The Effect of Job Security Regulations on Output in a Search Matching Model*

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Abstract

Burdensome labor regulations often result in a shift in production from the covered formal sector to the uncovered informal sector. This paper studies the welfare implications of job security regulations which make it difficult for a firm to fire a worker. The theoretical model is an extension of the Mortensen and Pissarides matching model with two sectors. Each sector has a constant returns to scale technology and the number of vacancies in each sector is determined by a zero profit condition. The total number of matches formed in each sector depends on the number of workers searching for a job and on the number of vacancies. Labor regulations introduce a cost only in the formal sector. This cost of regulations is due to a firm's inability to downsize its labor force when profits are low. An increase in the cost of regulations reduces the incentive to create a vacancy in the formal sector and increases the incentive to create a job in the informal sector. The structural model is estimated using Indian manufacturing data. The results show that the estimated cost of labor regulations vary significantly across Indian states and have large welfare implications. A policy of employment-at-will would increase total output by 26%. This increase in output is due to a 24% decrease in the unemployment rate and a shift in production from the informal sector to the more productive formal sector. This policy doubles employment in the formal sector, decreases the average unemployment spell by 26%, and decreases average tenure by 21%.

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1 Introduction

It is widely recognized that some government policies have an adverse effect on market outcomes. Parente and Prescott (2000), in the book "Barriers to Riches", argue that "differences in the knowledge individual societies apply to the production of goods and services" can explain variation in per capita income across countries. They claim that policies which constrain adoption of better production processes by firms contribute to income inequality.

Labor market regulations which make it costly for a firm to fire a worker will have two opposing effects on employment. These regulations have a positive effect on employment because it is expensive to fire a worker. Labor regulations have a negative effect on employment by decreasing the incentive to create jobs. If there is a sector in the economy which is not covered under these regulations, the firms will shift production from the covered sector to the uncovered sector. For example, job security regulations in India are size dependent, meaning that smaller firms are not covered under job security regulations. If the productivity of a worker is higher in the covered formal sector than in the uncovered informal sector, a shift in production to the informal sector will lead to inefficiencies. The size dependent regulations imposed by the government result in adoption of inefficient technology by firms. The goal of this project is to study the effect of labor market regulations on total output and employment when there is a sector which is uncovered under the job security regulations.

To study the disparate effects of the labor market regulations on the formal and informal sectors, we extend the Mortensen and Pissarides matching model by developing a two sector version of their model. A worker searching for a job is not always matched with a firm. Similarly, a firm with a vacancy might have to wait before it is matched with a worker. The technology is constant returns to scale in each sector. The distribution of match productivity is allowed to differ across the two sectors. The total number of matches formed in each sector depends on the number of workers searching for a job in that sector and on the number of vacancies. In the formal sector, firms cannot freely lay off workers. If a formal sector firm fires a worker, there is a possibility that the worker will be re-instated by the state government or through a court ruling. This constraint imposes a cost of regulations on formal sector firms. There is no such restriction on informal sector firms. The expected cost of regulations increases as the ability of firms to adjust their labor force decreases. An increase in the expected cost of regulations reduces the incentive to create a vacancy in the formal sector and increases the incentive to create a job in the informal sector.

The model is estimated using data on manufacturing workers in India. The cross sectional variation in job security regulations across Indian states is used to identify the cost imposed by these regulations. The data on labor market regulations come from the World Bank enterprise survey. This is a survey of formal sector firms from Indian states. The relevant survey questions were answered by the head of each business. The wage and employment data come from the National Sample Survey for year 1999-2000.

The estimates show that the cost imposed by labor market regulations varies significantly across different Indian states. Using the estimated structural model, we find that changes in job security regulation have large welfare implications. A policy of employment-at-will increases total production in the manufacturing sector by 26%. This big gain in efficiency comes from a 24% reduction in the unemployment rate and from a shift in production from the informal sector to the more productive formal sector. This policy doubles employment in the formal sector, reduces unemployment by 24%, decreases the average unemployment spell by 26%, and decreases average tenure by 21%. This significant increase in output emphasizes the extent of inefficiencies created by burdensome government policies.

The rest of the paper is organized as follows. Section 2 provides a brief summary of the relevant institutional structure. Section 3 discusses this paper in the context of past work. Section 4 presents a two sector model of job search and matching. Section 5 gives an overview of the data and defines the variables used in the estimation. Section 6 discusses the identification of the model parameters. Section 7 contains the results and section 8 concludes.

2 Indian Labor Laws

This section gives a brief outline of the Indian labor market regulations. It is difficult to capture the complex nature of these regulations. However, it is clear that smaller firms face less regulation, while larger firms are subject to many regulations. Most of the regulations are open to interpretation, and the state government gets to make the final decision on the implementation of these laws.

The firms are divided into the two sectors based on whether or not they are required to register with the government. The Factories Act (1948) requires only certain firms to register and to obtain a valid factory license for their operation. The Act requires a firm to register if

1. it uses power and employed at least 10 workers at some point during the year,
2. it uses no power and employed at least 20 workers at some point during the year.

For our purpose we will define a firm to be in the formal sector if it fits into one of the two categories above.[1] Under the Factories Act, state governments have the power to declare different departments from the same firm to be separate factories or two or more factories to be a single factory.

The Industrial Disputes Act was enacted on the eve of India's independence in 1947. This act provides for the conciliation and adjudication of industrial disputes.

Under the Industrial Disputes Act (1947), a permanent worker can be removed from service only for proven misconduct, habitual absence, or upon attaining the retirement age. A worker can challenge an order of dismissal in the state's labor court. If the dismissal is found to be unjustified, the court has the power to order reinstatement with continuity of service, back wages, and benefits. This act requires any industrial establishment employing more than 100 workers to apply for permission from the state government before resorting to lay-off or closure.[2],[3] The paper does not study the effect of this requirement on firms specifically. The point illustrated by these requirements is that it is difficult for a firm to lay off a worker. The Industrial Disputes Act does not apply to industrial establishments which are of a seasonal character or in which work is performed only intermittently.[4] If a question arises on whether an industrial establishment is of a seasonal character or whether work is performed only intermittently, the decision of the state government will be final. Again, this shows the extent to which a state government can influence the implementation of the law.

The provisions of the Industrial Disputes Act (1947) do not apply to casual workers or to contract workers. A daily wage worker is a casual worker. If a firm outsources part of the production process to a contractor, the workers employed by the contractor are the contract workers. A firm might be able to reduce the impact of the Industrial Disputes Act (1947) by outsourcing or hiring casual workers. However, the hiring of contract labor is heavily regulated by the Contract Labor (Regulation and Abolition) Act (1970). This act prohibits employment of contract labor in areas requiring perennial work connected with the production process. It applies to every establishment in which twenty or more workers were employed on any day of the preceding twelve months as

[1]The Act also lists 15 different categories of firms which come under the purview of the Factories Act, irrespective of the use of power or the number of workers engaged.

[2]The requirement that a firm needs to apply for permission from the government was included in the Act by an amendment in 1977. This amendment included firms with 300 or more workers. In another amendment in 1982, this limit was reduced to 100 workers.

[3]If the worker involved in the dispute is employed by the federal government, an application is made to a committee appointed by the federal government.

[4]The Industrial Disputes Act (1947) does not apply to workers carrying out managerial work and earning more than Rs 1,600 per month.

contract labor. Every contractor who employs or who employed twenty or more workers on any day of the preceding twelve months is required to register. Under the act, the government appoints an advisory board that investigates illegal employment of contract labor. The act is not applicable to establishments in which work of the intermittent nature is performed. The nature of work is decided by the government after consultation with the advisory board. Andhra Pradesh, a state in India, has amended its laws to facilitate the employment of contract workers in temporary and non-core activities. We will see in the data section that Andhra Pradesh is a state with flexible labor regulations relative to other states.

The last two acts discussed above are not applicable to the service sector. Some industries are not affected by these regulations due to the intermittent nature of the work performed. The construction industry is one such example. After removing the service sector, agriculture sector, and construction, we are left with the manufacturing sector. The manufacturing sector bears the major impact of these regulations. The share of manufacturing in GDP decreased during the 1990s. During the same time period, the share of the service sector in GDP increased by 9% points. This provides anecdotal evidence that labor regulations adversely affected the manufacturing sector.

Labor security regulations in India are open to interpretation by government officials. Due to this, the implementation of the regulations differs from state to state, depending on the ideology of the political party in power and on the strength of labor unions in a state. The direct cost of laying off a worker is not very high. For example, the severance pay is just 15 days of pay for every year of work.[5] The advance notice requirement is just 21 days.[6] The advance notice requirement is smaller if a firm wants to close the plant. The big cost of laying off a worker is due to the possibility that a firm may be asked to reinstate a worker who was laid off. In this case, a firm will have to pay the back salary, pay their own and the worker's legal cost, and absorb that worker's potentially lower productivity during and after the dispute. This makes it difficult to calculate the direct monetary cost of job security regulations in India. Also, it is clear that we need to capture the differences in the implementation of labor market regulations.

There are federal and state specific minimum wage acts in place in India. We do not focus on these acts because the minimum wage acts cover all workers, irrespective of the sector they are working in.

The institutional structure has implications for the model, identification strategy, and

[5]Severance pay is a payment to an employee who is laid off by a firm.

[6]Advance notice refers to the requirement in which an employer is required by law to notify a worker in advance before affecting any change in the employment conditions. The length of advance notice is specified by the law.

the choice of the estimation sample. The firms are divided into a covered formal sector and an uncovered informal sector according to size. Job security regulations impose a cost in the formal sector. The cost of regulation is allowed to vary across different states. The estimation sample consists of workers in the manufacturing sector, which is covered by the regulations discussed above.

The discussion above begs answer to the question: why do we care if production takes place in the formal or in the informal sector? The implicit assumption is that there is a minimum efficient scale of production. A firm which achieves this efficient scale of production employs more workers. Due to this, a firm with the efficient scale of production falls under the purview of the regulations discussed above. A government report estimates that worker productivity in the formal sector is 1.7 times that of a worker in the informal sector.[7] The results in this paper show that the estimated mean of the productivity distribution is significantly higher in the formal sector than the informal sector. Note that, due to the cost of regulations, a firm using the inefficient scale has an incentive to remain small to avoid the cost. This structure gives us sorting of the firms such that the inefficient firms are in the informal sector and efficient firms are in the formal sector.

The next section provides a background of the research on which this paper is built. In the introduction to the NBER conference report "Law and Employment - Lessons from Latin America and the Caribbean" the editors, Heckman and Pagés provide an excellent review of the literature. So, the next section is limited only to a brief summary of the work which is related to this paper.

3 Related Literature

This paper contributes to the literature that studies why factor price equalization does not hold across countries. Parente and Prescott (2000) in the book Barriers to Riches argue that the income differences across countries can not be explained by a growth model with same total factor productivity across countries. They contend that the difference in the total factor productivity arise due to protection provided by government policies to the insiders in a industry.

Hopenhayn and Rogerson (1993) calibrate a model of the US economy in which existing firms are deciding the size of the labor force and the potential entrant are making the entry decisions. They find that a tax on job destruction has a big negative

[7]The reported is available at `http://mospi.nic.in/mospi_seminarseries_nov04_3_6_final.pdf`. The productivity of a worker is defined as total value added in a sector divided by the total wage bill.

impact on employment. Kugler (2004) presents a two sector search matching model to derive implications of the reduction in severance pay on Columbian labor market outcomes.

Heckman and Pagés (2004) review the papers which study European, US and Latin American labor market regulations. The chapter reviews literature on minimum wage, job security regulation like severance pay, advance notice, and job stability regulations. There has been some work done in the past on the effect of labor laws on market outcomes in India. Fallon and Lucas (1993) study the effect of job security regulations in India and Zimbabwe. Fallon and Lucas (1993) study the effects of 1976 amendment to the Industrial Dispute Act by the central government which required all firms with more than 300 workers to apply for permission from the government to lay off a worker. Fallon and Lucas (1993) estimate the dynamic demand of labor in different industries before and after 1976. They find that labor demand decreased significantly at a 10% level for only 14 out of 36 industries.[8] Besley and Burgess (2004) looks at the effect of labor regulations on the economic performance across different Indian states over the last 50 years. State level amendments to the Industrial Disputes Act (1948) over 54 years is used to identify whether a state is pro-worker or pro-employer. Pro-worker states had lower levels of investment, employment, productivity, and output in the formal sector between 1958 and 1992. However, their measure of labor strictness and their methodology has been criticized in the literature. Bhattacharjea (2006) presents a list of inconsistencies in the interpretation of the amendments as pro-employer, pro-worker, or neutral.

The next section presents a two sector dynamic model which allows us to understand how alternate policies affect the market outcome.

4 Model

The model is a two sector version of the Mortensen and Pissarides (1994) matching model. The benefit of using a search-matching-bargaining model is that we do not need firm side data to analyze the cost of regulations. The model presented in this section is estimated by using the wage and employment data.[9] The assumption needed to identify the model using only worker side data are given in the identification section.

Consider an economy in which firms are producing tradable goods. This allows us to analyze effect of changes in policy without worrying about changes in the price of the

[8]The paper reports results at 25% level of siginificance.

[9]The state level data on labor market regulations, labor unions, and infrastructure are used to identify the cost of regulations.

output. Since we are focusing on the manufacturing sector, in which domestic prices and international prices tend to move together, this is a plausible assumption.

The production is organized in a formal sector and an informal sector. The basic difference between the formal and informal sector jobs is that the production and the employment in the formal sector is regulated under various labor laws whereas the production and the employment is unregulated in the informal sector. The firms engaged in production in the formal sector face an expected cost of regulations induced by the labor market regulations. An informal sector firm does not face such a cost. The next subsection explains in detail how the labor market regulations induce cost of regulations in the informal sector.

We will denote the informal sector by sector 1 and the formal sector by sector 2 and the pool of the unemployed workers by sector 0. A worker working in a small manufacturing firm with little or no investment in machinery is an example of an informal sector (sector 1) job. A job in a big manufacturing firm is an example of a formal sector (sector 2) job. The workers and firms face search frictions. The probability that a firm with a vacancy and a worker searching for a job are matched within a time interval is given by Poisson arrival process. The arrival rate of offers is governed by matching functions.

Matching Function: To study the effect of the labor market regulations on employment, it is important to let the job finding rate respond to the labor market regulations. In other words, we need to model the firm's decision to open a vacancy to study the effect of change in policy on the firm's behavior. The matching function gives us a convenient way to relate fundamentals of the model with the job finding rate. The matching function gives us the total number of matches made per unit time as a function of the total number of vacancies and the total number of workers looking for a job.

In this model, there are two types of vacancies in the market and unemployed workers are searching for both types of jobs.[10] There are two ways to model the job matching process. First, we can assume that there is only one matching function. In this case, all the vacancies and all the workers searching for a job will enter as arguments of the matching function. The number of matched formed in each sector will be given by the

[10] A better approach might be to let the worker search for the job in the sector with higher expected value. We need the assumption that for each sector there is a small fraction of workers who search in that sector, regardless of the payoff, to avoid the case where no one is searching and there is no vacancy in a sector. In this model, for workers to search in both sectors they should be indifferent between searching in the two sectors. The condition for a worker to be indifferent between searching in either sector is that the market tightness in one sector is directly proportional to the market tightness function in the second sector. The market tightness is given by number of vacancies in a sector divided by number of workers searching for a job in that sector. The constant of the proportionality is determined by the parameters of the model. Currently, I am working on estimation of the model with such a model.

total number of matches times the fraction of vacancies from that sector. The second approach is to assume there are separate matching functions for each type of job. In this case, number of matches formed in a sector will be a function of the number of vacancies for the jobs in the sector and the number of worker searching for a job in the sector. These are two extreme cases. In the first case, a firm opening a vacancy will face same matching frictions regardless of the composition of the two sectors. For example, if the number of vacancies for informal sector jobs is 50 and there is no vacancy for a formal sector job. If we use the first matching function, the rate at which this new formal sector vacancy is matches with a worker will be same as the rate at which a 51^{st} informal sector firm matches with a worker. On the other hand, according to the second matching function, a formal sector vacancy will be immediately matched with a worker, whereas an informal sector vacancy will face congestion due to 50 vacancies in the market. In our case, the two types of jobs are different in terms of the technology used and the scale of operation. The congestion effect faced by a firm should depend on the composition of the vacancies in the market. Furthermore, as a practical issue, same matching function might give us multiple steady states depending on in which sector a firm enters the market. Due to these reasons, we find the second approach more suitable.

Let the number of matched pairs per unit time be given by the matching function $m_k(\bar{\alpha}_k u_k L_t, v_k L_t)$ where, L_t is the size of the labor force in the economy at time t, $\bar{\alpha}_k$ is the average intensity of search by workers looking for a sector k job, u_k is the fraction of labor force searching for a sector k job and v_k is the number of vacancies for the sector k jobs per worker. An unemployed worker and an employed worker search for a job with different intensities. Let α_{ij} be the exogenously given search intensity of a worker in sector $i \in \{0, 1, 2\}$ looking for a sector $j \in \{1, 2\}$ job. Assume that the matching function is a constant returns to scale function.[11] The Poisson rate at which a vacancy is matched with a worker for a sector $k \in \{1, 2\}$ job will be

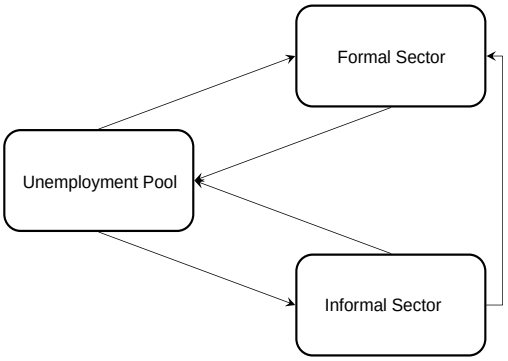
$$\frac{m_k(\bar{\alpha}_k u_k L_t, v_k L_t)}{v_k L_t} = m_k\left(\frac{1}{v_k/\bar{\alpha}_k u_k}, 1\right) = m_k\left(\frac{1}{\theta_k}, 1\right) = q_k(\theta_k) \tag{1}$$

where $\theta_k = \frac{v_k}{\bar{\alpha}_k u_k}$ is the market tightness facing the firms. The Poisson rate at which a worker who is searching for a sector k job with search intensity α_{ik} will meet a firm will be:

$$\alpha_{ik}\frac{m_k(\bar{\alpha}_k u_k L_t, v_k L_t)}{u_k L_t} = \alpha_{ik}\bar{\alpha}_k\theta_k m_k\left(\frac{1}{\theta_k}, 1\right) = \alpha_{ik}\bar{\alpha}_k\theta_k q_k(\theta_k) \tag{2}$$

[11] Pissarides (2000) cites papers giving evidence in favor of a constant returns to scale matching function for US and some European countries.

Figure 1: Inter Sector Flows



We normalize the average search intensity in the two sectors equal to one,

$$\alpha_{0k}\bar{\alpha}_k = 1, \alpha_{12}\bar{\alpha}_2 = \alpha$$

and make the following assumptions about the search intensities:

$$\alpha_{11} = \alpha_{2k} = 0 \tag{A1}$$

This assumption implies that a worker who is employed in the formal sector does not search, a worker who is employed in the informal sector searches only for a job in the formal sector. These inter sector flows are depicted in figure 4. The model can be easily extended to the case when the formal sector workers are also searching for a job. However, we do not observe any formal sector worker moving to the informal sector in data. We do observe workers from the informal sector moving to the formal sector. We also assume that an employed worker will have to quit the current job once he is matched with a firm. The idea behind this assumption is that a worker, who is matched with a formal sector firm, works at the formal sector firm as a temporary worker before the productivity shock is realized. This assumption makes the reservation wage for an employed worker same as an unemployed worker. It is plausible that a worker cannot use a job in the informal sector as an effective threat when bargaining with a formal sector firm.[12]

[12]If a worker in the informal sector is allowed to return to the job than the only difference will be that the rate of

A matched worker-firm pair observe productivity of the match at the time of matching. The productivity of a match is given by a random variable P_k with distribution $F_k(P_k)$ for $k \in \{1, 2\}$. The pair decides to engage in bargaining if the total match surplus is positive. The match surplus is shared between worker and firm according to the Nash Bargaining Rule. If the bargaining process is successful, the pair starts production and keep producing until the pair is hit by a separation shock. This separation shock destroys the match. It hits a sector k job at the Poisson rate λ_k^s.

A formal sector firm which is engaged in production incurs a cost, C_2, induced by the labor market regulations. The exact nature of this cost is discussed in the next subsection. An informal sector firm does not face such a cost. Next, we will solve the worker's and the firm's problem.

Worker's Problem: The value of holding an informal sector (sector 1) and formal sector (sector 2) job for a worker, who is paid a wage w, is given by the following asset pricing equation:

$$rv_1(w) = w + \lambda_1^s (v_0 - v_1(w)) + \alpha\theta_2 q_2(\theta_2)(\mathrm{E}_{P_2} \max\{v_2(w), v_0\} - v_1(w)) \tag{3a}$$

$$rv_2(w) = w + \lambda_2^s (v_0 - v_2(w)) \tag{3b}$$

A job is an asset which gives a worker a flow of w and expected changes in the value of the asset. In the informal sector a worker becomes unemployed at the rate λ_1^s which increases the value of the asset by $v_0 - v_1(w)$. The worker is matched with a formal sector firm at the rate $\alpha\theta_2 q_2(\theta_2)$. In that case, the value of the asset increases by $\mathrm{E}_{P_l} \max\{v_2(w), v_0\} - v_1(w)$. Note that once a worker is matched with a firm, the worker joins the unemployment pool before observing the matching quality shock. A worker in the formal sector becomes unemployed at the rate λ_2^s which increases the value of the asset by $v_0 - v_2(w)$. The above equations are using the equilibrium condition that the return from a job should be equal to the return on asset with the same value.

The value of unemployment for a worker will be:

$$rv_0 = b + \theta_1 q_1(\theta_1)\mathrm{E}_{P_1} \max\{v_1(w) - v_0, 0\} + \theta_2 q_2(\theta_2)\mathrm{E}_{P_2} \max\{v_2(w)) - v_0, 0\} \tag{4}$$

The first term on the right hand side is the unemployment benefit (b). The second and third terms are the changes in the value of an unemployed worker if the worker is matched with an informal sector and a formal sector firm, respectively.

outflow from the informal sector will decrease. If we keep the exogenous rate at which matches are broken constant, decrease in outflow means that an informal sector firm's value of generating a job will be higher (since the job will last longer). This will result in more vacancies in the informal sector. To match the data likelihood will decrease the mean of the match productivity distribution in the informal sector. This will result in an even higher gain in efficiency than I have reported. The estimation process will also adjust by increasing the exogenous rate at which the matches are broken.

Firm's Problem The value of a firm from a job with match quality P_k and which pays a wage w to the worker is: :

$$r\pi_1(w) = P_1 - w + \lambda_1^s \{\pi_{1v} - \pi_1(w)\} + \alpha\theta_2 q_2(\theta_2) \{\pi_{1v} - \pi_1(w)\} \tag{5a}$$

$$r\pi_2(w) = P_2 - C_2 - w + \lambda_2^s \{\pi_{lv} - \pi_2(w)\} \tag{5b}$$

where C_2 is the flows of total expected cost of regulations. In the next subsection it is shown how job security regulations effect C_2 and λ_2^s.[13] A firm with an open vacancy bears a flow cost of c_k^v and is matched with a worker at rate $q_k(\theta_k), k = 1, 2$. The value of opening a vacancy in sector k for a firm is:

$$r\pi_{kv} \quad = \quad -c_k^v + q_k(\theta_k) \mathrm{E}_{P_k} \max \{\pi_k(w(P_k)) - \pi_{kv}, 0\} \tag{6}$$

The value of creating a vacancy will be driven to zero by the free entry of the new firms in the equilibrium.

The Bargaining Rule: The surplus is distributed between the firm and worker according to the Nash Bargaining Rule. The benefit of using the Nash Bargaining Rule is that the decision to form a match depends only on the total surplus as shown in equation 8 and 9. In other words, a worker and a firm will have the same reservation productivity. We get the surplus from a match with productivity P_k by adding the firms and the workers value from a job and subtracting the outside options.

$$(r + \lambda_1^s + \alpha\theta_2 q_2(\theta_2)) S_1(P_1) = P_1 - rv_0 + \alpha\theta_2 q_2(\theta_2) \mathrm{E}_{P_2} \max \{v_2(w(P_2)) - v_0, 0\} \tag{7a}$$

$$(r + \lambda_2^s) S_2(P_2) = P_2 - C_2 - rv_0 \tag{7b}$$

Let $0 \leq \beta_k \leq 1$ is the bargaining power of a worker matched with a firm with type k vacancy. The Nash Bargaining Rule implies that the worker's and the firm's surplus in a sector k job is given by

$$v_k(w(P_k)) - v_0 = \beta_k S_k(P_k) \tag{8}$$

$$\pi_k(w(P_k)) - 0 = (1 - \beta_k) S_k(P_k) \tag{9}$$

The decision to start production will have the reservation productivity property. So, a firm and worker will start production if realized $P_k \geq P_k^R$, where $P_k^R = P_k : S_k(P_k) = 0$.

Job Creation: The incentive to create a new vacancy will drive down the value of a vacant job to zero in the equilibrium. Substituting the firm's surplus from equation 9 in equation 6 we get the following zero profit condition,

$$\mathrm{E}_{P_k} \max \{\pi_k(w(w_k)) - \pi_{kv}, 0\} = (1 - \beta_k) \mathrm{E}_{P_k} \max \{S_k(P_k), 0\} = \frac{c_k^v}{q_k(\theta_k)} \tag{10}$$

[13] The expected cost of regulations in sector 1 is set equal to zero.

Substituting π_k from the firm's payoff given in equation 5 and using the zero profit condition 10, we get the job creation equation:

$$\frac{\mathrm{E}_{P_1} \max\{P_1 - w_1, 0\}}{r + \lambda_1^s + \alpha\theta_2 q_2(\theta_2)} = \frac{c_1^v}{q_1(\theta_1)} \tag{11a}$$

$$\frac{\mathrm{E}_{P_2} \max\{P_2 - C_2 - w_2, 0\}}{r + \lambda_2^s} = \frac{c_2^v}{q_2(\theta_2)} \tag{11b}$$

The left hand side of the two equations is the expected benefit from opening a vacancy and the right hand side is the expected cost of a vacancy. The expected benefit from (or cost of) a vacancy is given by the flow of expected value of a job per unit time (or flow cost of a vacancy) multiplied by the average time a job lasts (or average time it takes to fill the vacancy). The right hand side increases as the market tightness θ_k increases. To maintain the equality, the left hand side should also increase. The only way this can be achieved is by decreasing w. In other words, when the market becomes tighter, a firm will find it profitable to create a job only if wages are lower. The job creation equation is analogous to the labor demand equation. It gives us a negative relationship between market demand captured by market tightness, θ_k, and wage, w.

Wage Equation: The supply side of the labor market is given by the wage equation. To get the wage equation substitute the worker's surplus in equation 3 from equation 8 and rearrange as follows:

$$w_1(P_1) = rv_0 + \beta_1(r + \lambda_1^s + \alpha\theta_2 q_2(\theta_2))S_1(P_1) - \beta_2\alpha\theta_2 q_2(\theta_2)\mathrm{E}_{P_2} \max\{S_2(P_2), 0\}$$
$$w_2(P_2) = rv_0 + \beta_2(r + \lambda_2^s)S_2(P_2)$$

Substituting the surplus from equation 7 we get

$$w_1(P_1) = (1 - \beta_1)\left(rv_0 - \beta_2\alpha\theta_2 q_2(\theta_2)\mathrm{E}_{P_2} \max\{S_2(P_2), 0\}\right) + \beta_1 P_1$$
$$w_2(P_2) = (1 - \beta_2)rv_0 + \beta_2(P_2 - C_2)$$

Substituting the worker's surplus from equation 8 into the worker's value from staying unemployed and using the free entry condition given by equation 10 we get

$$rv_0 = b + \theta_1 c_1^v \frac{\beta_1}{1 - \beta_1} + \theta_2 c_2^v \frac{\beta_2}{1 - \beta_2}$$

Substituting v_0 in the equations above, we get the following wage equations:

$$w_1(P_1) = (1 - \beta_1)\left(b + \theta_1 c_1^v \frac{\beta_1}{1 - \beta_1} + (1 - \alpha)\theta_2 c_2^v \frac{\beta_2}{1 - \beta_2}\right) + \beta_1 P_1 \tag{12}$$

$$w_2(P_2) = (1 - \beta_2)\left(b + \theta_1 c_1^v \frac{\beta_1}{1 - \beta_1} + \theta_2 c_2^v \frac{\beta_2}{1 - \beta_2}\right) + \beta_2(P_2 - C_2) \tag{13}$$

These equations are analogous to the labor supply equations. We can solve for the equilibrium market tightness by substituting the wage from equation 13 and 12 in the job creation equation 11. We get the following two equilibrium conditions:

$$(1-\beta_1)\mathrm{E}_{P_1}\max\{P_1 - \left(b + \theta_1 c_1^v \frac{\beta_1}{1-\beta_1} + (1-\alpha)\theta_2 c_2^v \frac{\beta_2}{1-\beta_2}\right), 0\} = \frac{c_1^v(r+\lambda_1^s+\alpha\theta_2 q_2(\theta_2))}{q_1(\theta_1)} \tag{14a}$$

$$(1-\beta_2)\mathrm{E}_{P_2}\max\{P_2 - C_2 - \left(b + \theta_1 c_1^v \frac{\beta_1}{1-\beta_1} + \theta_2 c_2^v \frac{\beta_2}{1-\beta_2}\right), 0\} = \frac{c_2^v(r+\lambda_2^s)}{q_2(\theta_2)} \tag{14b}$$

These equations show that equilibrium market tightness is independent of the unemployment level. We can get P_k^R by setting surplus equal to zero. The reservation productivity for the type 1 jobs is such that:

$$\begin{aligned} S_1(P_1^R) &= 0 \\ \left(b + \theta_1 c_1^v \frac{\beta_1}{1-\beta_1} + (1-\alpha)\theta_2 c_2^v \frac{\beta_2}{1-\beta_2}\right) &= P_1^R \end{aligned} \tag{15}$$

The reservation productivity for the type 2 jobs is such that:

$$\begin{aligned} S_2(P_2^R) &= 0 \\ \left(b + \theta_2 c_2^v \frac{\beta_2}{1-\beta_2} + \theta_1 c_1^v \frac{\beta_1}{1-\beta_1}\right) &= P_2^R - C_l \end{aligned} \tag{16}$$

Equations 14a & b, 16, and 15 are four equations in four variables $\theta_1, \theta_2, P_1^R, P_2^R$ and can be solved to get these four values.

In the next subsection we add structure to the cost of regulations in the formal sector to understand how implementation of the labor market regulations change the cost of regulations.

4.1 The Cost of regulations

The expected cost of regulations induced by the labor market regulations is the main focus of this paper. Under different policy regimes this cost might be different. As noted before, in India it is up to the state Governments to implement the labor market regulations. So, in case of the Indian states, a big part of the difference in the cost of regulations across states comes from the implementation of the regulations rather than the actual regulations. To understand effect of implementation of the regulations we add the following structure to the model.

Suppose there are two levels of productivity: low and high. Assume that matches start production at the high productivity level. The productivity of the match can be

affected by a low productivity shock. The low productivity shock reduces the productivity of the match by $P_2+\Delta$. It arrives at the Poisson rate λ^L. Let p_s is the probability that a firm will be allowed to lay off a worker in state s. If the worker is laid off, the firm incurs a separation cost C^l. The worker leaves the firm at the Poisson rate λ^w. The firm does not incur the separation cost if the worker leaves the firm. This possibility is include to account for the fact that some workers leave a firm due to exogenous reasons, for example retirement.[14]

We can re-write value of a job to a firm in the formal sector as,

$$\begin{aligned} r\pi_2(w) =& P_2 - w + \lambda^L(-p_s C^l + (1-p_s)(-P_2 - \Delta)) + (\lambda^L + \lambda^w)\left\{\pi_{2v} - \pi_2(w)\right\} \\ =& P_2(1-(1-p_s)\lambda^L) - w - \lambda^L(p_s C^l + (1-p_s)\Delta) + (\lambda^L + \lambda^w)\left\{\pi_{2v} - \pi_2(w)\right\} \\ \approx& P_2 - w - \lambda^L(p_s C^l + (1-p_s)\Delta) + (\lambda^L + \lambda^w)\left\{\pi_{2v} - \pi_2(w)\right\} \end{aligned}$$

The last equation above follows if λ^L is very small. Here, an implicit assumption is that the firm cannot lower the wage of the worker. If the firm is allowed to lower the wage, we will have get similar result because wage will be multiplied by a term similar to P_2 which is close to one. So, the cost of regulations C_2 defined in the last section is given by,

$$\begin{aligned} C_2 =& \lambda^L(p_s C^l + (1-p_s)\Delta)) \\ =& \lambda^L(\Delta - p_s(\Delta - C^l)) \\ =& C_{20} - p_s C_{21} \end{aligned}$$

We will identify the constants $C_{20} = \lambda^L\Delta$ and $C_{21} = \lambda^L(\Delta - C^l)$ from the data. One interpretation of this cost Δ is the legal cost and back wages firm might have to pay to the worker. The rate at which a formal sector job is destroyed is given by

$$\lambda_2^s = \lambda^L + \lambda^w$$

The rest of the analysis in the last section stays the same.

A strict job security regime (low p_s) will increase the cost of regulations if $\Delta > C^l$. The severance pay in India is one of the lowest in the South and South East Asian region.[15] The retrenchment benefit is half a month of salary for each year of service. So, it is plausible to assume that $\Delta > C^l$. In estimation, C_{21} turns out to be positive. This

[14]The mandatory retirement age for the government employees in India was 60 years in 1999. The firms in the private sector also follows the retirement age for the workers. However, in the private sector a firm can keep a worker after the retirement age. The retirement rule for skilled professionals is different.

[15]See Asher and Mukhopadhaya (2006).

implies that increases in labor market flexibility, captured by increase in p_s, decreases the cost of regulations.

Note that a increase in p_s will have two opposite effects on the steady state employment fraction in the formal sector m_2. A increase in p_s will have a negative effect on m_2 by increasing outflow from the formal sector and will have a positive effect on m_2 by increasing the incentive for a firm to open vacancy in the formal sector. The overall effect of changes in p_s will depend on the relative strength of these two effects. If we have information on the rate of outflow of workers from the formal sector in different states, we can figure out which effect is dominant by comparing m_2 and the rate of outflow from the formal sector for different states. A high rate of outflow of workers from the formal sector and a higher fraction of workers in the formal sector indicate the second effect will be dominant.

The effect of increase in p_s on the steady state fraction of employment in the informal sector will also be ambiguous. An increase in p_s will decrease m_1 due to increase in outflow from the informal sector. At the same time, the number of workers looking for an informal sector job will increase due to increase in the outflow of the workers from the formal sector.

The next subsection presents the steady state fraction of workers in the three sectors.

4.2 Steady State

In the steady state the inflow into a sector is equal to the outflow from the sector. The workers who are unemployed and workers in the informal sector who are matched with a sector 2 firm and draw a match quality greater than the reservation match quality will enter the formal sector. In the formal sector matches are broken at the rate of arrival of the productivity shock. In the steady state the inflow is equal to the outflow:

$$\theta_2 q_2(\theta_2)(1 - F_2(P_2^R))(m_0 + \alpha m_1) = \lambda_2^s m_2,$$

where m_0, m_1, m_2 are the fraction of the unemployed workers, workers in the informal sector and workers in the formal sector, respectively. The unemployed workers who are matched with a sector 1 firm and draw a match quality greater than the reservation match quality enter the informal sector. The workers who are hit by negative productive shock and workers who are matched with a type 2 firm move out of the informal sector. In steady state,

$$\theta_1 q_1(\theta_1)(1 - F_1(P_1^R))m_0 = (\lambda_1^s + \alpha\theta_2 q_2(\theta_2))m_1.$$

Substituting $m_2 = 1 - m_0 - m_1$ we have two equations in two variables.

$$m_0 = \lambda_2^s \left[\theta_2 q_2(\theta_2)(1 - F_2(P_2^R)) + \lambda_2^s + \frac{(\alpha\theta_2 q_2(\theta_2)(1 - F_2(P_2^R)) + \lambda_2^s)\theta_1 q_1(\theta_1)(1 - F_1(P_1^R))}{\lambda_1^s + \alpha\theta_2 q_2(\theta_2)} \right]^{-1} \tag{17}$$

and

$$m_1 = m_0 \frac{\theta_1 q_1(\theta_1)(1 - F_1(P_1^R))}{\lambda_1^s + \alpha\theta_2 q_2(\theta_2)} \tag{18}$$

The two equations above give the steady state fraction of unemployed workers and the fraction of workers in the informal sector. These fractions will be used in calculating the likelihood function.

In the empirical part of the model we introduce observed and unobserved worker heterogeneity. The observed heterogeneity is captured by educational attainment of a worker and it is assumed that there are unobserved types in population. The unobserved heterogeneity is observed by the firms but not by the researcher. It is assumed that workers with different education and different unobserved types draw productivity from different match productivity distribution. The firms and workers conduct directed search. The next section explains the variable definition and describes the data.

5 Data

The data come from two sources. The data on worker's wage, demographics and employment status come from the 55^{th} round of survey conducted in 1999-2000 by the National Sample Survey Organisation (NSSO).[16] The data on rigidity of labor regulation and general business environment of Indian states come from the Firm Analysis and Competitiveness Survey of India (2002). This survey was conducted by the Confederation of Indian Industry and the World Bank Group.

The National Sample Survey (NSS) is an all-India representative household consumer expenditure survey. It includes a parallel employment and unemployment survey every five years. The National Sample Survey Organisation started an annual survey in 1953. However, from 1972-73 onwards the survey was conducted quinquennially and the data used in this paper is from the quinquennial series. The annual surveys started again in year 1989 with a small sample size, while the large sample quinquennial surveys continued.

The survey has state-wide data with extensive information on consumption and employment. The data contain information on household characteristics like household size,

[16]For more information on NSSO go to `http://mospi.nic.in/nsso_test1.htm`.

religion, and social group. It includes information on economic status like land possessed and cultivated, monthly per capita consumer expenditure, indebtedness of rural labor households. The data also contains the demographic and migration particulars of all the household members. The survey ask questions about the principal usual activity of all the household members and the details of the enterprises for the usual status workers in the non-agriculture sector. In addition to the principal activities, it also contains particulars of two major subsidiary economic activities of the household members and details of the enterprises in which they are working. The survey asks questions about wage and salary earnings and mode of payment for the workers for all activities. The daily time disposition for the previous seven days along with the corresponding activity particulars are also available for each of the household members. In addition, the survey asks probing questions to the persons who were unemployed on all the seven days of the reference week. One-third of the households are re-surveyed after three months. This panel structure of the data is not used in estimation because it contains very few observations for each state, sector, and education group. The three month panel is used to understand the flows of workers in and out of different sectors.

In NSS 1999-2000 the actual number of persons surveyed was 509,779 from 72,576 rural households and 309,234 from 49,500 urban households. Based on current weekly status, which is based on 7 days of reference week of a worker, labor force participation rate was 37.7% in 1999-2000. Out of the workers in the labor force 4.3% were unemployed, 55% were self employed, 18.9% worked on regular salaried jobs, and 21.8% worked as daily wage workers or casual workers. Out of the regular salaried workers 65% work in the private sector and the rest in the public sector.

In this paper, we focus on workers in the manufacturing sector. The manufacturing sector account for a quarter of India's GDP.[17] There were 26 states in India in 1999-2000. However, the data on labor regulations contains data from only 11 states and Delhi. We restrict our sample to these ll states. These 11 states account for 65% of the Indian population. The final sample contains 11,386 regular workers from the manufacturing sector.

From section 2 we know that labor market regulations do not effect all workers equally. For our purposes we need to divide jobs according to coverage under the labor market regulations. A report by Expert Group on Informal Sector, published by the National Commission on Enterprises in the Unorganized/Informal Sector, India, noted that labor legislations, particularly relating to job security, are mostly applicable to en-

[17]The self employed workers are not included in the sample.

terprises employing ten or more workers.[18] The characteristics of these enterprises in terms of legal status, productivity and other economic parameters are also distinctly different from those units employing less than ten workers as revealed by various surveys. Similarly, the Annual Survey of Industries defines formal sector enterprises as those employing ten or more workers with electricity or twenty or more workers without electricity.[19] In the current estimation process the ASI's definition of formal workers has been chosen. So, a worker is defined to be working in the formal sector if number of workers at the enterprise are more than nine with electricity and more than nineteen without electricity. Rest of the workers are defined to be working on jobs in informal sector.

Table 1: Employment status of workers by states

State	No. of Workers	% Unemployed	% Employed in sector	
			Informal	Formal
Andhra Pradesh	1010	0.25	0.49	0.26
Gujarat	975	0.09	0.61	0.30
Haryana	247	0.13	0.58	0.29
Karnataka	703	0.20	0.50	0.30
Kerala	1131	0.46	0.42	0.11
Madhya Pradesh	814	0.22	0.49	0.29
Maharashtra	1799	0.22	0.50	0.28
Punjab	566	0.19	0.60	0.20
Tamil Nadu	1562	0.19	0.57	0.25
Uttar Pradesh	1179	0.23	0.61	0.16
West Bengal	1400	0.34	0.39	0.27
Total	11386	0.24	0.51	0.24

Table 1 contains fraction of the workers employed on the regular salaried jobs in the formal sector and the informal sector and fraction of the unemployed workers. The rate of unemployment in sample is 24.0% which is higher than the unemployment rate of 4.3% in 1999-00. There are several reasons for this difference. A big porportion of the labor force is self employed and the self employed are removed from the sample. The agricultural workers who are unemployed are also removed from the sample by looking at the usual status and the usual industry of an unemployed worker based on a reference period of one year. As we can see, there is significant variation in employment fractions and the unemployment rate across different states. Unemployment varies from 46% in Kerala to 9% in Gujarat. Employment in the informal sector does not vary a lot from

[18]The report is available at `http://www.mospi.nic.in/Manual%2002.doc`.
[19]For more on Annual Survey of Industries, India go to `http://mospi.nic.in/stat_act_t3.htm`.

Table 2: Average Wage of workers by states and job types

State	Mean Wage in sector	
	Informal	Formal
Andhra Pradesh	56	169
Gujarat	85	168
Haryana	138	216
Karnataka	84	210
Kerala	80	163
Madhya Pradesh	64	194
Maharashtra	101	215
Punjab	78	179
Tamil Nadu	72	160
Uttar Pradesh	72	162
West Bengal	88	209
Total	81	188

state to state. If we leave out Kerala and West Bengal employment in the informal sector goes from 49% to 61%. Employment in the formal sector moves from 11% for Kerala to 30% in Gujarat.

Table 2 gives the average wage of workers across states and two types of jobs in Indian rupee (Rs.). In 1999, the dollar rupee exchange rate was Rs. 43.50 per dollar. The daily real wage reported in the table is constructed by dividing the weekly wage by the number of full days worked in the week. If a worker worked for half time, all seven days of weeks, then the number of full days will be three and a half. The nominal daily wage is converted into real daily wage by using the state specific consumer price index for the industrial workers. As shown in Table 2, the variation in average wage across states in the informal sector is smaller than that in the formal sector.

The state level data of general business environment come from the Firm Analysis and Competitiveness Survey of India (2002) conducted by the Confederation of Indian Industry and the World Bank Group. The Firm Analysis and Competitiveness Survey is a survey of 2000 formal sector firms from 12 Indian states in the year 2002.[20] The stated goal of the survey is to advise the state governments on changing the policies that hinders expansion, or competitiveness of firms in potential export markets. The survey asks the managers questions about their firm. The managers are also asked questions about general business environment of the states including question about law and order,

[20]There is a difference of 1 to 2 years between the wage and employment data and the state level data. However, these are the qualitative question asked from the managers and it is highly unlikely the response would have changed in one year.

labor regulations, corruption, and infrastructure.

These are the indices constructed using the survey questions:

1. The index of the labor regulations, corruption, infrastructure is constructed by assigning 1 if the answer is 1, 0 if the answer is 2, and -1 if the answer is 3 to the question: From the list of 11 states tell us whether each state is better, worse or the same as your state with respect to (Code - better = 1; same = 2; worse = 3):
   (a) Labor relations,
   (b) hassles with local Government Officials,
   (c) power supply,
   (d) transport and delivery time,
   (e) telecommunication,
   (f) law and order.
2. The index of the best business environment is constructed using the answer to the question "Which state has the best business environment?"
3. The index of the worst business environment is constructed using the answer to the question "Which state has the worst business environment?"
4. The index for ideal labor fraction is constructed using the answer to the question "Given your current level of output, if you were free to choose without restrictions your current level of employment, what % of the current level would you choose?"
5. The index for implementation of the regulation is constructed using the answer to the question "How many times did the inspectors visit the plant last year (2001) for labor and social security?"

The state level variables are presented in table 3. The states are sorted according to the index of labor regulations. A higher value means that the labor regulations are less restrictive. The variables show that Kerala and West Bengal are two states with most restrictive labor regulations. These are the only two Indian states governed by a left leaning government for a long time. We also see a lower fraction of formal sector employment in these two states.

The next section presents the estimation and identification strategy employed to estimate the model.

Table 3: State level variables

State Name	Labor Regulation	Best Busi. Env.	Ideal Emp. Frac.	Corr-ption	Labor Out Flow	Union Inte-nsity	Fem. Lite-racy
Maharashtra	0.36	39.69	90.73	2.10	16.97	0.23	67.51
Gujarat	0.20	18.34	81.96	2.30	16.75	0.15	58.60
Andhra Pradesh	0.19	10.49	93.69	1.65	9.39	0.16	51.17
Karnataka	0.16	7.85	91.54	2.26	16.88	0.18	57.45
Tamil Nadu	0.04	7.42	86.96	2.25	12.51	0.23	64.55
Punjab	0.13	6.07	93.94	1.45	28.75	0.20	63.55
Haryana	-0.05	3.71	89.52	1.28	15.35	0.18	56.31
Madhya Pradesh	-0.13	2.43	95.91	1.62	12.08	0.12	50.28
Uttar Pradesh	-0.30	1.64	95.81	2.09	30.32	0.12	42.98
Kerala	-0.23	1.28	87.08	1.38	4.14	0.43	87.86
West Bengal	-0.40	1.07	94.26	1.98	10.29	0.24	60.22

6 Estimation and Identification

The parameters of the model presented in the last section are obtained using the maximum likelihood estimation method. We will first layout the functional. In the next subsection, identification strategy is discussed. The last subsection describes estimation of the likelihood function.

It is assumed that the productivity of a match is product of a state specific deterministic term and a log normal random variable. The match productivity for a job in sector k is given by

$$P_k = (X\gamma_k)\epsilon_k$$

Here the vector X contains state specific variables and $\gamma_k = \{p_{k0}, p_{k1}, ...p_{km}\}$ is the parameter vector. It is assumed that $\log \epsilon_k \sim N(0, \sigma_k^2)$.

The rate at which a match is broken in the formal sector is also a function of the state specific variables.

$$\lambda_2^s = \lambda^L p(X\gamma_p) + \lambda^w$$

Here γ_p is the parameter vector and p(.) is the probability that a firm is able to lay off the worker when the profits are low. It is a function of the state specific variables X. The two Poisson rates λ^w and λ^L are same across all states. It is assumed that $p(.)$ follows the following functional form:

$$p(X\gamma_p) = \frac{1}{1 + \exp(-X\gamma_p)}$$

The bargaining power of workers in the two sectors vary across states. The bargaining power of a worker in sector k is a function of state specific variables X and parameter vector η_k. It is given by

$$\beta_k = \frac{1}{1 + \exp(-X'\eta_k)}$$

It is assumed that there are different types of workers in the data. The workers of different types draw productivity shock from a different distribution when matched with a firm. The heterogeneity in productivity distribution is observed by the firms but not by the researcher. The firms open a type specific vacancy. In other words, a firm specifies the type of worker when opening a vacancy and a worker searches for his/her own type job.

In the next subsection we discuss the identification of the model in the case when there is no unobserved heterogeneity. The identification with the unobserved type follows because we have assumed a functional form for the match productivity distribution.

6.1 Identification

The model presented in the section 4 have the following parameters.

- The distribution of the match productivity and the reservation productivity: $F(P_k)$, P_k^R.
- The bargaining power each of the two sectors: β_k.
- The Poisson arrival rates: λ^w, λ_1^s, λ^L, λ^H.
- The matching function and the cost of a vacancy: $q_k(\theta_k) = \theta_k^{-mu_k}$, c_k^v.
- The search intensity parameter for worker in the informal sector: α.
- The cost of regulations, C_2, and p_s for each state.

The parameters of the model are identified using the wage equations (equation 12 and 13), steady state conditions, two market equilibrium conditions (equation 14), two reservation wage equation (equation 15 and 16) and the observed separation rate of the workers from the formal sector. The reservation wage of a worker is given by setting the total surplus from a match equal to zero. The model predicts that the minimum observed wage in the data will be:

$$\begin{aligned} w_1(P_1^R) &= rv_0 - \alpha\theta_2 c_2^v \frac{\beta_2}{1-\beta_2} &&= P_1^R \\ w_2(P_2^R) &= rv_0 &&= P_2^R - C_2 \end{aligned}$$

Using the above relation we can identify the reservation productivity as a function of the cost of regulations. Note that, even if the distribution of P_1 is same across states, the minimum wage in the informal sector might be different because of the differences in the market tightness for the two sectors. The market tightness might be different across states due to the differences in $p(X_p^{'}\gamma_p)$ and C_2. From the first equation, w'e can identify P_2^R as a function of C_2 and we can directly identify P_1^R. The wage equation for the two sector is given by:

$$\begin{aligned} w_1(P_1) =&(1-\beta_1)w_1(P_1^R) + \beta_1 P_1 \\ w_2(P_2) =&(1-\beta_2)w_2(P_2^R) + \beta_2(P_2 - C_2) \end{aligned}$$

The two wage equations with the two minimum wages help us identify distribution of the match productivity up to bargaining power of the worker. The expected value of a formal sector job for an informal sector worker can be identified by $\alpha\theta_2 c_2^v \frac{\beta_2}{1-\beta_2} = w_2(P_2^R) - w_2(P_2^R)$.

In the steady state the inflows into a sector are equal to the outflows. We have the following equalities:

$$\begin{aligned} \theta_2 q_2(\theta_2)(1-F_2(P_2^R))(m_0 + \alpha m_1) =&\lambda_2^s m_2 \\ \theta_1 q_1(\theta_1)(1-F_1(P_1^R))m_0 =&(\lambda_1^s + \alpha\theta_2 q_2(\theta_2))m_1 \end{aligned}$$

The left hand side of the first equation is the rate of inflow of the workers from the unemployment pool and the informal sector to the formal sector. The right hand side is the rate of outflow of the workers from the formal sector. Similarly, the left hand side of the second equation is the rate of inflow of the workers from the unemployment pool to the formal sector. By assumption, workers do not move directly from the formal sector to the informal sector. The right hand side is the rate of outflow of the workers from the informal sector. We observe m_1, m_2, and m_0. The formal sector and the informal sector job finding rate and λ_1^s can be expressed as functions of λ_2^s and b,

$$\begin{aligned} \theta_2 q_2(\theta_2) =&\frac{\lambda_2^s m_2 - (w_2(P_2^R) - w_2(P_2^R))(1-F_2(P_2^R))m_1}{(1-F_2(P_2^R))m_0} \\ \theta_1 q_1(\theta_1) =&rv_0 - b - \theta_2 q_2(\theta_2) \\ \lambda_1^s =&\frac{\theta_1 q_1(\theta_1)(1-F_1(P_1^R))m_0}{m_1} - \alpha\theta_2 q_2(\theta_2) \end{aligned}$$

The separation rate of the worker in the formal sector for each state is available from the Annual Survey of Industry. We estimate λ_2^s using the separation rate of the workers in the formal sector. There is no unemployment benefit in India. There are job security

schemes in which the workers are assisted by providing employment in large scale infrastructure programs. These programs are labor intensive and relevant for the workers in the casual workers.[21] So, we set the unemployment benefit for the workers searching for a job in the formal and the informal sector equal to zero. This helps us pin down the two job finding rates.

The rate of return r is set equal to the real interest rate on the government bonds. The annual interest rate on the government bonds in 1999 was around 12.0%. The bargaining power of the workers cannot be identified but we can identify variation in the bargaining power across states. The bargaining power of the workers in the informal sector tend to be lower than the bargaining power of the workers in the formal sector.[22] The bargaining power of the workers in Andhra Pradesh is set to 0.5 for the informal sector and 0.75 for the formal sector. The bargaining power in the other states is equal to bargaining power in Andhra Pradesh plus effect of union intensity and general awareness of law measured by the female literacy rate. Since we have only the worker side data, the productivity distribution for a sector is identified for a fixed bargaining power. A higher bargaining power of worker will result in lower estimates of the mean of the productivity distribution. The reason is that we are identifying the productivity distribution using the observed wages and expected wage is increasing in match productivity and bargaining power. This means that larger bargaining powers in the formal sector means that we will get smaller differences in productivity between the two sector. In other words, if we assumes that the worker's bargaining power is same in two sectors than we will get bigger effects than what we estimate. So, our choice of bargaining power is on the conservative side.

The cost of a vacancy and the cost of regulations are identified from the market equilibrium condition in equation 14. The next subsection presents the EM algorithm used to estimate the parameters of the model.

6.2 Estimation

The EM algorithm is used to estimate the maximum likelihood estimates of the parameters of the model presented in section 4.[23] The EM algorithm is a two step iterative procedure to find maximum likelihood estimates of a model which depends on unobserved latent variables. In the E-step, called so for the Expectation step, the expec-

[21] One such program is Jawahar Rozgar Yojana. For more information on the Jawahar Rozgar Yojana see Gaiha et al (1998).

[22] Reference `http://www.oecd.org/dataoecd/54/25/38355655.pdf`.

[23] The name of the algorithm comes from Dempster, Laird and Rubin (1977). The algorithm had been in use before 1977.

tation of likelihood is calculated for given values of the unobserved latent parameters. In the M-step or the Maximization step the parameters of the model are estimated by maximizing the function obtained in the E-step. The parameter estimates obtained in the M-step are then used to obtain the unobserved latent parameters. The next E-step is constructed using the estimates of the latent parameters obtained in the last step. This process is iterated till the likelihood converges.

In our model proportions of the unobserved worker types are the unobserved latent variables. We first describe how likelihood is estimated and then we talk about the EM algorithm in the context of our model.

Likelihood Estimation: The likelihood of data is given by probability of observing a flow, wage w_j, and a stock, employment status d_j. The likelihood of observing w_j, d_j for a type i worker is given by:

$$\begin{aligned} L(w_j, d_j|\Psi_i) =& \mathrm{P}(w_j, d_j|\Psi_i) \\ =& \mathrm{P}(w_j|d_j, \Psi_i)\mathrm{P}(d_j|\Psi_i) \\ =& \begin{cases} \mathrm{P}(w_j|\epsilon_k \geq \epsilon_k^R, \Psi_i)\mathrm{P}(d_j = k|\Psi_i) & \text{if } k \neq 0 \\ \mathrm{P}(d_j = 0|\Psi_i) & \text{if } k = 0 \end{cases} \end{aligned}$$

Here Ψ_i is a vector containing the model parameters for the unobserved type i workers. In the steady state inflow in a sector is equal to the outflow. We get the following formula for probability of a worker in sector d_j by using the steady state conditions.

$$\begin{aligned} \mathrm{P}(d_j = 0|\Psi_i) =& \frac{\lambda_2^p \mathrm{P}(d_j = 2|\Psi_i) + (\lambda_1^p + \alpha\theta_2 q_2(\theta_2) F(\epsilon_2^R))\mathrm{P}(d_j = 1|\Psi_i)}{\theta_2 q_2(\theta_2)(1 - F(\epsilon_2^R)) + \theta_1 q_1(\theta_1)(1 - F(\epsilon_1^R))} \\ \mathrm{P}(d_j = 1|\Psi_i) =& (1 - F(\epsilon_1^R))\frac{\theta_1 q_1(\theta_1)\mathrm{P}(d_t = 0|\Psi_i)}{\lambda_1^p + \alpha\theta_2 q_2(\theta_2)} \\ \mathrm{P}(d_j = 2|\Psi_i) =& (1 - F(\epsilon_2^R))\frac{\theta_2 q_2(\theta_2)(\mathrm{P}(d_t = 0|\Psi_i) + \alpha\mathrm{P}(d_t = 1|\Psi_i))}{\lambda_2^p} \end{aligned}$$

Let $g_k(w_j|\Psi_i)$ be the density of observed wage for the unobserved type i worker who is working in sector k. The likelihood of observing w_j, d_j for a type i worker is given by:

$$\begin{aligned} L(w_j, d_j = 0|\Psi_i) =& \frac{\lambda_2^p \mathrm{P}(d_j = 2|\Psi_i) + (\lambda_1^p + \alpha\theta_2 q_2(\theta_2) F(\epsilon_2^R))\mathrm{P}(d_j = 1|\Psi_i)}{\theta_2 q_2(\theta_2)(1 - F(\epsilon_2^R)) + \theta_1 q_1(\theta_1)(1 - F(\epsilon_1^R))} \\ L(w_j, d_j = 1|\Psi_i) =& \begin{cases} g_1(w_j|\Psi_i)\frac{\theta_1 q_1(\theta_1)\mathrm{P}(d_t=0|\Psi_i)}{\lambda_1^p + \alpha\theta_2 q_2(\theta_2)} & \text{if } \epsilon_1 \geq \epsilon_1^R \\ 0 & \text{if } \epsilon_1 < \epsilon_1^R \end{cases} \\ L(w_j, d_j = 2|\Psi_i) =& \begin{cases} g_2(w_j|\Psi_i)\frac{\theta_2 q_2(\theta_2)(\mathrm{P}(d_t=0|\Psi_i) + \alpha\mathrm{P}(d_t=1|\Psi_i))}{\lambda_2^p} & \text{if } \epsilon_2 \geq \epsilon_2^R \\ 0 & \text{if } \epsilon_2 < \epsilon_2^R \end{cases} \end{aligned}$$

The log likelihood of the observed data $\{w_j, d_j\}_{j=1}^n$ will be:

$$l(\{w_j, d_j\}_{j=1}^n|\Psi, \rho) = \sum_{j=1}^{n} \log(\sum_{i=1}^{m} \rho_i L(w_j, d_j|\Psi_i))$$

Here ρ_i is the proportion of i^{th} type worker in the population.

EM Algorithm: The EM algorithm consists of following steps:

1. Estimate the likelihood function $l(\{w_j, d_j\}_{j=1}^n|\Psi, \hat{\rho})$ for a given $\hat{\rho}$.
2. Get an estimate of Ψ by maximizing the likelihood function for fixed $\hat{\rho}$.
3. Update the unobserved type fractions by using the following formula:

$$\hat{\rho}_i^{'} = \frac{1}{n} \sum_{j=1}^{n} \frac{\hat{\rho}_i L(w_j, d_j|\hat{\Psi}_i)}{\sum_{i=1}^{m} \hat{\rho}_i L(w_j, d_j|\hat{\Psi}_i)}$$

4. If the likelihood is converged then stop, otherwise go back to the first step with $\hat{\rho} = \hat{\rho}^{'}$.

The variance covariance matrix is estimated by inverting the estimated information matrix.

The sample is divided into three different education groups. The workers with primary school or less education are in group one, the workers with middle school to high school education are in group two and the workers with more than high school education are in group three. The model is estimated separately for the three education groups. In the next section we will talk about the results and how changes in parameters change mean wage and the steady state fractions of workers in the three sectors.

7 Results

This section presents the results for the workers with more than high school education. The model is estimated with three unobserved productivity types for this group. The proportion of the unobserved types, with standard error in the parenthesis, are presented in table 4. The proportions of different unobserved types are identified by the distribution of wages in a state. If the right tail of the wage distribution is thicker, the proportion of the lowest productivity types will be higher. As shown in the table, the proportion of the lowest type is highest in the three poorest states (in terms of the per capita income): Andhra Pradesh, Madhya Pradesh, and Uttar Pradesh have 11%, 16%, and 14% lowest productivity type workers, respectively. The three states: Karnataka, Kerala, and Tamilnadu are the medium income states and the proportions of the lowest

Table 4: Type Probability

State	Proportion of Workers with Unobserved Productivity		
	Type 1	Type 2	Type 3
Andhra Pradesh	0.11	0.40	0.49
	(0.0709)	(0.0986)	
Gujarat	0.03	0.41	0.56
	(0.0205)	(0.0424)	
Haryana	0.04	0.35	0.61
	(0.0282)	(0.0826)	
Karnataka	0.08	0.28	0.64
	(0.0358)	(0.0513)	
Kerala	0.03	0.35	0.62
	(0.0152)	(0.0536)	
Madhya Pradesh	0.16	0.28	0.56
	(0.0628)	(0.0561)	
Maharashtra	0.03	0.27	0.70
	(0.0807)	(0.0347)	
Punjab	0.02	0.39	0.59
	(0.0131)	(0.0610)	
Tamil Nadu	0.07	0.42	0.51
	(0.0192)	(0.0338)	
Uttar Pradesh	0.13	0.34	0.54
	(0.0277)	(0.0302)	
West Bengal	0.06	0.19	0.75
	(0.0161)	(0.0308)	

productivity type in these three states is 8%, 3%, and 7%. The proportion of the low productivity type varies from 2% to 6% for the richest five states. The proportions of the medium and the high productivity type also follow similar pattern. The proportion of the lowest type is estimated imprecisely for some states. This is expected because the proportion are small which means that very few observations are used for the identification of the lowest proportion. The standard error for the medium type is low.

The estimates of the model with three unobserved productivity types are presented in the table 5.[24] The standard error of the estimates are reported in the parenthesis. The top part of the table presents estimates which are different for different types and the bottom part of the table presents estimates of the parameters which are same for all three unobserved types.

The estimate of the search intensity for a formal sector job while working in the

[24]The rates reported in the table are monthly rates and all wages and cost are in Indian rupee per week. In 1999 the average exchange rate was \$1 = Rs 43.50.

informal sector (α) is higher for the high productivity type. A higher α decreases the outside option of a informal sector worker and hence reduces the minimum wage. Intuitively, higher α means option value of staying unemployed to look for a formal sector job is lower. As noted in the identification strategy section, this parameter is identified by the difference in the observed minimum wage for each type. The lowest productivity type worker search for a job in the formal sector at 55% intensity of an unemployed worker. This goes up to 65% for the type 2 worker and 77% for the type 3 worker.

The standard deviation of log of the productivity random variable increases the expected value of a match. The estimate of the standard deviation is the highest for the type 3 workers in the informal sector and for the type 1 workers in the formal sector. The cost of search is type and sector specific. The cost of search for i^{th} type and k^{th} sector is given by the product of the parameter c_{ki} and the constant in the productivity function P_{ki0}.

The constant term of the productivity parameter p_{k0} for the three types are 17, 68, and 82 for the informal sector and 59, 98 and 142 for the formal sector. These parameters are identified by the wage distribution for a fixed bargaining power of the worker. The coefficient for all the state specific variables included in the productivity parameters for the both sector are statistically significant. The reason might be that the variation comes from only 11 states and most of the variation in the observed wage distribution is soaked by the unobserved types.

The bargaining power of a worker in Andhra Pradesh is set to 0.5 for the informal sector and 0.75 for the formal sector. The labor unions are more organized and powerful in the formal sector than the informal sector. So, a formal sector worker is likely to have higher bargaining power than an informal sector worker. The bargaining power varies across states as a function of union intensity and the female literacy rate.[25] The bargaining power of a worker in the informal sector varies from 0.37 for Uttar Pradesh to 0.92 for Kerala. In the informal sector it varies from 0.72 to 0.87 for the two states. The Cobb Douglas coefficient of the matching function is 0.54 for the informal sector and 0.23 for the formal sector. The matching function is identified by the steady state condition that inflows in a sector should be equal to outflows.

[25]The bargaining power of a k^{th} sector worker in state s is

$$\beta_k(uint_s) = \frac{1}{1+\exp(-\beta_{k0} - \beta_{k1} unit_s - \beta_{k2} flit_s)}.$$

Here $uint_s$ is the union intensity in state s and $flit_s$ is the female literacy rate. The coefficient $\beta_{10} = 0$, $\beta_{20} = 1.1$ and $uint_s = flit_s = 0$ for Andhra Pradesh.

Table 5: Estimates

	Informal Sector			Formal Sector		
	Type 1	Type 2	Type 3	Type 1	Type 2	Type 3
Intensity of search	0.55	0.65	0.77			
	(3.850)	(0.544)	(0.255)			
SD of log of the	0.68	0.62	1.16	0.55	0.51	0.70
Productivity Distribution	(0.007)	(0.005)	(0.001)	(1.435)	(0.002)	(0.001)
The Cost of Search	4.14	3.67	2.30	3.30	3.11	5.32
Factor, c_k^v	(0.055)	(0.002)	(0.000)	(0.007)	(0.024)	(0.285)
Productivity Distribution	16.97	68.20	81.67	59.17	98.29	142.26
Factor, p_{k0}	(2.728)	(3.122)	(4.369)	(155.867)	(0.453)	(0.425)
These estimates are same for all three types.						
Electricity, p_{k1}	-0.18			-0.23		
	(53.826)			(124.877)		
Transportation, p_{k2}	-0.14			0.31		
	(52.562)			(183.980)		
Telecommunication, p_{k3}	-0.32			-0.42		
	(77.292)			(202.905)		
Law and Order, p_{k4}	0.52			0.88		
	(35.313)			(68.375)		
Business Environment, p_{k5}	0.80			-0.42		
	(3.067)			(8.342)		
Worker's Bargaining Power $= 1/(1+\exp(\beta_{k0}+\beta_{k1}x_1+\beta_{k2}x_2))$						
Union Intensity, β_{k1}	2.86			2.17		
	(0.004)			(5.757)		
Female Literacy, β_{k1}	0.05			0.01		
	(0.000)			(0.032)		
The Cobb Douglas Parameter of the Matching Function						
	0.54			0.23		
	(0.002)			(0.001)		
Cost of regulations $= C_{20} - p_s C_{21}$						
C_{20}	188.16					
	(0.279)					
C_{21}	-176.71					
	(0.429)					
Separation Rate						
Informal Sector	0.22					
	(0.000)					
Labor Regulation				1.13		
				(0.051)		
Corruption				-0.07		
				(1.039)		
Desired Unemployment Fraction				0.27		
				(8.249)		
Average number of Inspections				-0.26		
				(0.002)		

Table 6: Job Finding Rate for the Informal and the Formal Sector Job

	Informal Sector			Formal Sector (×10)		
State	Type1	Type 2	Type 3	Type1	Type 2	Type 3
Andhra Pradesh	0.41	0.42	0.82	0.085	0.243	0.459
Gujarat	0.36	0.36	0.73	0.030	0.239	0.347
Haryana	0.35	0.36	0.73	0.026	0.207	0.310
Karnataka	0.34	0.34	0.71	0.081	0.380	0.411
Kerala	0.10	0.10	0.21	0.002	0.035	0.109
Madhya Pradesh	0.43	0.44	0.88	0.069	0.403	0.511
Maharashtra	0.27	0.25	0.52	0.135	0.455	0.399
Punjab	0.29	0.31	0.62	0.003	0.042	0.146
Tamil Nadu	0.27	0.29	0.57	0.006	0.079	0.180
Uttar Pradesh	0.51	0.53	1.03	0.023	0.199	0.421
West Bengal	0.29	0.31	0.62	0.009	0.100	0.195

The cost of regulations is A function of two constants and a term which varies across states, $C_2 = C_{20} - p_s C_{21}$. The probability that a firm will be able to lay off the worker (p_s) when level of productivity is low is estimated using the state specific variables. Only two of the included four variables: index of labor regulation and average number of inspections are significant. The two constants C_{20} and C_{21} are 188 and 177, respectively. The cost of regulations is discussed in detail in the next section.

The exogenous separation rate (λ_1^s) in the informal sector is equal to 0.22. On average a match breaking exogenous separation shock arrives every 4.5 months in the informal sector. The overall separation rate in the informal sector depends on the separation shock (λ_1^s) and the rate at which a informal sector worker is matched with a formal sector firm ($\alpha\theta_2^{1-\mu_2}$). The market tightness θ_2 varies across states and productivity types. Table 6 contains job finding rate for an unemployed workers in two sectors for all three unobserved productivity types. The rate at which an informal sector worker is matched with a formal sector firm will be given by multiplying the entries on the right hand side of the table with the estimated search intensity parameter presented in table 5. In Andhra Pradesh, on average, a type one unemployed worker meets an informal sector firm per 2.4 months. This average is also 2.4 months for a type two worker and 1.2 month for a type three worker. On average it takes 9.75 years for a type one worker to meet a firm in the formal sector, 3.4 years for a type two and 2.2 months for a three worker. The estimated job finding rate for the workers from both states vary a lot across states. The variation is bigger for the formal sector workers. The formal sector job finding rate is lowest for two states with the least favorable business environment: Kerala and West Bengal.

Table 7: The cost of regulations

State	Probability Of Lay Off	Cost of regulations
Andhra Pradesh	0.47	105.87
Gujarat	0.41	115.78
Haryana	0.40	117.72
Karnataka	0.47	104.99
Kerala	0.33	130.18
Madhya Pradesh	0.43	111.67
Maharashtra	0.55	91.00
Punjab	0.27	140.64
Tamil Nadu	0.34	128.75
Uttar Pradesh	0.34	128.30
West Bengal	0.36	124.57

The differences in the job finding rate for a formal sector job come from the differences in the cost of regulations. The cost of regulations varies across states depending on the probability that a firm in the formal sector will be able to lay off a worker in response to a negative productivity shock. In the next section we conduct policy experiments by varying the lay off probability.

7.1 Counterfactuals

The expected cost of regulations induced by the labor market regulations and the probability that a firm will be able to lay off a worker when faced with a negative productivity shock are presented in table 7.

We will study the effect of a employer friendly policy which reduces the restrictions on an employer's decision to break the employment relationship. Such a policy will have a positive effect by increasing incentive to create new job due to the reduction in the expected cost of regulations. At the same time, the policy will increase rate of outflow of workers to the unemployed pool. So, effect of such a policy will depend on which of the two effect is more powerful.

Table 8 and 9 contain results of two policy experiments. In the first experiment p_s is changed by moving values of the index of labor regulations to 0.36. The biggest change is 16% points for Uttar Pradesh. The biggest value of p_s is for Maharashtra. In the second policy experiment, we look at the effct of a policy such that firms are free to fire a worker. This policy is implemented by fixing $p_s = 1$ for all states. We look at the following outcomes:

Table 8: Counterfactuals

Probability Of Lay Off	Unemployment Sector	Informal Sector	Formal Sector
Estimated	36.69	40.98	22.33
Change lab regula--tion index = 0.36	35.93	39.35	24.72
Employment at will, $P_s = 1$	27.90	25.19	46.91

Table 9: Counterfactuals

Probability	Ave. Tenure			Unemploy-	Output	
Of Lay Off	1	2	1+2	ment Spell	Average	Total
Estimated	1.71	94.62	34.48	3.48	91.73	270717.29
Increase P_s	1.70	78.75	31.42	3.33	92.17	275284.17
Employment at will	1.57	41.14	27.32	2.57	101.32	340589.47

- total production,
- the employment fractions,
- the average tenure of a worker,
- the average unemployment spell.

A policy of employment at will doubles the employment in the formal sector and reduces unemployment by 24%, decreases average unemployment spell by 26% and average tenure by 21%, increases output by 26%. We get similar results for the first experiments with smaller magnitude of change. A 26% increase in output shows the welfare implication of restrictive job security regulations are substantial.[26] As noted at the end of section 6, these result depend on the worker's bargaining power in two sectors. We fixed worker's bargaining power in two sector such that we get conservative estimate of increase in the total output. These are the preliminary estimate and we need to conduct robustness checks to test the validitiy of this result. However, the choice of unidentified parameters is on the conservative side.

[26]Guner et al. (2006) study macroeconomic implications of policies which depend on the size of the firm. They find that policies that reduce the average size of an establishment by 20% lead a reduction in output up to 8.1%. Guner et al. (2006) are doing a cross country study using the Lucas (1978) worker-manager model. The size distribution of the firms is calibrated using the US economy.

8 Conclusion

We studied the effect of job security regulation on market outcome in presence of a sector which is not covered under these regulations. The welfare implications of job security regulations in Indian manufacturing industry are substantial. A policy of employment-at-will increases total manufacturing output by 26%. To estimate the welfare effect a two sector model with matching frictions is estimated using data from Indian states. The model is flexible, favorable labor market regulations can lead to an increase or decrease in employment in the informal sector. The job security regulations also have a substantial impact on the structure of the work force. If there is no restriction on firms to lay off workers, employment and fraction of workers in the formal sector increases, average tenure decreses but unemployment spell falls.

Workers in the informal sector usually have poor working conditions and lower benefits. Job security regulations are not fulfilling their purpose. These regulations tend to shift production from the formal sector, which has lower separation rate, to the informal sector which has higher separation rate. The effect of job security regulations is that they make jobs in the formal sector more secure at the cost of workers who are unemployed or in the uncovered sector.

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