most restrictive labour market frameworks. Essentially we do not have a theoretical framework that can explain the empirical facts and justify the complex statistical models of wages fitted to the data. In parallel a rich literature has developed on equilibrium wage distributions with some degree of heterogeneity in workers and/or jobs. However, this literature is not capable of accounting for the rich wage dynamics and for a number of key issues.

such as sorting; it does not provide a framework that is rich enough to explain what we observe about wages. Our aim in this paper is to take the first steps in bridging this gap offering a model of wages with stochastic shocks, which is consistent with equilibrium wage determination, when jobs and workers are heterogeneous and there are search costs.

Thus the key ingredients of our model are: Workers differ from each other according to a productivity relevant characteristic. Firms are also heterogeneous and their productivity is subject to possibly persistent shocks - this will lead to stochastic shocks to wages. The production function allows for complementarity between worker and job characteristics, leading to the possibility of sorting in the labour market. Jobs can decide whether to remain completely idle, or post a vacancy. They hire any worker who leads to a positive surplus - this accounts of course for the option value of keeping the vacancy. Finally, there are search costs: workers receive job offers while unemployed or employed at exogenously given rates (that may differ across these states). We solve this model and derive the implied dynamics of wages and the cross sectional wage distribution, as well as the distribution of matches.

Our model offers both an empirical framework for understanding wage determination and as a result offers a way for evaluating the impact of labour market regulation, such as the minimum wages or restrictions on firing. In a search framework protecting workers from being fired can have ambiguous effects on employment. Our framework will allow this effect to be quantified. But, as important, it allows us to analyse the effect of regulation on the distribution of wages and profits and thus showing who pays and who benefits from such a policy in this non-competitive environment.

Our paper draws from the literature on matching and assignment models (Sattinger, 1993) as well as on the literature on equilibrium wage distributions in a search environment (Mortensen and Pissarides, 1995) and Burdett and Mortensen, 1998). Matching models of the labour market have become standard in the macroeconomic literature since the seminal works of Diamond (1982), Mortensen (1982) and Pissarides (1990). Moreover, it is now well understood that search models can give rise to wage dispersion even if workers are homogeneous (see Burdett and Judd, 1983 and Burdett and Mortensen, 1998). However, matching models with heterogeneous workers and jobs is a relatively new topic of interest fueled by the need to understand dispersion of wages of similar individuals. In general, workers differ by the numbers of years of education
and experience, and jobs differ by the type of industry. There is thus an enormous amount of differences between workers and between jobs that are not accounted for by observables in the data. Marriage models with heterogeneous agents in a frictional environment are studied in Sattinger (1995), Lu and McAfee (1996), Shimer and Smith (2000), and Atakan (2006). To the best of our knowledge, there have not yet been any empirical applications of assignment models with transferable utility in a frictional environment with heterogeneous agents.

There is a large body of empirical evidence showing that wages differ across industries, thus indicating that a matching process is at work in the economy (see for example Krueger and Summers, 1988). Static, competitive equilibrium models of sorting (Roy models) have been estimated by Heckman and Sédlacek (1985) and Heckman and Honore (1990), while Moscarini (2001) and Sattinger (2003) explore theoretical extensions of Roy models with search frictions.

How much sorting is there with respect to these unobserved characteristics? Abowd, Kramarz and Margolis (2000; AKM) and Abowd, Kramarz, Lengermann and Roux (2003) use French and U.S. matched employer-employee data to estimate a static, linear log wage equation with employer and worker fixed effects (by OLS). They find a small, and if anything negative, cross-sectional correlation between job and worker fixed effects. Abowd, Kramarz, Lengermann and Perez-Duarte (2004) document the distribution of these correlations calculated within industries. In the U.S. 90% of these correlations range between -15% and 5%, and in France between -27% and -5%. These negative numbers, although hard to interpret, offer *prima facie* evidence of no positive sorting. However, the evidence based on the log-linear decomposition used by AKM should not be interpreted as evidence that there is no sorting: the person and firm effects which are estimated from the linear log wage equation are complicated transformations of the underlying individual-specific, unobserved productivity-relevant characteristics; A structural model is thus required to recover the true underlying joint distribution of characteristics. Abowd *et al.* present some evidence that a matching model inspired from Shimer (2005) could both generate sorting on unobservables and the sort of empirical regularity that they find. More recently, Melo (2008) has proposed a matching model, extending Lu and McAfee (1996) and Shimer and Smith (2000) to allow for on-the-job search, that also produces the same prediction.

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3 Sattinger develops a framework but does not prove the existence of an equilibrium. Lu and McAfee prove the existence for a particular production function \( f(x, y) = xy \). Shimer and Smith prove the existence of an equilibrium in a more general setup and derive sufficient conditions for assortative matching. Atakan shows that Becker's (1973) complementarity condition for positive sorting is sufficient if there exist explicit search costs.
Our framework allows us to investigate empirically whether sorting actually is important in practice.

In many ways, our model is similar to Mortensen and Pissarides’s (1990) model. Workers and jobs meet at random at a frequency that depends on some matching function and productivity shocks are responsible for endogenous lay-offs. As in equilibrium search models, on-the-job search generates both job-to-job mobility and wage dispersion, and we follow Postel-Vinay and Turon’s (2007) extension of Postel-Vinay and Robin’s (2002) sequential auction model to model offers and counter offers and contract renegotiation upon productivity shocks.

2 An Overview of the Model

In the economy there are a fixed number of individuals and a fixed number of jobs or production lines. Individuals may be matched with a job and thus working, or they may be unemployed job seekers. Jobs on the other hand may be in three different states. First they may be matched with a worker, in which case output is produced. Second, they may be vacant and waiting for a suitable worker to turn up. Finally jobs may be inactive, and thus potential entrants in the labour market. Individuals all have different levels of human capital, indexed by $x$. Jobs on the other hand also differ from each other according to some productivity relevant characteristic $y$. Output depends on the characteristics of both sides with possible complementarities. Crucially though, productivity follows a first order Markov process, which leads to the value of the match changing, with consequences for wage dynamics, worker mobility, job creation, and job destruction that are at the centre of our model.

Individuals maximise their discounted income over an exponential lifetime; jobs maximise profits. When a job and a worker meet and the total match surplus is positive, the worker is hired and thus the match is formed. At this point the worker is paid a wage consistent with the reservation value of the best alternative option, plus a share of the excess match surplus. This process is discussed in detail in the next section.\footnote{In parallel work Lentz (2008) considers a model of on-the-job search with endogenous search intensity, where all workers match with any job when transiting from unemployment and sorting is the result of differing returns to search effort by worker type.} A further important feature is that a shock to job productivity may trigger a wage renegotiation. This will happen if under then new productivity the match surplus remains positive but the wage is too high under the
new conditions. On the other hand there is no incentive to renegotiate when there is a shock increasing the surplus, but as we shall show this will increase the value of being employed in this job because of the prospect of future wage increases. Finally we close the model by a free entry condition: all production lines, whether active or not have a productivity relevant parameter, which they know. This determines whether they will want to enter the market and post a vacancy. The marginal job has zero surplus from entering the market and posting a vacancy.

3 The Formal Description of the Model

3.1 Setup

Each individual worker is characterised by a level of permanent productivity, which we denote by $x$, observable by all agents, but not the researcher. We can normalise $x$ to be uniformly distributed $[0, 1]$, without any loss of generality. There are $L$ individuals of which $U$ are unemployed. We also denote by $u(x)$ the (endogenous) measure of $x$ among the unemployed.

Jobs are characterised by a productivity parameter $y$, which is also observable by all agents and is normalised to be uniformly distributed $[0, 1]$. There are $J$ jobs in the economy and the (endogenous) measure of vacant posts is $v(y)$. The number of vacancies is denoted by $V$. The number of inactive posts, i.e. potential posts for which jobs have not advertised a vacancy, is $I$.

The endogenous measure of $y$ among these posts is $i(y)$.

In a given job, $y$ fluctuates according to a jump process. $\delta$ is the instantaneous arrival rate of jumps and the new $y'$ is drawn from $U [0, 1]$

A match between a worker $x$ and a job $y$ produces a flow of output $f(x, y)$; this allows for the possibility that $x$ and $y$ are complementary in production, implying that sorting will increase total output.

We denote the measure of existing matches by $h(x, y)$. We can relate the density of individual productivities to the density of active matches as well as the density of productivities for the unemployed by

$$\int h(x, y) \, dy + u(x) = L.$$  

Similarly we can write an equivalent relationship between the distribution of job productivities,
active matches, unfilled vacancies and inactive jobs

\[ \int h(x, y) \, dx + v(y) + i(y) = J. \]  
\[ (2) \]

In both cases the relationship is essentially an accounting identity. Finally, matches can end both endogenously, as we characterise later, and exogenously. We denote by \( \xi \) the rate at which workers retire.

We now discuss the process by which workers get to know about vacant jobs. We assume that the unemployed workers search for work at a fixed intensity \( s_0 \). The search intensity for an employed worker is \( s_1 \). The process of search leads to a total number of meetings, that as usual depends on the number of posted vacancies as well as on the number of total searchers in the economy, weighted by their search intensities. This matching function is denoted by \( M(s_0U + s_1(L - U), V) \). We define the equilibrium parameter

\[ \kappa = \frac{M(s_0U + s_1(L - U), V)}{[s_0U + s_1(L - U)]V}. \]  
\[ (3) \]

Then \( s_0\kappa v(y) \) and \( s_1\kappa v(y) \) are the rates at which unemployed and employed workers of any type contact vacancies of type \( y \). Symmetrically, \( s_0\kappa u(x) \) and \( s_1\kappa h(x, y') \) are the rates at which a job of any type contacts a worker of type \( x \), either unemployed or currently employed at a job of type \( y' \).

### 3.2 Match formation and rent sharing

Define \( P(x, y) \) as the present value of all that the worker and the firm will produce together or separately earn in the future. For the time being, we assume that this value only depends on the partners’ characteristics \( x \) and \( y \). We shall later verify that this is indeed the case. Let \( W_0(x) \) denote the present value of unemployment for a worker with characteristic \( x \), and let \( \Pi_0(y) \) denote the present value of a vacancy. We can define the “surplus” of an \((x, y)\) match as

\[ S(x, y) = \Pi_1(w, x, y) - \Pi_0(y) + W_1(w, x, y) - W_0(x). \]  
\[ (4) \]

Feasible matches \((x, y)\) are such that \( S(x, y) > 0 \).

When an unemployed worker \( x \) finds a vacant job \( y \) a match is thus formed if and only if
The wage for a worker transiting from unemployment is \( w = \phi_0(x, y) \) and is set to split the surplus according to Nash bargaining with worker’s bargaining parameter \( \beta \):

\[
W_1(\phi_0(x, y), x, y) - W_0(x) = \beta S(x, y).
\] (5)

We assume that incumbent employers match outside offers. A negotiation game is then played between the worker and both jobs as in Cahuc, Postel-Vinay and Robin (2006). If a worker \( x \), currently paired to a job \( y \) such that \( S(x, y) > 0 \), finds an alternative job \( y' \) such that \( S(x, y') > S(x, y) \), the worker moves to the alternative job. Alternatively, if the alternative job \( y' \) produces less surplus than the current job, but more than the worker’s share of the surplus at the current job, \( W_1 - W_0(x) < S(x, y') \leq S(x, y) \), the worker uses the outside offer to negotiate up her wage. In either case, the worker ends up in the higher surplus match, and uses the lower surplus match as the outside option when bargaining. The bargained wage in this case is \( w = \phi_1(x, y, y') \) such that

\[
W_1(\phi_1(x, y, y'), x, y) - W_0(x) = S(x, y') + \beta \left[ S(x, y) - S(x, y') \right],
\] (6)

where \( S(x, y) > S(x, y') \). Finally, if \( S(x, y') \leq W_1 - W_0(x) \), the worker has nothing to gain from the competition between \( y \) and \( y' \) and the wage does not change.

Note that the present value of the new wage contract \( W_1(\phi_1(x, y, y'), x, y) \) does not depend on the last wage contracted with the incumbent employer, but only on the total surplus of the previous outside option. The continuation value for workers when the match is destroyed, by the worker moving to unemployment or an alternative job, is not a function of the last negotiated contract. This is the fundamental reason why the total output \( P(x, y) \) and the total surplus \( S(x, y) \) are only functions on \( x \) and \( y \). Therefore, a simple rent splitting mechanism applies. This follows from the Bertrand competition that is engendered by employees’ search on the job which disconnects the poached employees’ outside option from both the value of unemployment and their current wage contract. Shimer (2005) provides an analysis where incumbent employers do not match outside offers and where the current wage determines the new contract.

In our approach there is an asymmetry between workers and firms because the latter do not search when the job is vacant. As a result they do not fire workers when they find an alternative
who would lead to a larger total surplus, nor do they force wages down when an alternative worker is found whose pay would imply an increased share for the firm. We decided to impose this asymmetry because in many institutional contexts it is hard for the firm to replace workers in this way. Moreover, we suspect that even when allowed firms would be reluctant to do so in practice.

3.3 Renegotiation

Wages can only be renegotiated by mutual agreement. This will happen either when a suitable outside offer is made, or because a productivity shock reduced the value of the surplus sufficiently. Specifically, a productivity shock changes $y$ to $y'$. If $y'$ is such that $S(x, y') < 0$, the match is endogenously destroyed. The worker becomes unemployed and the job will either post a vacancy, or perhaps become idle and not seek to fill the position again. Suppose now that $S(x, y') \geq 0$. The value of the current wage contract becomes $W_1(w, x, y')$. If $W_1(w, x, y') - W_0(x) \in [0, S(x, y')]$, neither the worker nor the job has a credible threat to force renegotiation because both are better off with the current wage $w$ being paid to the worker than walking away from the match. In this case there will be no renegotiation. If, however, $W_1(w, x, y') - W_0(x) < 0$ or $W_1(w, x, y') - W_0(x) > S(x, y')$ (with $S(x, y') \geq 0$) then either the worker has a credible threat to quit or the job has a credible threat to fire the employee. In this case a new wage contract is negotiated. To define how the renegotiation takes place and what is the possible outcome we use a setup similar to that considered by MacLeod and Malcolmson (1993) and Postel-Vinay and Turon (2007). The new wage contract is such that it moves the current wage the smallest amount necessary to put it back in the bargaining set. Thus, if at the old contract $W_1(w, x, y') - W_0(x) < 0$, a new wage $w' = \psi_0(x, y')$ is negotiated such that

$$W_1(\psi_0(x, y'), x, y') - W_0(x) = 0,$$

which just satisfies the worker’s participation constraint. If at the new $y'$, $W_1(w, x, y') - W_0(x) > S(x, y')$, a new wage $w' = \psi_1(x, y')$ such that the firm’s participation constraint is just binding

$$W_1(\psi_1(x, y'), x, y') - W_0(x) = S(x, y').$$
3.4 Value Functions

The value functions of the agents have been kept implicit up to now. The next step in solving the model is thus to characterise the value functions of workers and jobs. These define the decision rules for each agent. Proceed by assuming that time is continuous. The discount rate is denoted by $r$.

Unemployed workers. Unemployed workers are always assumed to be available for work at a suitable wage rate. Thus the present value of unemployment to a worker of type $x$ is $W_0(x)$, which satisfies the option value equation:

$$ rW_0(x) = b(x) + s_0\kappa\beta \int S(x, y)^+ v(y) dy, \quad (7) $$

where we define $a^+ = \max\{a, 0\}$. The integration is over all $y$ that lead to feasible (positive surplus) matches for someone with human capital $x$.

Vacant jobs. Vacancies can be open or idle depending on whether the expected profit is greater or less than the cost of posting the vacancy. Using (4), (5), and (6), the present value of profits for an unmatched job meeting a worker with human capital $x$ from unemployment is

$$ \Pi_1(\phi_0(x, y), x, y) - \Pi_0(y) = (1 - \beta) S(x, y). $$

Similarly,

$$ \Pi_1(\phi_1(x, y, y'), x, y) - \Pi_0(y) = (1 - \beta) \left[ S(x, y) - S(x, y') \right] $$

is the present value of profits for a job matched with a worker $x$ who was poached from a firm of type $y'$. Based on this notation, the present value of an open vacancy for a job with productivity $y$ is

$$ r\Pi_0^{\text{open}}(y) = -c + \delta \int \left[ \Pi_0(y') - \Pi_0(y) \right] g(y') dy' + s_0\kappa(1 - \beta) \int S(x, y)^+ u(x) dx 
+ s_1\kappa(1 - \beta) \int \left[ S(x, y) - S(x, y') \right]^+ h(x, y') dx dy' \quad (8) $$
where $c$ is a per-period cost of keeping a vacancy open. In (8) the second term term reflects the impact of a change in productivity from $y$ to $y'$. The third term is the flow of benefits from matching with a previously unemployed worker. The fourth term is the flow of benefits from poaching a worker who is already matched with another job; the integration is over all possible $y'$ that are less attractive to worker type $x$ and would thus move to the job with type $y$. In the future, the firm behaves optimally and the value of a vacancy is $\Pi_0(y) = \max\{\Pi_0^{\text{open}}(y), \Pi_0^{\text{idle}}(y)\}$, i.e. the max of the value of an opened and an idle vacancy.

If the job decides to remain inactive, then it does not pay the cost of posting vacancies and has no chance of meeting a worker. Its present value only depends on future productivity draws, which may lead them into posting a vacancy:

$$r \Pi_0^{\text{idle}}(y) = \delta \int [\Pi_0(y') - \Pi_0(y)] q(y')dy'.$$

Note that a match $(x, y)$ may yield a positive output $f(x, y)$ but the cost of a vacancy exceeds the expected profit. Thus it is possible that a job which looses a worker to another job, just “closes down” rather than posting a new vacancy, until its potential productivity $y$ increases. Combining the two ways in which a job may be unmatched, the present value of an unmatched job of type $y$ is obtained by:

$$r \Pi_0(y) = \max \left\{ r \Pi_0^{\text{idle}}(y), r \Pi_0^{\text{open}}(y) \right\}$$

$$= \max \{0, -c + \zeta(y)\} + \delta \int [\Pi_0(y') - \Pi_0(y)] q(y')dy'. \quad (9)$$

with

$$\zeta(y) \equiv s_0 \kappa (1 - \beta) \int S(x, y)^+ u(x)dx + s_1 \kappa (1 - \beta) \int [S(x, y) - S(x, y')]^+ h(x, y') dxdy'. \quad (10)$$

and a job $y$ is inactive whenever

$$\Pi_0^{\text{idle}}(y) > \Pi_0^{\text{open}}(y)$$

or

$$c > \zeta(y). \quad (11)$$
This condition is like the free entry condition of a standard search-matching model with ex-ante homogeneous jobs; with heterogeneous firms it defines the marginal opening vacancies.

**The match output and joint surplus**  We can write the surplus of any \((x, y)\) match as the fixed point defined by

\[
(r + \delta + \xi) S(x, y) = f(x, y) - rW_0(x) - r\Pi_0(y) + \delta \int S(x, y')^+ q(y') dy' + s_1\kappa\beta \int [S(x, y') - S(x, y)]^+ v(y') dy'.
\]

(12)

The important point to note from this expression is that the surplus of an \((x, y)\) match never depends on the wage; the Bertrand competition between the two jobs for the worker ensures this. As a result the Pareto possibility set for the value of the worker and the job is convex in all cases, implying that the conditions for a Nash bargain are satisfied. This contrasts with Shimer’s (2006) model, where jobs do not respond to outside offers and where the actual value of the wage determines employment duration in a particular job.

**Employed workers**  Let \((x, y)\) characterise a viable match with \(S(x, y) \geq 0\). Let \(W_1(w, x, y)\) denote the present value to the worker of a wage contract \(w\) for this match. In order to determine the wage which solves \(W_1(\phi_0(x, y), x, y) - W_0(x) = \beta S(x, y)\) or \(W_1(\phi_1(x, y, y'), x, y) - W_0(x) = S(x, y') + (1 - \beta) [S(x, y) - S(x, y')]\) we need to determine \(W_1(w, x, y)\) for any \(w\). Note that there is no need to define \(W_1(w, x, y)\) for the case \(S(x, y) < 0\). If a productivity shocks moves \(y\) to \(y'\) such that \(S(x, y') < 0\) then the worker and the firm separate irrespective of the wage.

This can be formalised in the function describing the surplus to the worker for any wage \(w\):

\[
(r + \delta + \xi + s_1\kappa v(A(w, x, y))) [W_1(w, x, y) - W_0(x)] = w - rW_0(x) + \delta \int \min \{S(x, y'), W_1(w, x, y') - W_0(x)\}^+ q(y') dy' + s_1\kappa \int A(w, x, y) [\beta S(x, y) \lor S(x, y') + (1 - \beta) S(x, y) \land S(x, y')] v(y') dy'
\]

(13)
where \( v(A) = \int_A v(y) \, dy \) for any set \( A \) and

\[
A(w, x, y) = \{ y' : W_1(w, x, y) - W_0(x) < S(x, y') \},
\]

and we make use of lattice order notations \( \lor \) for supremum and \( \land \) for infimum.

### 3.5 Steady-state flow equations.

To solve for equilibrium we need to define the steady state flow equations.

The total number of matches in the economy will be

\[
L - U = J - V - I = \int h(x, y) \, dx \, dy.
\]  

(14)

Existing matches, characterised by the pair \((x,y)\), can be destroyed for a number of reasons. First, there is exogenous job destruction resulting from worker death, at rate \( \xi \); second, with probability \( \delta \), the job component of match productivity changes to some value \( y' \) different from \( y \), and the worker may move to unemployment or may keep the job; third, the worker may change job, with probability \( s_1 \kappa v(M_1(x,y)) \) - i.e., a job offer has to be made (at rate \( s_1 \kappa V \)) and has to be acceptable \( (y' \in M_1(x,y)) \). On the inflow side, new \((x,y)\) matches are formed when some unemployed or employed workers of type \( x \) match with vacant jobs \( y \), or when \((x,y')\) matches are hit with a productivity shock and exogenously change from \((x,y')\) to \((x,y)\). In a steady state all these must balance leaving the match distribution unchanged. Thus formally we have for all \((x,y)\) such that the match is acceptable, i.e. \( y \in M_0(x) \) or \( S(x,y) > 0 \):

\[
[\delta + \xi + s_1 \kappa v(B(x,y))] \, h(x, y) = \delta \int q(y)h(x, y') \, dy' \\
+ [s_0 u(x) + s_1 h(x, B(x,y))] \kappa v(y),
\]  

(15)

where

\[
B(x,y) = \{ y' : S(x, y) > S(x, y') \},
\]

\[
B(x,y) = [0, 1] \setminus B(x,y).
\]
This equation defines the steady-state equilibrium, together with the accounting equations for the workers:

\[ u(x) = L - \int h(x, y) \, dy, \]  

(16)

and the jobs

\[ v(y) + i(y) = J - \int h(x, y) \, dx, \]  

(17)

Noting that vacancies are posted only if costs are low enough (given productivity) we get that the density of vacancies is

\[ v(y) = \begin{cases} 
J - \int h(x, y) \, dx & \text{if } c \leq \xi(y) \\
0 & \text{if } c > \xi(y), 
\end{cases} \]  

(18)

and the density of inactive jobs is given by

\[ i(y) = \begin{cases} 
0 & \text{if } c \leq \xi(y) \\
J - \int h(x, y) \, dx & \text{if } c > \xi(y), 
\end{cases} \]  

(19)

The total number of vacancies \( V \) is thus obtained as

\[ V = \int_{c \leq \xi(y)} \left[ J - \int h(x, y) \, dx \right] \, dy. \]  

(20)

### 3.6 Equilibrium

In equilibrium all agents follow their optimal strategy and the steady state flow equations defined above hold. The exogenous parameters of the model are the number of workers and jobs \( L/J \), the distribution of worker types and job productivities \( l(x) \) and \( n(y) \) respectively, the transition function for productivity dynamics \( q(y') \), the matching function \( M(s_0 U + s_1 (L - U), V) \) as well as the arrival rate of shocks, \( \delta \), the retirement rate \( \xi \), the search intensities for the unemployed, \( s_0 \) and employed workers , \( s_1 \), the discount rate, \( r \), the value of leisure \( b \), the cost of posting a vacancy \( c \) bargaining power \( \beta \), and the production function \( f(x, y) \). The equilibrium is characterized by knowledge of the number of vacancies, \( V \), the joint distribution of active matches, \( h(x, y) \) and the surplus function \( S(x, y) \) obtained by solving simultaneously equations (20), (15) and (12). In these equations, we substitute for \( U \) using equation (14), \( \kappa \) using equation (3), \( u(x) \)
using equation (16), \( c(y) \) using equation (10), and \( v(y) \) using equation (18).

### 3.7 Policy instruments

Our model provides a way of evaluating the employment and distributional impact of labour market regulation. It is ideally suited for understanding who pays and who benefits from such policies. Labor market regulation can consist of payments for the unemployed, which changes \( b(x) \), an element of the model. We also introduce three further policy instruments: experience rating, minimum wages, and severance pay. We model experience rating as a tax, \( \tau_d \), on endogenous separations. This can be accomplished by subtracting the term \( \delta q \left( C(x) \right) \tau_d \) from equation (12), where \( C(x) = \{ y : S(x, y) > 0 \} \).

Incorporating a minimum wage puts a constraint on the ability of workers and jobs to make transfers. As a result, the condition for match feasibility will depend on the match surplus being high enough to cover a minimum wage contract, and still provide positive surplus to the job. Given this constraint, an \((x, y)\) match is feasible if and only if \( S(x, y) \geq 0 \) and \( W_1(w, x, y) - W_0(y) \leq S(x, y) \). This requires defining the value to a filled job of an \((x, y)\) match paying a wage \( w \). The key practical difficulty is that the matching set for the unemployed depends both on whether the surplus is positive and on the value of filling the vacancy at the minimum wage. Before, \( S(x, y) > 0 \) was sufficient to determine the feasible matches. For all matches that are feasible subject to the minimum wage constraint, the wage is determined as

\[
    w = \max \{ w, w^* \},
\]

where \( w^* \) solves (13) with either (6) or (5) on the left hand side depending on whether the worker is hired away from another job or hired from unemployment.

Severance payments are modelled as a transfer \( \tau_s \) from the firm to the worker at the time of endogenous job destruction. In the absence of a binding minimum wage a severence payment would have no effect since it does not change the match surplus, it simply adds \( \delta q \left( C(x) \right) \tau_s \) to the worker surplus and subtracts the same term from the firm surplus: this can be undone by adjusting the wage. However, in the presence of a binding minimum wage it puts an additional constraint on feasible matches. A match is only feasible if it at the minimum wage the share going to the worker, including the expected severence payment, does not exceed the total match.
surplus; \( S(x, y) \geq 0 \) and \( W_1(w, x, y) - W_0(y) + \delta q(\mathcal{U}(x)) \tau_s \leq S(x, y) \). In practice many countries, including the US do have minimum wages and consequently studying the impact of severance payments is of importance.

4 An Illustrative Numerical Example

5 What might we learn about sorting from wages?

[Incomplete]

As discussed in the introduction, Abowd \textit{et al} (1999) use a simple empirical measure of sorting that can be obtained by estimating a log-wage equation in which wages are a linear function of a worker fixed effect, a firm fixed effect, and an orthogonal worker-firm effect

\[
\log(w_{it}) = z_{it} \beta + \alpha_i + \sum_{j=1}^{J} d_{it}^{j} \psi_j + u_{it},
\]

where \( z_{it} \) are time varying observables of workers, \( \alpha_i \) is a worker fixed effect, \( \psi_j \) is a firm fixed effect, and \( u_{it} \) is an orthogonal residual. The correlation between \( \hat{\alpha}_i \) and \( \hat{\psi}_{j(i)} \) in a given match is taken as an estimate of the degree of sorting.

To assess the degree to which the correlation between these estimated fixed effects is informative on the degree of sorting on type, we will conduct this exercise for each of the numerical examples considered in Section 4. Based on the results in Melo (2008) and our own simulations (not reported here) this estimated correlation is not necessarily informative on the degree of sorting in the model.\(^5\) Indeed, this suggests the need to estimate the production function in

\(^5\)In addition to this effect, Postel-Vinay and Robin (2006) note that in terms of asymptotics, OLS estimate of \( \beta \) is consistent as \( i \to \infty \) for fixed \( T \) and OLS estimates of \( \alpha \) and \( \psi \) are consistent when \( T \to \infty \) faster than \( I \) and \( J \). In practice, the data contains millions of workers, tens of thousands of firms, and fewer than ten years. Indeed, empirical estimates of sorting which are based on worker and firm fixed effects introduce a negative bias, which will introduce a spurious negative correlation when calculating the correlation between worker and firm fixed effects. This is illustrated as follows; empirically, \( \beta \) and \( \psi_j \) are estimated from the within transformation

\[
\log w_{it} - \log w_i = (x_{it} - x_i)\beta + \sum_{j=1}^{J} (d_{it}^{j} - \bar{d}_i^{j}) \psi_j + u_{it} - \bar{u}_i.
\]

This makes it clear that we need to see workers change firm to identify the firm fixed effects \( \psi_j \). The worker fixed effects are estimated as

\[
\hat{\alpha}_i = \log w_i - \bar{x}_i \beta - \sum_{j=1}^{J} \bar{d}_i^{j} \hat{\psi}_j.
\]

Notice, any statistical error affecting the estimate of the firm effect translates directly to the estimate of the worker effect, with a sign reversal. OLS estimates of firm and worker effects are likely to be imprecise and
order to answer the question regarding the degree of sorting on unobservables.

6 The Data

7 Estimation and Results

[TALK ABOUT THE TREATMENT OF MEASUREMENT ERROR]

To estimate the model we use simulated method of moments, combined with an MCMC based method developed by Chernozhukov and Hong (2002). Our estimator is asymptotically equivalent to the minimiser of the moment criterion function

\[ S = \sum_{k=1}^{K} \alpha_k^2 (\hat{m}_k - m_k(\theta))^2 \]  

where \( \hat{m}_k \) is a moment estimated from the data, \( m_k(\theta) \) is the equivalent moment computed from data simulated by the model at the parameter point \( \theta \) and \( \alpha_k^2 \) is one over the variance of the estimated moment \( \hat{m}_k \).

Based on Chernozhukov and Hong we define a posterior distribution of the parameters as

\[ g(\theta|\hat{m}_k) \propto \pi(\theta) \exp(-NS) \]

where \( \pi(\theta) \) represents a prior distribution, which we take as diffuse. Drawing a sample of \( \theta \)s from \( g(\theta|\hat{m}_k) \) and taking the average provides an estimator of \( \theta \) which is asymptotically equivalent to the one minimizing 22. We use MCMC methods to draw sample parameters from this posterior distribution (see Chibb and Roberts and Cassela). The 2.5th and 97.5th percentile of the sample of \( \theta \)s drawn is an estimate of the confidence intervals of the parameters.

The moments we chose to fit represent labour market transitions, the cross sectional wage distribution and wage dynamics. We have deliberately chosen to overidentify the model to better understand what aspects of the data it can fit well, while at the same time ensuring we try to fit all aspects. They are shown in Table 1, where the data moments are compared to the simulated ones at the optimal parameter estimates for the three education groups we use: less than high school High School and College.

\[ \text{spuriously negatively correlated given short time dimension and limited worker mobility.} \]
Table 1: Model Fit

<table>
<thead>
<tr>
<th></th>
<th>Less than highschool</th>
<th>Highschool</th>
<th>College</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data</td>
<td>Model</td>
<td>t-stat</td>
</tr>
<tr>
<td>$h_{EU}$</td>
<td>0.033</td>
<td>0.033</td>
<td>0.004</td>
</tr>
<tr>
<td>$h_{UE}$</td>
<td>0.134</td>
<td>0.134</td>
<td>0.015</td>
</tr>
<tr>
<td>$h_{\Delta J}$</td>
<td>0.028</td>
<td>0.027</td>
<td>0.062</td>
</tr>
<tr>
<td>$\Delta w_{EUE}$</td>
<td>-0.039</td>
<td>-0.051</td>
<td>0.584</td>
</tr>
<tr>
<td>$\Delta w_{J-t0-J}$</td>
<td>0.039</td>
<td>0.054</td>
<td>-0.767</td>
</tr>
<tr>
<td>$\sigma^2_{\Delta w_{EUE}}$</td>
<td>0.221</td>
<td>0.228</td>
<td>-0.228</td>
</tr>
<tr>
<td>$\sigma^2_{\Delta w_{J-t0-J}}$</td>
<td>0.254</td>
<td>0.228</td>
<td>0.503</td>
</tr>
<tr>
<td>$\bar{w}$</td>
<td>2.243</td>
<td>2.283</td>
<td>-0.807</td>
</tr>
<tr>
<td>$\sigma^2_{\bar{w}}$</td>
<td>0.349</td>
<td>0.247</td>
<td>1.448</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.062</td>
<td>-0.810</td>
<td>1.111</td>
</tr>
</tbody>
</table>

The t-statistic is for the null of equality between the model and data moments.

All transitions are fitted extraordinarily well for all education groups. The mean and variance of log wages wages also fit well, with the exception of the variance of log wages for the college education group which is underestimated. In terms of skewness the performance of the model varies among education groups although the only significant deviation is for the college group where the data is more negatively skewed than the model.

Turning now to wage dynamics, the model is capable of tracking reasonably well the wage changes around transitions; the wage gain from changing jobs ($\Delta w_{J-t0-J}$) is particularly well fitted. The wage loss associated with job changes via unemployment ($\Delta w_{EUE}$) is overestimated by the model for all but the lowest education group. We are also able to fit the variance the wage growth between jobs ($\sigma^2_{\Delta w_{J-t0-J}}$) with the exception of high school graduates. The variance of wage growth for those changing jobs via unemployment ($\sigma^2_{\Delta w_{EUE}}$) is underestimated by the model, other than for the lowest skill individuals. However, taken together the fit of the transitions, of the cross sectional distribution of wages and of wage growth across transitions seems to replicate reasonably well the facts.

The parameters implied by our estimation are presented in Table 2. The arrival rates of job offers are between 3 and 6 times higher among the unemployed than they are among the employed, depending on the education group. This implies an option value to remaining unemployed and expecting better job offers, particularly for the highest skill individuals. This is reinforced by the fact that the arrival ate of offers when unemployed is very high, with more
Table 2: Parameter Estimates

<table>
<thead>
<tr>
<th></th>
<th>Less than HS</th>
<th>Highschool</th>
<th>College</th>
</tr>
</thead>
<tbody>
<tr>
<td>$s_0$</td>
<td>1.108</td>
<td>1.208</td>
<td>0.215</td>
</tr>
<tr>
<td>$s_1$</td>
<td>0.390</td>
<td>0.251</td>
<td>0.035</td>
</tr>
<tr>
<td>$\xi$</td>
<td>0.026</td>
<td>0.018</td>
<td>0.005</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.092</td>
<td>0.017</td>
<td>0.029</td>
</tr>
<tr>
<td>$f_1$</td>
<td>3.034</td>
<td>3.627</td>
<td>3.699</td>
</tr>
<tr>
<td>$f_2$</td>
<td>0.966</td>
<td>1.032</td>
<td>0.714</td>
</tr>
<tr>
<td>$f_3$</td>
<td>0.092</td>
<td>0.097</td>
<td>0.224</td>
</tr>
<tr>
<td>$f_4$</td>
<td>-0.905</td>
<td>-0.721</td>
<td>-1.315</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.337</td>
<td>0.073</td>
<td>0.164</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.335</td>
<td>0.220</td>
<td>0.252</td>
</tr>
</tbody>
</table>

The production function is parametrized as

$$f(x, y) = \left( \exp \left( f_1 + f_2 \Phi^{-1}(x) \right)^{f_4} + \exp \left( f_1 + f_3 \Phi^{-1}(y) \right)^{f_4} \right)^{1/f_4},$$

where $\Phi$ is the standard normal cdf. This has the interpretation of a CES production function and log-normally distributed worker and firm types.

than one offer a month for the two lower education groups. For college graduates the arrival rate is (perhaps surprisingly) substantially lower, with one offer every 4.7 months. When employed the two lower education groups need to wait 2.5 (lowest skill) or four months. However, college graduates only obtain one offer every 2.5 years: this is important in terms of understanding wage growth. Note that with such low arrival rates we still fit job transitions almost perfectly.

The rate of arrival of productivity shocks is highest for the lower skilled individuals with one very 11 months. The higher the arrival rate of shocks the closer the productivity process is to iid. The shocks have been defined to be uniform $(0,1)$. The scale and shape of the distribution is embeded in the parameters of the production function since these cannot be identified separately without also observing output - we discuss these shortly.

Among the lowest skill 33.7% of the surplus goes to workers on being hired. The equivalent number for the college graduates and the high school graduates is 16.4% and only 7.3% for high school graduates. So other than for the lowest skill, bargaining power is low, implying that outside offers have a very important role to play in wage setting relative to upfront rent sharing when a match is formed.

The production function is clearly far from additive, implying complementarity between worker and firm productivity. The elasticities of substitution for the three education groups
are 0.52, 0.42 and 0.57 respectively; from this production structure we expect to find sorting in the labour market and relatively high welfare costs to the extent that it is prevented. We have assumed that productivity is normally distributed. The scal factor for job productivity, $f_3$ shiws that the variance is highest among college graduates - assuming the same share in production across education groups. From the value of $f_2$ the variance of individual productivity is more or less the same across all education levels.

The standard deviation of the measurement error is 0.335 for monthly earnings for the lowest skill but lower for the other two skill groups. This measurement error contributes substantially to the variance of wage growth both in the data and the model.

### 7.1 Sorting in the labour market

The structure of the estimated production function implies that it is efficient to sort high quality workers (high $x$) into productive jobs (high $y$). The existence of search frictions prevent this from happening perfectly. The existence of productivity shocks, which change the quality of jobs increases mismatch further. The shaded area in figure 1 represents the set of matches that actually occur - the matching set. Perfect sorting would imply that all matches would lie on an upward sloping line. The larger the proportion of the figure that is covered by the matching set the more the incidence of mismatch. The lowest skill group seems to to have the least amount of sorting in place.

These figures however hide the fact that matches are not uniformly distributed over this set. Indeed most of the density is clustered around the centre of the figure. To obtain a better understanding of the sorting process we present conditional quantiles of firm types (by worker type) and vice versa in figure 2 From the left panel we see that the distribution of firm type shifts to the left (the quantiles increase) as the quality of the worker $x$ grows: jobs with better quality workers are more productive as implied by sorting. As reflected in the matching sets we discussed above, the slope of the quantiles (and hence the degree of sorting increases with education. The right hand side panel provides the conditional quantile for workers, given job type. These quantiles display a discontinuity; to the right of this discontinuity there is very strong evidence of sorting for all education groups:the distribution of quality of workers ($x$) shifts rapidly to the right as firm productivity increases. The reason for the discontinuity is that
Figure 1: Matching Sets and Distribution of Matches by Education

(a) \( \{x, y | S(x, y) > 0 \} \), Less than highschool

(b) \( \{x, y | S(x, y) > 0 \} \), Highschool

(c) \( \{x, y | S(x, y) > 0 \} \), College
below a productivity threshold inactive jobs do not post vacancies, inhibited by the cost of doing so; however if they are employing a worker they will continue operating. These jobs used to be higher productivity before being hit by negative shocks and thus carry disproportionately higher quality workers, than firms just to the right of the discontinuity. Jobs that hire low skill workers need to have a productivity level in the top 40% to make it worthwhile posting a vacancy.

In figure 3 we present the employment rate for workers and the activity of the firms. For all education groups the higher skill workers have the highest employment rates - these increase with education, with very little unemployment for the highest education level, at least above the 10th percentile of ability. The right hand side panel shows the share of producing firms: to the left of the discontinuity we have jobs that were filled when the firm was above the productivity threshold. The dotted line represents idle firms. All firms would be idle to the left of the threshold for posting vacancies if they had no worker, so this graph is zero after the threshold and one minus the producing firms to the left of it. The share of jobs actively looking for a worker is represented by the lowest line and to the right of the threshold increases with productivity because higher productivity firms are more choosy and take longer to fill a vacancy.

7.2 Policy Experiments

The potential for labour market regulation arises from the job search frictions and the externalities they cause during the job allocation process. These externalities arise both from the classic issue of “overcrowding” among job seekers, i.e. when an extra person seeks a job it reduces the arrival rate for others. An extra dimension arises because of heterogeneity and sorting though: by having low quality jobs compete for workers they lengthen the time it takes to fill higher productivity ones, without adding much when they are filled (because they have zero or near zero surplus). This implies that because of complementarity, cutting some low productivity jobs may increase welfare, even if this means that some very low productivity workers never work.

Other than specific attempts to change such frictions by improving the job search technology any intervention in the labor market will improve welfare only to the extent that it can address such externalities, if of course they are significant. Thus the planners problem offers an upper bound to welfare improvements through regulation, such as minimum wages, severance pay etc. The planner maximises total output and home production subject to the flow constraints implied
Figure 2: Quantiles of Matching Set.
The blue, green and red lines are the 25th, 50th, and 75th percentiles.
Figure 3: Employment Rate by Worker Type and Share of Producing, Vacant and Idle Jobs by Firm Type
implied by the frictions, i.e.

\[
max_{h^{SP}, u^{SP}, Y^{SP}} \{ Y = \int_y \int_x f (x, y) h^{SP} (x, y) \, dx \, dy \\
+ \int_x b (x) u^{SP} (x) \, dx - cV^{SP} \}
\]

subject to the equations 14, 15, 16, 17 and 20.

Table 3 shows the breakdown of contributions to total welfare under different scenarios. The first column relates to the fully decentralised economy we observe from the data. The second column shows the results of the planner maximising welfare as in 23. In practice this leads to almost no increase in welfare, with some reallocation from market production to home production and a slight decline in employment - this is true for all education levels. The implication being that any labour market regulation will either leave welfare unchanged or reduce it. Before going on to this in column three we present the results from removing frictions: this increases welfare by 5% for the two lower education groups and 9% for college graduates. Interestingly in the frictionless economy all work.

Now we turn to the two labour market policies we consider, namely minimum wage and (in addition) severance pay. In both cases the optimum policy is no minimum wage and no severance pay, which is a reflection of the fact that the planner cannot improve welfare. Instead we try policies that are similar to those enacted in practice. The minimum wage is thus set to 50% of mean wages and severance pay is set at three months pay. In both cases overall welfare declines (as expected) but just very little. However for the lowest education group (and to a lesser extent for the high school graduates) there are very large drops in employment; the fact that welfare does not change by much reflects the fact that the surplus of the matches destroyed is very low. For the unskilled (less than high school) severance pay reduces employment further from the minimum wage benchmark, while for the high school graduates nothing much changes when we add severance over and above the minimum wage.\footnote{Remember that severance has no effect without the minimum wage; severance is thus an incremental policy over and above the minimum wage.}

Interestingly, both these policies have little or no effect on college graduates.

A further aspect of policy relates to the distribution of gains. Figure 4 shows how the value of unemployment and its rate are affected by minimum wages and severance pay. For the
Table 3: Policy Effects on Output and Employment

<table>
<thead>
<tr>
<th></th>
<th>Less Than Highschool</th>
<th>Highschool</th>
<th>College</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decentralized Planner</td>
<td>Constrained Benchmark</td>
<td>Frictionless Minimum Wage</td>
</tr>
<tr>
<td>Steady-state output</td>
<td>100.00</td>
<td>100.03</td>
<td>105.27</td>
</tr>
<tr>
<td>Market Production</td>
<td>85.60</td>
<td>84.47</td>
<td>105.27</td>
</tr>
<tr>
<td>Home Production</td>
<td>15.94</td>
<td>17.12</td>
<td>0.00</td>
</tr>
<tr>
<td>Recruiting Costs</td>
<td>-1.54</td>
<td>-1.56</td>
<td>0.00</td>
</tr>
<tr>
<td>Employment</td>
<td>79.14</td>
<td>77.88</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>100.18</td>
<td>104.55</td>
</tr>
<tr>
<td>Market Production</td>
<td>95.09</td>
<td>94.28</td>
<td>104.55</td>
</tr>
<tr>
<td>Home Production</td>
<td>7.53</td>
<td>8.49</td>
<td>0.00</td>
</tr>
<tr>
<td>Recruiting Costs</td>
<td>-2.62</td>
<td>-2.58</td>
<td>0.00</td>
</tr>
<tr>
<td>Employment</td>
<td>87.81</td>
<td>86.92</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>100.26</td>
<td>108.96</td>
</tr>
<tr>
<td>Market Production</td>
<td>97.95</td>
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<td>108.96</td>
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<td>Home Production</td>
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<td>0.00</td>
</tr>
<tr>
<td>Recruiting Costs</td>
<td>-3.30</td>
<td>-3.53</td>
<td>0.00</td>
</tr>
<tr>
<td>Employment</td>
<td>91.72</td>
<td>89.37</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Notes: The minimum wage is calculated as one half the mean wage in the decentralized economy for Highschool educated workers. Severance pay is set equal to 1.5 months of the match output in the month prior to separation, and also uses the minimum wage. Unemployment Insurance is modelled as a top-up to non-employment income equal to three percent of match output in a perfectly sorted match (0.03f (x, x)) It is funded by a proportional tax on match output. Balanced budget requires the tax to satisfy \( u \int f (x, x) u (x) \, dx = \tau \int f (x, y) h (x, y) \, dx \, dy \).
Figure 4: Employment and Welfare Effects of Policy by Education

Notes: The minimum wage is calculated as one half the mean wage in the decentralized economy for Highschool educated workers. Severance pay is set equal to 1.5 months of the match output in the month prior to separation, and also uses the minimum wage. Unemployment Insurance is modelled as a top-up to non-employment income equal to three percent of match output in a perfectly sorted match \(0.03 f(x,x)\). It is funded by a proportional tax on match output. Balanced budget requires the tax to satisfy \(ui \int f(x,x)u(x)dx = \tau \int f(x,y)h(x,y)dxdy\).
lowest education group, which is typically the target for such policies, both minimum wages and severance pay increases unemployment and decreases the welfare of the lowest 20% to 30% of the skill distribution. Thus, although on aggregate the policies have no substantial effects they seem to inflict welfare losses to the lowest skill individuals. These distributional effects are much lower for the high school graduates. Interestingly college graduates tend ot benefit from the minimum wage: it causes a transfer of more of the surplus from firms to workers, without destroying almost any jobs or reducing welfare overall.

The implication of these results are that standard employment regulation has very little effect on welfare overall because it tends to destroy very low value matches. On the other hand it does cause losses among very low skill workers (in the observable and the unobservable dimension). Moreover, it causes quite a lot of unemployment, again for these very low skilled workers. In terms of this model this does not reflect itself in welfare. However, if we believe that unemployment has other longer term ill effects, not captured here the results certainly imply that such regulation can only be detrimental. Indeed we have also shown that there is very little scope for improving welfare through such regulations, even if it were optimally chosen. On the other hand this economy is far from perfect: the large amounts of missmatch causes a loss of between 5%-9% of overall welfare depending on the education level. The issue is not the lack of imperfections but finding the appropriate tools to deal with them. These have to improve the mobility of workers and ledad to better matching. Severance compensation and minimum wages in particular are not the appropriate instruments for this.

7.3 Wage Dynamics

8 Conclusion and further work

[Incomplete]

Estimation of the model presented here is the subject of current research. The natural type of data to use in the empirical implementation is matched worker and firm data, an avenue we are actively pursuing. One obstacle in this strategy is the need to take a stand on the formation of jobs into firms, and the possibility of interaction between workers within a firm. An additional interesting question is how much we can learn about earnings processes using standard panel data on workers and the restrictions from the model. The model predicts an earning process with
lots of heterogeneity, in which the time varying part of earnings is dependent on the permanent component. In addition, job mobility and unemployment durations are dependent on the same underlying permanent component.

With an estimated version of the model in hand we will be well placed to evaluate important policy questions, such as employment protection legislation and minimum wages, within a coherent empirical economic model.
References


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