Firing Costs and Flexibility: Evidence from Firms' Employment Responses to Shocks in India*

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Abstract

A key prediction of models of dynamic labor demand is that restrictions on firing attenuate firms' employment responses to economic fluctuations. We provide the first direct empirical test of this prediction using data on industrial firms in India. We exploit the fact that fluctuation in rainfall within districts, through its effects on agricultural productivity, generates variation in local demand and local labor supply. Using a measure of labor regulation strictness, we compare factories' input and output responses to these shocks in pro-worker and pro-employer districts. Our results confirm the theory's predictions: industrial employment is more sensitive to shocks in areas where labor regulations are less restrictive. We verify that our results are robust to controlling for endogenous firm placement and vary across factory size in the pattern predicted by the institutional features of labor laws in India.

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1 Introduction

An old insight from labor economics is that firing costs reduce the extent of employment adjustment to economic shocks: during a downturn, firing costs reduce the number of layoffs, while during an upturn, hiring is curbed because of the possibility of having to lay off workers in the future (Oi 1962, Nickell 1986, Hamermesh 1993). Employment inflexibility (from the firm's perspective) and its possible negative effects on average as well as aggregate output, employment and wages, is therefore the price of job security provisions, and this is the basis of a great deal of policy debate surrounding draconian labor laws that have been enacted in many countries (as documented, for example, by Botero et al 2004).[1]

In this paper we provide the first direct test (to our knowledge) of the prediction that the magnitude of employment responses to shocks should vary negatively with the degree of employment protection. Obtaining a credible test of this prediction is difficult for a number of reasons. In the first place, we require a setting where there is variation across space and/or time in the extent of employment protection, with the added requirement that this policy variation does not simply reflect variation in unobserved determinants of employment. Arguably, the latter condition does not obtain in cross-country or even within-country time-series variation in employment protection policies (however, see Heckman and Pages (2004) for some evidence that labor reforms in Latin America may be considered to have been exogenous).

Being able to credibly attribute differences in outcomes to differences in labor regulation is obviously a general problem for any study of the effects of labor policies. An additional concern for a study such as ours is the identification and measurement of fluctuations. Because the source of fluctuations is typically not observable or directly quantifiable, previous empirical studies have inferred the magnitude of fluctuations from changes in observable

[1] The effects of job security provisions on average and aggregate outcomes are, however, theoretically ambiguous. Because firing restrictions reduce hiring as well as firing, the average level of employment (for a given firm) may either increase or decrease (Bentolila and Bertola 1990 suggest that for realistic parameter values higher firing costs may actually raise average employment). The effects on aggregate levels of output and employment are also indeterminate, once we account for the effects of these restrictions on entry and exit (however see Hopenhayn and Rogerson 1993 for calibrations that suggest a negative overall effect of a tax on job destruction). Finally, as Basu, Fields and Gupta (2008) argue, job security provisions can even result in a lower level of wages, hurting the very constituency they are meant to protect.

quantities such as output or sales. For example, Bentolila and Saint-Paul (1992), in their study of the effects of the introduction of flexible labor contracts in Spanish manufacturing, measure shocks by the change in log sales of a firm, which they then relate to employment responses. Similarly, Abraham and Houseman (1993) relate (aggregate) employment to output in their comparison of employment dynamics in the United States and Germany.

This approach is problematic for at least two reasons. Firstly, fluctuations in aggregate or firm-level output can reflect either unobserved demand or cost shocks (or both), and the corresponding change in employment can be expected to be different in each case. Secondly, this method cannot satisfactorily distinguish between fluctuations that are foreseeable and those that are inherently unpredictable. The distinction is potentially important because, depending on the structure of adjustment costs, it may be optimal to smooth foreseeable fluctuations in advance, so that the resulting variation in employment is of a different character than in the case of unpredictable shocks. Indeed, the relation between employment and leads and lags of aggregate output is likely to be very different in the two cases. The key innovation of this paper is its utilization of a well-defined and measurable source of fluctuations that are strictly unpredictable in nature, exogenous to the labor regime and comparable across the units of study–this is the precise sense in which we think of our test as being 'direct'. This approach avoids the problems associated with defining fluctuations in terms of endogenously determined variables.

Our setting is rural India, where agriculture exists alongside industry. Differences in employment protection laws across the states of India (and over time) provide variation in firing costs in the industrial sector. An institutional feature of employment protection laws in India is that they only apply to factories above a certain size threshold. As we discuss in more detail later, this provides us with a credible way to ascertain whether our results are due to labor regulation or are instead being driven by unobserved factors that happen to correlate with the extent of employment protection.

To obtain a plausible shock variable, we measure rainfall fluctuations that affect agricultural yield. In this particular context, rainfall shocks are ideal for a number of reasons: (1) They plausibly give rise to labor supply and/or output demand shifts for local industries via their effect on agricultural yields; (2) they are unpredictable in nature and therefore not likely to induce anticipatory smoothing of employment (which is important for our purposes because our data are not disaggregated enough at the temporal level to identify such anticipatory smoothing); (3) they are temporary and recurring and therefore factor into the forward looking decisions of firms; (4) they are exogenous to the labor regime and are not caused by employment changes in the industrial sector or by any other factors that may affect employment, and (5) we are able to provide evidence that the measured rainfall fluctuations represent comparable shocks across labor regimes. The empirical strategy is then to test whether these shocks induce larger factory employment responses in states that have enacted pro-employer legislation.[2]

Our results provide a confirmation of the prediction that industrial employment should be more flexible in pro-employer regions. We first confirm that rainfall fluctuations do indeed impact agricultural production, wages and incomes, but not differentially across labor regimes. We then document that high (low) rainfall increases (decreases) industrial employment, indicating the operation of a demand effect via agricultural incomes. Furthermore, as predicted by theory, the induced change in employment is indeed significantly greater in pro-employer states.[3] We verify this result at two different levels of aggregation: at the level of the district and at the state-industry level (the latter is based on a longer panel of data, as detailed in Section 4.4). Consistently across both datasets, we find that the employment response to the measured shock is 7-8% greater in pro-employer regions than in pro-worker regions.

Because labor regulation is likely to be related to a host of factors which may directly affect employment adjustment, it is possible that our results in part reflect the effects of

[2] A potential complication in this exercise is that rainfall fluctuations create opposing effects on employment: on the one hand, good (bad) rainfall increases (decreases) agricultural incomes and hence demand for local industrial goods, but on the other hand good (bad) rainfall may increase (decrease) agricultural demand for labor and represent a negative (positive) labor supply shock for local industry. However, we show in Section 3 that if rainfall fluctuations create comparable wage and price shocks across labor regimes, the *net* effect of price and wage changes on employment is magnified in lower firing cost regimes-this is the hypothesis being tested. Key to this test is the comparability of measured fluctuations across space and time, which we establish in Section 6.

[3] We present some additional evidence indicating that the dominant channel of influence of rainfall fluctuations is local demand, rather than wages. We split industries into two groups: those that we think are likely to be producing for local markets and those that are less likely to be dependent on local demand. Consistent with our interpretation, we find that in the face of poor rainfall, employment declines to a much greater extent in the former group of industries, and that the magnitude of the response is greater in pro-employer regimes.

these factors. We attempt to deal with this in several ways. First, we test the robustness of the results to the inclusion of a set of controls that may be plausibly correlated with labor regulation. In particular, we control for interactions of the rainfall shock variable with the following: the ratio of agrarian employment to total employment, the percent landless in the total population, average capital-to-output ratio amongst factories, and the share employed in industries linked to agriculture. The idea is that the way in which districts respond to rainfall shocks may well be related to these characteristics, which in turn could be correlated with the strictness of labor regulation. We verify that the results are indeed robust to the inclusion of these interaction terms.

Second, we exploit the institutional features of labor regulation in India: as set down by the Industrial Disputes and Resolution Act of 1947, laws regulating the layoff and retrenchment of workers only apply to formal sector establishments employing at least 50 workers. Furthermore, an even stricter set of regulations govern retrenchment and layoffs for establishments employing more than 100 workers. Consistent with this definition of the labor laws, we find that the employment responses to local rainfall shocks in the small-scale factory sector (i.e. factories employing fewer than 50 workers) do *not* vary by the strictness of the labor regime, whereas the response to these shocks in the large sector (i.e. factories with more than 100 workers) is indeed more highly correlated with labor regulations than the response in the medium sector (i.e. factories employing between 50 and 100 workers). We believe this is compelling evidence that the differential responses across labor regimes for regulated factories are indeed attributable to differences in labor regulation.

If capital is mobile, there may be selection of firms into regions, raising a subtle issue of interpretation. It is not implausible that factories that need to be flexible in their employment may choose to locate in regions with weak employment protection - in this case, the results noted above would reflect this selection, rather than the effect of employment protection on employment responses of the "average" factory. Although regulation in India significantly constrains the relocation of firms, the selection effect may operate through the entry decisions of new firms. While this interpretation is still consistent with an overall effect of labor regulations, it has a different policy implication because to the extent that there is indeed selection, we will be exaggerating the effect of firing costs on employment flexibility. Assuming that the technological substitutability of other inputs for labor is uniform within each industry, one possible way to remove the selection effect may be to compare the employment responses of factories within the same industry that are located in different regions with different labor regimes. When we confine attention to responses within the same industry, we find that our results on employment responses remain practically unchanged, suggesting that selection into labor regimes is not a concern.

Our focus in this paper is primarily on the test of the hypothesis that firing costs reduce employment flexibility, but it is natural to ask how reduced flexibility translates into outputs, profits and intensity of usage of non-labor inputs. Although we have less confidence in the accuracy of measurement of non-labor variables in the factory data, it does appear that the average change in output and profits due to shocks is no greater for factories in pro-labor regions. Taken at face value, this finding suggests that the latter are able to compensate for the lack of employment flexibility by adjusting along other margins.

We can think of a few explanations along these lines: (1) There may be selection of factories into labor regimes on the basis of their ability to substitute non-labor inputs for labor – however, to the extent that this "flexibility" varies by industry type, we find that the differential response across pro-worker and pro-employer states does not change even after conditioning on rainfall shock by industry type fixed effects; (2) Factories in pro-labor regimes may be differentially adjusting non-labor inputs without significant losses – we are, however, unable to find any evidence of such differential adjustment; (3) Differential exit patterns across labor regulation regimes might explain the lack of a profit effect, if the factories with the most negative profits were closing in pro-worker districts and thus leaving the sample in response to shock – we do not, however, find evidence for differential attrition in response to shock; (4) Factories that cannot adjust employment may nevertheless be able to bargain down the wage – leaving aside the fact that it seems unlikely that firms in pro-labor regimes may be more successful at bargaining wages than firms in pro-employer regimes, we are not able to find any direct evidence for this based on changes in the industrial wage; (5) Factories may adjust the intensity of worker usage rather than adjusting employment on the extensive margin – measuring responses in man-days per worker, we do not find differentially intensive usage of workers in response to shock; and (6) Factories may be adjusting to shocks by hiring and firing casual workers who are not reported on the employment rolls, and are not protected by labor regulations – we are unable to test this hypothesis because we do not have a reliable source of data on casual employment.

Our employment results are a striking confirmation of the hypothesis that job security provisions in India have constrained labor adjustment on the part of firms. Because we are looking at employment adjustment in the formal manufacturing sector (which is the only part of the economy subject to the labor laws in question), this is only one part of the full picture - to understand the overall effects of labor laws on employment and job security requires more comprehensive data. Reduced job creation and destruction rates may seem to imply longer unemployment spells, and possibly disproportionately so for certain segments of the labor force, but it is not immediately clear how this plays out in an economy in which there is a large unregulated informal sector co-existing with a smaller, regulated (but more productive) formal sector. In fact it has been conjectured that labor regulations, inasmuch as they only apply to the formal sector, tend to encourage informality. In the Indian context, this could account for the preponderance of small firms - in fact, the vast majority of non-agricultural workers in India are employed in the informal sector.

We believe this is a promising line of inquiry for future research. In the Chilean context, Montenegro and Pages (2004) use household survey data and find that job security provisions and minimum wage requirements confer positive benefits on older and skilled workers, as well as male workers, but that these benefits are achieved at the expense of young, unskilled and/or female workers. These costs of labor regulation are likely to be magnified when labor is not very mobile. Jayachandran (2006) shows that agricultural productivity shocks in rural India create large changes in the wage when labor is immobile and incomes are near subsistence level, a finding that may be related to the inability of the manufacturing sector to absorb workers. There is a sizable literature on another aspect of job security provisions, namely their effect on aggregate employment and output. Fallon and Lucas (1993) estimated labor demand to show that the increased stringency of job security provisions in India after 1982 resulted in a large reduction in employment. Similar findings are reported in Besley and Burgess (2004), based on comparing employment and output across labor regimes in India. Aghion, Burgess, Redding and Zilibotti (2008) have extended the analysis to show that the effect of labor regulations on aggregate employment and output have been greater in more regulated product markets. Overall, the negative effects of firing restrictions are many, and need to be weighed against the employment stability that they confer.

Finally, our paper also ties into a wider literature that seeks to understand the workings of the rural economy in India. Whereas the existing literature tends to focus on either the agricultural sector or the industrial sector in isolation, our results highlight the close relation between the two - in particular, our finding of the significance of local demand for the factory sector may be surprising, and should be treated as a caveat against thinking of formal sector products as being bought and sold in national rather than regional markets.

The remainder of the paper is organized as follows. Section 2 describes labor regulations in India; Section 3 outlines a standard model of labor demand with firing costs; Section 4 describes the data; Section 5 describes the empirical strategy; Section 6 describes the results; and Section 7 concludes.

2 Labor Regulation in India

The basis of labor regulation in India is the Industrial Disputes Act (IDA) of 1947, which sets out the regulations governing employer-worker relations and the legal procedures to be followed in the case of labor disputes in the factory sector. The IDA was passed by the central government, and in its original form applied equally to all states. But since India is a federal democracy, with both the central and state governments having jurisdiction over labor legislation, the act has since been amended by state governments. These amendments have caused the states to differ markedly in their labor regulations.

The IDA covers several aspects of industrial disputes, such as unfair labor practices, strikes and lockouts, and layoffs and retrenchments. It calls for the setting up of special bodies (tribunals, boards of conciliation, labor courts, etc) to arbitrate disputes in the industrial sector, while specifying their composition and extent of authority. Of specific interest for us are Sections V-A and V-B of the IDA, that describe the regulations pertaining to layoffs and retrenchments. The regulations in Section V-A cover industrial establishments in which more than "..fifty workmen on an average per working day have been employed in the preceding calendar month" (Section 25-A, Chapter V-A, IDA; see Malik 2007). This section asserts the right of workers who have been laid off or retrenched to adequate compensation. Specifically, workers who have been on the rolls for at least a year are entitled to compensation at fifty-percent of their regular wage for each day that they are laid-off (up to a maximum of 45 days). Workers who are to be retrenched are to be given one month's notice and are eligible for compensation from the employer equal to fifteen days' average pay for each year of completed service. Section V-A also limits closure of undertakings, by requiring notification of the government at least sixty days prior to closure. Furthermore, all workers thereby dispossessed of jobs are to be compensated as per the compensation for retrenched workers.

Section V-B lays out some special provisions that apply only to industrial establishments employing at least one hundred workers.[4] This section is more draconian - it requires that no workers may be laid-off or retrenched without the prior permission of the government. Closure of establishments requires an application to be filed with the government at least ninety days before the proposed closure. The penalty for violating the regulations in V-B includes a prison term of up to a year and/or fine of five thousand rupees in the case of illegal closure, and prison term of up to a month and a fine of one thousand rupees in the case of illegal layoff or retrenchment.

The IDA does not cover temporary or casual workers, so that in principle firms could work around the provisions in V-A and V-B by using casual labor. We do not have any data on the extent of casual labor and are therefore unable to identify whether casual labor is indeed being substituted for formal labor. However, as Fallon and Lucas (1993) note, the vigorous opposition of labor unions as well as the restrictions imposed on the use of contract labor by the Contract Labor Regulation and Abolition Act of 1970 are likely to significantly curtail this channel of avoidance of labor regulation.

[4] In the original IDA, this section only applied to establishments with more than 300 workers, but this threshold was subsequently revised by the central government in 1982.

3 Model

We outline a partial-equilibrium model based on Bertola (1990) that formalizes the key intuition of the paper. To keep the model simple, we do not directly introduce an agricultural sector or specify a labor supply equation - instead, we consider the labor demand of a price-taking firm that is subject to exogenous shocks to the wage and output price, the shocks being assumed to flow from productivity shocks to agriculture.

The model is set in continuous time. Consider an infinitely-lived price-taking firm that uses only labor to produce its output according to an increasing, concave production function $f(L)$. The firm discounts future profits at the constant rate r. There are two possible states of the world, denoted by G (good, or high, rainfall) and B (bad, or low, rainfall). The associated prices and wages in these states are given by p_G, w_G, p_B and p_B respectively.

Suppose that the state is currently B at time t. The transition to the G state follows a Poisson process with constant rate of arrival θ_G. Similarly the transition from state G to state B is a Poisson process with constant arrival rate θ_G. We model employment protection in terms of a simple firing cost: hiring workers is frictionless but firing workers is assumed to entail a cost of c per worker. This linear specification of adjustment costs is convenient for our purposes, but not strictly necessary. However, because our data cannot be used to distinguish between different adjustment cost specifications, we stay with the linear specification here, while remaining agnostic about the exact form.

In what follows, we will consider a stationary policy for the firm such that the firm employs L_G workers whenever the state is G and L_B workers whenever the state is B. We will assume that $p_G > p_B$, corresponding to the assumption that high-rainfall tends to raise demand for the industrial good. The wage rates in the two states are unrestricted, although we may assume without loss of generality that $w_B < w_G$, reflecting the possibility that poor rainfall reduces the labor demand in agriculture, and thereby increases the labor supply to industry. For concreteness, we will assume that the price of output and the wage in the different states are such that $L_G > L_B$ (i.e. the demand effect outweighs the wage effect, as will turn out to be true in the data).

The choice of L is analogous to investment in an asset whose return is stochastic. Since the policy is stationary, we need only define the value of the asset in the two states of the world, G and B. Let V_G and V_B denote these two values. Given the assumptions on the transition probabilities, we can use the standard asset equation to write:

$$rV_G = p_G f(L_G) - w_G L_G + \theta_G[V_B - V_G - c(L_G - L_B)] \tag{1}$$

$$rV_B = p_B f(L_B) - w_B L_B + \theta_B[V_G - V_B] \tag{2}$$

Upon transitioning to state B from state G the firm chooses L_B to solve:

$$\max \quad V_B - c(L_G - L_B) \tag{3}$$

The first-order condition is simply $\frac{\partial V_B}{\partial L_B} = c$.

On transitioning to state G from state B the firm chooses L_G to solve:

$$\max \quad V_G \tag{4}$$

The first-order condition is $\frac{\partial V_G}{\partial L_G} = 0$. These first-order conditions, along with (1) and (2) imply that $\frac{\partial V_B}{\partial L_G} = \frac{\partial V_G}{\partial L_B} = 0$.

Using the asset-pricing equations, we also have:

$$\frac{\partial V_B}{\partial L_B} = \frac{1}{r+\theta_B}[p_B f'(L_B) - w_B + \frac{\partial V_G}{\partial L_B}]$$

$$\frac{\partial V_G}{\partial L_G} = \frac{1}{r+\theta_G}[p_G f'(L_G) - w_G - c\theta_B + \frac{\partial V_B}{\partial L_G}]$$

The first-order conditions, together with the fact that $\frac{\partial V_B}{\partial L_G} = \frac{\partial V_G}{\partial L_B} = 0$ then imply:

$$p_B f'(L_B) = w_B - (r+\theta_B)c$$

$$p_G f'(L_G) = w_G + c\theta_G$$

These equations capture the intuition that adjustment costs create a wedge between the firm's marginal revenue product and the wage. The effective wage is therefore higher than the actual wage during good times and lower during bad times. It is easy to see that an increase in the firing cost c reduces employment in the high-rainfall state G and increases employment in the low-rainfall state B. Put differently, fluctuations represented by rainfall shocks will induce smaller employment adjustments in more regulated environments. This is the hypothesis we will proceed to test.

As we noted earlier, shocks represented by rainfall fluctuations plausibly create opposing effects on industrial labor demand, through the demand and labor supply channels. The model outlined here clarifies that it is the *net* effect on labor demand of these wage and price shocks that is magnified in lower firing cost (i.e. more flexible) regimes. That is to say, if the net effect of good rainfall is to increase (decrease) industrial employment, then we should expect to observe a greater increase (decrease) in employment in regions where labor regulations are less stringent. However, this conclusion is conditional on rainfall shocks representing identical demand and labor supply fluctuations across different labor regimes, i.e. on whether the rainfall shocks are comparable across regions. We will present some evidence in Section 6 to argue that this restriction appears to hold in our setting.

4 Data

4.1 Labor Regulation

As discussed in Section 2, the basis of industrial labor regulation in India is the Industrial Disputes Act (IDA) of 1947. The Act sets out the legal procedures to be followed in the case of labor disputes such as lay offs, retrenchments and strikes in a factory. The IDA was passed by the central government, but has since been extensively amended by state governments, causing Indian states to differ markedly in their labor regulations.

Besley and Burgess (2004) read all state level amendments made to the Industrial Disputes Act during 1958-1995 in 16 major Indian states (from Malik (1997)). Each amendment was coded as being either pro-worker, neutral, or pro-employer, depending on whether it lowered, left unchanged or increased an employer's flexibility in hiring and firing factory workers, respectively. A state's labor regulation regime in any year was then obtained as the sum of these scores over all preceding years. Based on this cumulative score, Besley and Burgess (2004) classified four states–Gujarat, Maharashtra, Orissa and West Bengal–as "pro-worker" in 1988. Six states–Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Rajasthan and Tamil Nadu–were categorized as "pro-employer", leaving six others–Assam, Bihar, Haryana, Jammu and Kashmir, Punjab and Uttar Pradesh–to be classified as "neutral" with respect to labor laws. These categorizations are summarized in Table 2.

We followed this scheme of cumulating the Besley-Burgess scores to categorize the states as *Pro-worker*, *Pro-employer* or *Neutral* in each year of our study. Since there were few labor law amendments after 1987, this classification remains identical to the original Besley-Burgess classification for 1988 throughout our study period. The only exception is Karnataka, which switched from being neutral to being pro-employer between 1987 and 1988.

4.2 The Industrial Sector

Manufacturing establishments in India are broadly classified as either 'factories' or informal enterprises, where the distinction is based on a cutoff defined in terms of employment: according to the Factory Act, a factory is a manufacturing establishment that employs at least 10 workers if it uses power, and at least 20 workers if it does not. Since factories alone are subject to industrial entry and labor regulation laws such as those laid out in the Industrial Disputes Act, our data set on manufacturing establishments pertains to the factory sector.

The source of our data on factories is the Annual Survey of Industries (ASI), a cross-sectional, national survey/census of factories which is conducted annually by the Central Statistical Organization of India. The ASI has two parts, the first being a census of all factories employing 100 workers or more, and the second a survey which randomly samples about a quarter of all other registered factories. The data are not a panel at the factory level due to the unavailability of factory identifiers, but the combined data from the ASI census and survey sections are fully representative of all factories in India, and can be used to estimate industrial sector aggregates at regional levels by weighting the factory-level data by the inverse of the sampling probabilities.

4.3 District Level Data Set: Factories, Rainfall Shock, Agricultural Production and Household Expenditure

The majority of our regressions examine the effects of labor regulation and rainfall shocks on the industrial sector at the spatial level of *districts*, the primary administrative unit in India. Our district-level data set is on 330 Indian districts, which constitute the 16 largest Indian states and account for nearly 95 percent of India's population. To arrive at district level estimates of factory sector employment, revenue, input costs, fixed capital and wages, we used the survey weights to aggregate unit (factory) level data from three rounds of ASI. Our final district data set has observations on 330 districts across three years - 1987, 1990 and 1994.[5] Tables 1a and 1b summarize characteristics of the districts in our sample and the industrial sector outcome variables we use, respectively. The summary statistics are grouped by pro-worker, pro-employer, and neutral states.

Our rainfall data are from the Center for Climatic Research at the University of Delaware.[6] The rainfall measure for a latitude-longitude node (on a 0.5 ° latitude by 0.5° longitude grid) combines data from 20 nearby weather stations using an interpolation algorithm based on the spherical version of Shepard's distance-weighting method. We matched these rainfall data to districts by calculating the grid point nearest to the geographic center of a district.

Previous research on India suggests that while low rainfall hurts agricultural production, excess rainfall helps.[7] Our primary measure of the rainfall shock (*Rainshock*) is therefore constructed in such a way that higher values indicate *lower* amounts of rainfall. *Rainshock* is equal to one when the annual district rainfall is less than the twentieth percentile of the district's historical average, zero when it is between the twentieth and eightieth percentiles, and minus one when it is above the eightieth percentile (this is identical to Jayachandran's 2006 definition of rainfall shocks).[8]

[5] Please see Table 3 for a summary of data sources, years of data used, and relevant variables from each dataset.

[6] This is the *Terrestrial Air Temperature and Precipitation: Monthly and Annual Time Series (1950-99), Version 1.02*

[7] See Jayachandran (2006), who finds similar results for the effects of excess rainfall on agricultural yields.

[8] This definition of shocks seems appealing because adjusting the number of workers in the face of small fluctuations is an unlikely event in as regulated an environment as we are considering. Nonetheless, we have also experimented with a continuous shock measure, which is the negative of the deviation of annual rainfall from the district's historical average, normalized by the historical standard deviation of rainfall in

Before examining the relationship between *Rainshock*, labor laws and factory employment, we show that *Rainshock* is associated with drops in agricultural production, wages and district mean per capita expenditure. Our data on agricultural production and wages of agricultural laborers are from an updated version of the district level *India Agriculture and Climate Data Set*. This data set was originally compiled for the years 1957/58 to 1986/87 by James Robert E. Evenson and James W. McKinsey Jr. using statistics published by the Directorate of Economics and Statistics (within the Indian Ministry of Agriculture). These data have been updated to 1996 using more recent issues of the same government publications.[9] We measure district annual agricultural production by a constant price-weighted sum of the district output of all major crops, where the individual crop prices are fixed at their average value in 1957-87.

Data on average household per capita expenditure in districts are based on Consumption Expenditure Surveys conducted by India's National Sample Survey Organization (NSSO) in 1987, 1993 and 1999. These cross-sectional, nationally representative household surveys are a standard source of poverty measurement in India. In estimating district level averages, households were weighted by the inverse of the sampling probabilities.[10]

4.4 State and Industry Level Data Set

In some of our regressions, we use state-industry level panel data which are also drawn from multiple rounds of ASI. We are hesitant to attempt to distinguish between industries in the district data set due to the small sample size at the district level. Fortunately, the ASI is designed to estimate manufacturing sector outcomes by industry at the state level, with every state and industry group surveyed as an individual stratum. This stratification by industries is at the 3-digit level of the ISIC classification of industries, which makes for a high level of disaggregation.

We aggregated our district level data on rainfall to the state level by taking simple aver-

the district. The results (available upon request), are qualitatively similar to the ones we report using the discrete shock measure, but less precise.

[9] Yield data updates were compiled by Rohini Pande and Siddharth Sharma.

[10] We are grateful to Rohini Pande and Petia Topalova for sharing with us their district-level estimates based on the NSSO Consumption Expenditure Surveys.

ages of district rainfall within each state. Our state level rainfall shock measure is analogous to the district level measure, and is defined in terms of deviations from the historical state averages of rainfall. There was no need to modify the labor regulation dummies since they were already defined at the state level. We then merged these with state-industry level factory data constructed by aggregating unit level annual ASI data using sampling weights and 3-digit industry codes. The resulting data set is an annual panel covering 130 industry groups across 13 states over a period of seventeen years (1980-1997).[11]

5 Empirical Strategy

5.1 District Level Regressions

Exploiting variation in rainfall across districts over time, we first measure the impact of rainfall shocks by regressing district outcomes on a rainfall shock measure ($Rainshock_{jt}$) for district j and year t. The regressions control for macro shocks with year fixed effects and for time-invariant regional variation with district fixed effects. For outcome x, our base specification is thus:

$$x_{jt} = \alpha Rainshock_{jt} + \sum_{j} \rho_j \mathbf{1}\left(District = j\right) + \sum_{t} \rho_t \mathbf{1}\left(Year = t\right) + \epsilon_{jt}. \tag{5}$$

The coefficient α estimates the average affect of the rainfall shock on the district outcome x_{jt}. Since *Rainshock* is constructed to take on higher values the lower the amount of rainfall, a negative estimate of α would mean that low rainfall has a negative effect on x_{jt}.

The theory suggests that the response of the industrial sector to shocks depends on industrial labor regulation. Accordingly, our key regressions estimate how the effect of rainfall shocks varies across districts with different labor regulation regimes by interacting

[11] The state-industry data on factories were used by Phillipe Aghion, Robin Burgess, Stephen Redding and Fabrizio Zilibotti in Aghion et al.(2008). We are grateful to the authors and the American Economic Review for making these data publicly available.

$Rainshock_{jt}$ with the labor law dummies:

$$\begin{aligned} x_{jt} &= \alpha Rainshock_{jt} + \beta\Big(Rainshock_{jt} \text{ x } Proworker_{jt}\Big) \\ &+ \delta\Big(Rainshock_{jt} \text{ x } Proemployer_{jt}\Big) \\ &+ \sum_j \rho_j \mathbf{1}\left(District = j\right) + \sum_t \rho_t \mathbf{1}\left(Year = t\right) + \epsilon_{jt}. \end{aligned} \quad (6)$$

As described earlier, districts are either *Pro-worker*, *Pro-employer* or *Neutral*, depending on the cumulative value of the Besley-Burgess labor law index in their state. Thus, β and δ measure the effect of rainfall shocks on *Pro-worker* and *Pro-employer* districts, respectively, relative to that in *Neutral* districts. For example, suppose that the average effect of rainfall shocks, as measured by α in equation 5, is negative. Then a negative estimate of δ would imply that the decrease in x_{jt} due to low rainfall is larger in *Pro-employer* districts as compared to *Neutral* districts. If α in equation 5 is estimated to be positive, then a negative estimate of δ would imply that relative to *Neutral* districts, the increase in x_{jt} due to low rainfall is lower in *Pro-employer* districts.

We estimate Equation 6 for several outcome variables. To begin with, we examine the direct effect of rainfall shocks by looking at how district agricultural production, farm wages and household per capita expenditures decline when the rains fail. Then, our main set of estimations examine the impact of rainfall shocks and labor regulation on employment in the factory sector. Finally, we look at other industrial sector outcomes such as input costs, wages, revenue and profits.

We would like β and δ to capture how responses to rainfall shocks vary across districts with different labor laws, holding all other district characteristics constant. One concern with our interpretation of the coefficients is that labor regulation might be correlated with other factors that determine how rainfall impacts on the local economy or how factories respond to the rainfall shock. For example, since workers might lobby the government for pro-worker regulation, states with more non-agricultural employment (and thus presumably a larger blue-collar lobby) may have enacted more pro-worker legislation. But less agricultural districts are also less likely to be dependent on rainfall. Another possibility is that factories' response to shocks varies by their capital intensity, and that labor laws are correlated with the average labor intensity of factories. Jayachandran (2006) addresses such concerns by including relevant district characteristics and their interactions with rainfall shock as controls. Following a similar strategy in our district level estimations, we add as controls the interactions of $Rainshock_{jt}$ with baseline characteristics of the districts that may correlate with the extent of labor regulation, such as the percent of total employment that is employed in the agrarian sector, the percent of total employment in food-based sectors, and the average capital to output ratio in industry.

5.2 State and Industry Panel Regressions

We also replicate our main results on the differential responses to rainfall shocks across labor regulation regimes using a panel which measures the factory sector by state and industry:

$$\begin{aligned} x_{skt} &= \alpha Rainshock_{st} + \beta\Big(Rainshock_{st} \text{ x } Proworker_{st}\Big) \\ &+ \delta\Big(Rainshock_{st} \text{ x } Proemployer_{st}\Big) \\ &+ \sum_s \sum_k \rho_{sk} \mathbf{1}\left(State = s \,\&\, Industry = k\right) + \sum_t \rho_t \mathbf{1}\left(Year = t\right) + \epsilon_{jt}. \quad (7) \end{aligned}$$

This is analogous to the district level regressions that measure how the response to rainfall shocks varies by labor law. x_{skt} measures the outcome in state s, 3-digit industry group k and year t. The rainfall shock $Rainshock_{st}$ is measured at the state level by averaging the rainfall in districts within every state, and as in the district level regressions, it is interacted with state labor law dummies. Thus, the interpretation of β and δ is similar to that in the district level specification. The regressions control for state-industry and year fixed effects.

Clearly, compared to the district data, the local rainfall shock is less precisely measured in these state level data. But the state-industry panel adds to our analysis in several ways. With data stretching over a period of seventeen years at annual frequency, the state-industry panel offers substantially more variation in rainfall over time. Secondly, since the ASI is stratified by state and industry, estimates of factory sector outcomes are more precise in these data. Therefore, one of our first robustness checks is to replicate the main district level results on the state and industry panel.

5.3 Robustness Checks Using the District and State-Industry Panels

In Section 6, we present the main results on employment responses, as well as a variety of supporting results which demonstrate the consistency and robustness of our empirical findings. These include 1) exploiting the fact that larger firms (in particular, the IDA specifies two employment size cutoffs) are subject to more draconian firing costs; 2) testing for differential responses to shocks across industry types classified by their *a priori* susceptibility to local demand; and 3) robustness to the inclusion of fixed effects which control for the potential selection of firms into states based on their level of flexibility in response to shocks.

6 Results

6.1 Effects of Rainfall Shocks on Agricultural Production, Agricultural Wages, and Expenditures

We begin by testing our premise, which is that the factory sector is impacted by rainfall shocks through their effects on the local population. To test whether poor rainfall induces a negative shock to local demand, we examine the impact of rainfall shocks on agricultural production and expenditures. The results of these regressions, which control for district and year fixed effects (thus exploiting changes within districts over time), are reported in Table 4. Columns 1 and 2 capture the main effects of rainfall shocks on the value of agricultural production and per capita monthly expenditures. We see large declines associated with a rainfall shock in both these variables, indicating that the mechanism of rainfall shocks' effects on the factory sector through local demand could be at play.

Next, we test whether rainfall shocks may also induce a labor supply effect – i.e. low (high) rainfall, as it reduces (increases) the productivity of agricultural laborers, would drive down (up) the agricultural wage and move workers into (out of) the industrial sector. We test for this mechanism by measuring the impact of rainfall shocks on the agricultural wage, and find, as reported in column 3, that the agricultural wage does seem to fall (rise) in response to a bad (good) rainfall shock.[12]

Finally, in columns 3-6 of Table 4, we verify that the effects of rainfall shocks on agricultural production and wages, as well as expenditures, are not differential across pro-worker and pro-employer states. If the effects *were* indeed different, the differential impact of rainfall shocks on industrial employment across labor regulation regimes may not purely be driven by the difference in regimes, but rather simply by the way in which the local economy responds to shocks differently across regimes. Columns 3-6 indicate that, for the measures mentioned above, this does not seem to be a concern: we cannot reject the hypothesis that the response of agricultural outcomes and per capita expenditures to rainfall shocks is the same across pro-worker and pro-employer states.

6.2 Effects of Rainfall Shocks on Employment by Labor Regulation Strictness

In Table 5, we report our main results on the response of industrial employment to shocks across pro-worker and pro-employer states. As mentioned in Section 5, we use both the district-level and the state-industry-level panels to test the theoretical prediction that the employment response to shocks should be larger the lower the firing costs.

Columns 1, 2, 5 and 6 of Table 5 report the average impact of rainfall shocks on measures of employment: workers and man-days in the district panel, and workers and employees in the state-industry panel. The impacts across these outcomes are large (in relation to the district and state-industry means) and negative: for example, moving from the 80th to the 20th percentile of the historical rainfall distribution generates a decrease of 500,000 man-days (column 2).

We then interact the rainfall shock variable with dummies for pro-worker and pro-employer states (as described in detail in Section 5); the results on employment are reported

[12] A decline in agricultural production could also affect the industrial sector through its effect on the price of of agricultural outputs, which are often used as intermediate inputs into production in the industrial sector (e.g. cotton sold to textile mills). As we do not have price data for these inputs, we cannot test for this channel directly. However, when we regress the value of "materials" used in production on the rainfall shock main effect, we find a small and insignificant negative coefficient (results not shown here), indicating that, at least the value of intermediate materials used does not decline in response to rainfall shock.

in columns 3, 4, 7 and 8. Note that in these regressions, we control for interactions of rainfall shock with baseline district characteristics, including the percentage agrarian employment, percent landless in district, average capital-to-output ratio in the district, and percent employed in industries linked to agriculture. We also control for district and year fixed effects in the district panel, and analogously, state-by-industry fixed effects in the state-industry panel. For three out of the four employment-related outcomes shown, we can reject the hypothesis that the response to shock is equal across pro-employer and pro-worker states. Further, the point estimate on the difference between the two interaction coefficients shows that the employment response is *greater* in pro-employer states. Indeed, in pro-worker states, we see no statistically significant response in employment at all. In terms of magnitudes, pro-employer districts shed about 1900 more workers than pro-worker districts, and pro-employer state-industry groups shed about 270 workers more than their pro-worker counterparts - in percentage terms, these figures are results are remarkably consistent, implying a 7.7% relative difference in response. These results constitute our main test of the theoretical predictions from the canonical labor demand model laid out in Section 3.

6.3 Effect of Shocks on Employment by Factory Size

In this section, we exploit the particulars of the regulation set forth in the IDA related to the extent of firing costs for large factories. As described earlier, the IDA regulation stipulates that larger factories will face higher firing costs. In particular, factories with employment below 50 face no firing costs; factories with employment between 50 and 100 must compensate workers who are retrenched; and factories with employment greater than 100 workers must file each layoff with the government, who then has the power to deny the factory the ability to retrench. Accordingly, we partition our factories data and aggregate to the district level corresponding to these cutoffs, thus creating three district level panel datasets, one for small, one for medium, and one for large factories.

In Table 6, we report the results of regressions of employment on the rainfall shock and its interactions with the labor dummies, separately for the small-, medium- and large-factory datasets. Again, we focus on the test of the null hypothesis that the employment response to shocks was equal across pro-worker and pro-employer states. Comparing across the datasets, we find that the response of workers and man-days exhibited a small but insignificant difference across labor regulation regimes in small factories, a larger but still insignificant differential response for medium factories, and the largest and most significant differential response for large factories.

In Table 7, we test that the differential employment response across pro-worker and pro-employer states is largest for large factories. To do this, we pool the three datasets (small, medium and large factories) and include triple interactions (rainfall shock by labor regulation by size), controlling for district by size, rainfall shock by size and year fixed effects (s indicates size index and r indicates rainfall shock index):

$$\begin{aligned} x_{jt} &= \zeta_1\Big(Rainshock_{jt} \text{ x } Proworker_{jt} \text{ x } Large_{jt}\Big) + \zeta_2\Big(Rainshock_{jt} \text{ x } Proemployer_{jt} \text{ x } Large_{jt}\Big) \\ &+ \zeta_3\Big(Rainshock_{jt} \text{ x } Proworker_{jt} \text{ x } Medium_{jt}\Big) + \zeta_4\Big(Rainshock_{jt} \text{ x } Proemployer_{jt} \text{ x } Medium_{jt}\Big) \\ &+ \beta_1\Big(Rainshock_{jt} \text{ x } Proworker_{jt}\Big) + \beta_2\Big(Rainshock_{jt} \text{ x } Proemployer_{jt}\Big) \\ &+ \sum_s \sum_j \rho_{js}\mathbf{1}\left(District = j \;\&\; Size = s\right) + \sum_s \sum_r \rho_{rs}\mathbf{1}\left(Rainshock = r \;\&\; Size = s\right) \\ &+ \sum_t \rho_t \mathbf{1}\left(Year = t\right) + \epsilon_{jt}. \end{aligned}$$

As before, the omitted categories are small factories and neutral states. To implement our test, we estimate the model above and then test the null hypotheses that $\zeta_2 - \zeta_1 = 0$ and $\zeta_4 - \zeta_3 = 0$; these nulls are that the differential response to shocks across pro-worker and pro-employer states is the same across large versus small factories and medium versus small factories, respectively. The results are reported in Table 7: we find that we can statistically reject that null for employment in the large versus small comparison, and the differences across coefficients for medium versus small are in the predicted direction (negative) but insignificant.

6.4 Effect of Shocks on Employment by Industry Type

Next, we use the state-industry panel introduced earlier to test whether the differential employment response to rainfall shocks varies by industry type. In particular, we group industries based on their susceptibility to local demand shock. If, as the results from Table 4 suggest, rainfall shocks affect the factor sector predominantly through their effects on local demand for the goods that factories produce, then industries which are more dependent on local demand should exhibit 1) a greater employment response to rainfall shocks in general, and 2) a larger differential response across pro-worker and pro-employer states.

We test for these effects first by splitting the state-industry panel by industry type and estimating the same model as in equation 7 separately for the two types. As before, our main employment outcomes are number of workers and number of employees. We split the data based on National Industrial Classification (NIC) code, grouping all industries between 200 and 299, inclusive, and between 300 and 399, inclusive. NIC codes 200-299 describe industries whose focus is agricultural and natural industrial products, such as food products and beverages, textiles, paper, wood and leather products. NIC codes 300-399 describe the more technological and heavy industries like chemicals and pharmaceutical, metal products, machinery and electronics. Although both industry groups are likely to contain traded and non-traded goods industries, we expect the first to be more dependent on local demand.

The results are reported in Table 8. Across the two industries, the results draw two main conclusions: 1) the average employment response to shocks is nearly twofold in industries more susceptible to local demand; and 2) the differential response across pro-worker and pro-employer states is much larger and more significant for industries tied to local demand. In results reported in Table 9, we verify that in pooled regressions which include triple interactions (rainfall shock by labor regulation by NIC code grouping), we see that the differential employment response across pro-worker and pro-employer states is *larger* in industries tied to local demand versus those which are not. These results appear consistent with both the demand channel interpretation of the effects of rainfall shocks on the factory sector, as well as with our basic premise that shocks induce differential responses across labor regulation regimes.

6.5 Robustness to Selection into Labor Regulation Regime by Industry Type

In this section, we address the concern that firms' location decisions across states are non-random, and may be correlated with labor regulation regimes as well as the way in which these firms adjust to shocks. For example, if the least "flexible" firms – i.e. those which require the most labor adjustment in times of shock – locate where there are weak worker lobbies (which often generate pro-employer amendments), the differential response across pro-worker and pro-employer states would tend to overstate the effect of labor regulations on the average firm.

We address this concern by including rainfall shock by industry type fixed effects in the state-industry level panel regressions described earlier. To the extent that firms' "flexibility" is encapsulated by NIC codes for industry type, including interactions of rainfall shock categories with industry type dummies controls for the potential selection of "flexible" firms into pro-worker states.

In Table 10, we report results of regressions including controls for rainfall shock by industry type fixed effects, using the state-industry panel data. For ease of comparison, in columns 1 and 2, we reproduce the results from Table 5 without industry-rainshock controls. In columns 3 and 4, we add rainfall shock by industry type effects, and find that the results remain almost completely unchanged. This gives us some confidence that our findings are robust to firm selection into labor regimes.

6.6 Effects of Shocks on Output and Profits

Finally, we examine whether firms in pro-worker states were able to adjust their output to the same extent as those in pro-employer states in response to shock, and whether the constraints imposed by firing costs impact pro-worker firms' profits more than pro-employer firms. To test these hypotheses, we again employ the district-level panel, and run regressions of the form described in equation 6, which include district and year fixed effects.

The results of these regressions are reported in Table 11. We use as dependent variables the value of total output, value added, and profits. We find no differential adjustment across pro-worker and pro-employer states in all three of these outcomes. The results on total output (in column 1) seem consistent with our evidence on the equal effects of rainfall shocks across pro-worker and pro-employer states on agricultural production and household expenditures; we find a large decline in output (consistent with rainfall shocks' effects through a demand channel), but no differential decline across labor regulation regimes. We find similar results on value added, reported in column 2 (a large average decline, but no differential response).

On the other hand, the results on profits are surprising, in the sense that we might expect there to be a larger profit decline in pro-worker states, who were constrained by firing costs from adjusting the level of employment optimally. Column 3 reports these results. Several potential arguments could explain the results on profits.

We might expect that the constraints imposed on firing costs by labor regulation could generate adjustment along other margins of inputs. If this were the case, we might see that, for example, capital or intermediate inputs would adjust more intensively in pro-worker states than pro-employer states. If firms were able to adjust along these margins well enough, we might not measure an effect on profits.

To test this hypothesis, we use as dependent variables the value of capital and intermediate inputs–in particular, materials, fuel and electricity. The results are reported in columns 1-4 of Table 12. For all four outcomes, we find no differential adjustment across pro-worker and pro-employer states in response to shock. These results indicate that non-labor inputs are not declining more intensively in pro-worker states to mitigate the impact of employment adjustment constraints.

The second hypothesis is related to differential attrition of factories across labor regulation regimes. We might find no effects on profits if the firms with the largest negative profits are going out of business (dropping out of the sample) more intensively in pro-worker states in response to the shock. To test this hypothesis, we look directly at responses in the number of factories in the district to rainfall shock. Column 5 of Table 12 reports the results. We find no evidence of differential declines in the number of factories across pro-employer and pro-worker states in response to shock.

The third hypothesis we examine for the lack of differential declines in profits is that the industrial wage declined more intensively in pro-worker states than in pro-employer states.[13] If this were the case, we would expect that in pro-worker states, firms would see a greater reduction in the wages per worker than that seen by firms in pro-employer states. To test this hypothesis, we examine wages per worker. The results are reported in columns 6 of Table 12. The results show that wages per worker do not decline differentially across pro-worker and pro-employer states.

The fourth hypothesis related to the non-result on profits is that since firms in pro-worker states are constrained from adjusting the *number* of workers to the optimal extent, they may choose instead to adjust the labor intensity of their current workforce, e.g. the number of hours per day or the number of days per month each worker puts forth in labor. If this were the case, we should observe that pro-worker states use workers differentially *more* intensively in times of shock. We use two outcomes to test this hypothesis: man-days per worker, and value of total output per worker (the second of which is used under the assumption that a worker more intensively utilized will produce more output). The results of these regressions are reported in columns 7-8 of Table 12. Again, we find no evidence of differential adjustment across pro-worker and pro-employer states.

Lastly, there are two hypotheses for which, due to data constraints, we have no test, which might explain the results on profits. First, the prices of non-labor inputs might be adjusting differentially across pro-worker and pro-employer states. If we saw a larger reduction in the price of non-labor inputs in pro-worker states, profits fluctuations due to shocks may equalize across labor regulation regimes. We believe this explanation is unlikely to be the only one, given that if the prices of non-labor inputs changed differentially across pro-worker and pro-employer states, we would likely see a differential change in the use of those inputs as well; the results from columns 1-4 of Table 12 seem to refute this claim.

Second, if pro-worker firms were more intensively laying off casual laborers (i.e. part-time laborers who are not accounted for in the data) during periods of shocks, these firms might be able to achieve a commensurate reduction in "effective" employment as the reduction seen for firms in pro-employer states. This explanation would also be consistent with the fact

[13] In fact, we might suspect the opposite, if we believe that worker lobbies in pro-worker states are better able to bargain for wage stability; in this case, we would expect the wage to fall more intensively in response to shock in *pro-employer* states.

(from column 5 of Table 12) that reductions in the wage bill are equal across pro-employer and pro-worker states.

7 Conclusion

Job security provisions, although politically popular, have been the focus of intense academic debate. The job security they confer needs to be weighed against reduced flexibility in hiring and firing, which in turn has been found to have negative impacts on aggregate outcomes. In this paper, we have devised a novel test of the fundamental hypothesis that employment protection laws attenuate the employment responses of firms to external shocks. We exploit a setting which exhibits variation in labor regulation as well as a measurable source of unpredictable shocks. Our setting is rural India, where rainfall fluctuations create demand and wage shocks for local industries, and where labor regulation varies temporally as well as spatially. Our results provide a striking confirmation of the theory - rainfall shocks change industrial employment by shifting the demand for industrial products, and the employment adjustment is more pronounced in regions where labor regulations are less restrictive. We also examine the responses of factories that were exempt from the regulation, and find that there is no differential adjustment across labor regimes, consistent with our interpretation that the differential responses for non-exempt factories are indeed attributable to labor regulation.

While there is now a sizeable literature that examines the effects of labor laws on various aggregate outcomes, the identification of the effects of job security provisions on firms' adjustments has been limited by the difficulty of finding a measurable source of fluctuations that are exogenous to the labor regime. We have shown in this paper that in developing-country settings, the geographic proximity of industry and agriculture provides a convenient source of measurable, external variation in economic conditions that can be used to shed light on the constraining effect of labor regulations on employment adjustment.

We have stressed the implications of employment protection for firms' ability to adjust labor, but another under-researched question is how different groups in society stand to benefit differently from employment protection. This is a particularly important avenue for future research, and one that should lead to a better understanding of the distributional consequences of such policies.

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TABLE 1
Data Sources

Source	*Years*	*Variables*
Annual Survey of Industries (conducted by the Central Statistical Organization of India)	1988, 1991, 1994	Employment, Fixed Capital, Output, Raw Material and Fuel Expenditures in factories (the formal industrial sector)
Terrestrial Air Temperature and Precipitation: Monthly and Annual Time Series, version 1.02 (Center for Climatic Research, University of Delaware)	1950-1999	Rainfall Shock
Besley and Burgess (2004) (based on state level amendments to the Industrial Disputes Act of India)	1949-1995	Labor Regulation
India Agriculture and Climate Data Set (updated using statistics published by the Directorate of Economics and Statistics, Ministry of Agriculture, India)	1957-1996	Agricultural Yields
Consumer Expenditure Survey (conducted by the National Sample Survey Organization of India)	1987, 1993, 1999	Household Per Capita Expenditure

TABLE 2
Pro-worker, pro-employer and neutral states in our sample

Pro-worker	*Neutral*	*Pro-employer*
Gujarat	Bihar	Andhra Pradesh
Maharashtra	Haryana	Karnataka*
Orissa	Karnataka*	Rajasthan
West Bengal	Madhya Pradesh	Tamil Nadu
	Punjab	
	Uttar Pradesh	

Notes: (*) Karnataka switches from neutral to pro-employer in 1987-88; classifications are based on adding the number of pro-worker laws and subtracting the number of pro-employer laws passed in each state; these classifications hold between 1987 and 1994, inclusive; for details, please refer to the Data section

TABLE 3A
Summary statistics by pro-worker, neutral and pro-employer states

	District-level panel		
	Pro-worker	Neutral	Pro-employer
Number of districts (1988)	78	186	80
Labor regulation strictness measure*	1.79	0	-1.54
	(0.76)	(0)	(0.50)
Rainfall shock	-0.03	-0.12	0.09
	(0.68)	(0.67)	(0.62)
% agrarian employment in district	44.48	45.57	46.04
	(16.31)	(15.66)	(15.53)
% landless in district	22.40	16.67	19.89
	(13.56)	(11.87)	(13.09)
Average capital-to-output ratio in district	1.56	1.60	1.09
	(2.76)	(4.96)	(1.66)
% empl. in industries linked to agriculture	43.26	43.82	46.65
	(31.25)	(33.93)	(32.31)

Notes: *Labor regulation strictness measure from Besley and Burgess (2004); states are classified as pro-worker, pro-employer, or neutral based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; rainfall shock variable = 1 if annual rainfall < 20th percentile of historical distribution, = 0 if > 20th and < 80th percentile of historical distribution, and = -1 if > 80th percentile of historical distribution; share of agrarian employment, percent landless, capital-to-output ratios, and share employed in agriculture-related industries are measured in 1988; for details, please refer to the Data section; please also refer to the Data section for data sources and more detailed definitions

TABLE 3B
Outcome variables by pro-worker, neutral and pro-employer states

	Pro-worker	Neutral	Pro-employer
District-level employment outcomes:			
Number of workers	24406.92	8806.28	19560.38
	(44328.34)	(14086.25)	(28465.96)
Man-days (thousands)	10088.15	3429.88	7078.49
	(18998.96)	(5836.59)	(9937.37)
State-industry level employment outcomes:			
Number of workers	5016.81	2678.27	3807.37
	(14090.93)	(7619.89)	(13920.15)
Number of employees	6543.20	3444.01	4674.66
	(16638.14)	(9349.44)	(14867.71)
Other district-level outcomes:			
Agricultural production	99917.92	79458.38	92412.49
	(72989.70)	(62873.04)	(76355.40)
Monthly per capita expenditures	320.34	308.41	346.62
	(134.76)	(129.99)	(124.58)
Capital stock at close of business year	421.36	135.41	239.09
	(790.44)	(334.22)	(568.89)
Value of materials used in production	813.67	253.60	422.67
	(1839.71)	(463.95)	(697.14)
Value of electricity used in production	35.58	13.63	22.18
	(59.49)	(30.28)	(28.96)
Value of fuel used in production	80.60	28.27	44.09
	(145.01)	(60.82)	(58.77)
Value of Total Output	1274.213	396.03	661.96
	(2842.30)	(728.12)	(1058.61)
Value added	243.96	71.51	120.16
	(576.19)	(146.71)	(207.96)
Profits	64.60	21.63	30.62
	(218.02)	(63.19)	(87.78)

Notes: states are classified based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; agricultural production is a weighted sum, in which agricultural output for each crop (in kg) is weighted by the crop's average price from 1950 to 1987 (in INR/kg); per capita expenditures are in 1999 INR; capital stock, materials, fuel, total output, value added and profits have been converted to thousands of 2009 US dollars; for details, please refer to the Data section; please also refer to the Data section for data sources and more detailed definitions

TABLE 4
Effect of rainfall shock on agricultural production and household expenditures

	District panel					
Dependent variables:	Agricultural production	Agricultural wage	Per capita expenditures	Agricultural production	Agricultural wage	Per capita expenditures
Rainfall shock	-6419***	-0.175	-14.28***	2,027.73	-0.69***	-16.052
	(1567)	(0.134)	(5.269)	(2434.50)	(0.25)	(16.566)
Rainfall shock x						
Pro-worker state				-8,039.81	0.36	-0.972
				(6365.09)	(0.38)	(12.546)
Pro-employer state				-2,293.02	0.35	13.357
				(3032.01)	(0.27)	(11.818)
Fixed effects		District + Year			District + Year	
Ho: Rainfall shock x Pro-employer state - Rainfall shock x Pro-worker state = 0				**5747**	**0.003**	**-14.33**
				(6485)	**(0.41)**	**(11.58)**
Number of observations	11309	11309	1071	10894	10894	1071

Notes: *** p<0.01; ** p<0.05; * p<0.1; robust standard errors are reported in parentheses below the coefficient estimates and allow for correlation in the error term within state-year groupings; states are classified as pro-worker, pro-employer, or neutral based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; "Rainfall shock" = 1 if annual rainfall < 20th percentile of historical distribution, = 0 if > 20th and < 80th percentile of historical distribution, and = -1 if > 80th percentile of historical distribution; "Agricultural production" and "Per capita expenditures" are as defined in Table 1b; "Agricultural wage" is the daily wage rate in INR

TABLE 5

Effect of rainfall shock on industrial employment, by labor regulation strictness

	District panel				*State-industry panel*			
Dependent variables:	Number of workers	Man-days (thousands)	Number of workers	Man-days (thousands)	Number of workers	Number of employees	Number of workers	Number of employees
Rainfall shock	-582.0	-250.0*	-72.888	-100.838	-157.7***	-192.2***	-48.317	-58.478
	(358.9)	(137.9)	(1026.305)	(397.696)	(49.60)	(59.63)	(44.427)	(55.372)
Rainfall shock x								
Pro-worker state			297.128	123.607			-64.980	-97.386
			(675.939)	(279.754)			(85.740)	(109.308)
Pro-employer state			-1,618.231*	-482.886			-327.849***	-376.578***
			(861.106)	(317.319)			(115.713)	(130.690)
Fixed effects	District + Year				State x 3-digit industry code + Year			
Ho: Rainfall shock x Pro-employer state - Rainfall shock x Pro-worker state = 0			**-1915***	**-606.5**			**-262.9****	**-279.2***
			(1088.0)	**(445.0)**			**(132.70)**	**(156.00)**
Number of observations	1042	1042	1000	1000	24374	24374	24374	24374

Notes: *** p<0.01; ** p<0.05; * p<0.1; robust standard errors are reported in parentheses below the coefficient estimates and allow for correlation in the error term within state-year groupings; states are classified as pro-worker, pro-employer, or neutral based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; "Rainfall shock" = 1 if annual rainfall < 20th percentile of historical distribution, = 0 if > 20th and < 80th percentile of historical distribution, and = -1 if > 80th percentile of historical distribution

TABLE 6
Effect of rainfall shock on employment by factory size

	Small factories (<50 workers)		*Medium factories (>50 & <100 workers)*		*Large factories (>100 workers)*	
Dependent variables:	Number of workers	Man-days (thousands)	Number of workers	Man-days (thousands)	Number of workers	Man-days (thousands)
Rainfall shock	-1,302.121***	-491.341***	-173.927	-80.369	1,402.460	474.337
	(424.830)	(162.381)	(191.776)	(69.396)	(1068.268)	(385.856)
Rainfall shock x						
Pro-worker state	250.820	49.651	280.497**	84.456*	-217.360	-2.388
	(523.560)	(194.217)	(120.894)	(44.953)	(665.245)	(249.391)
Pro-employer state	-2.844	-28.041	-81.036	-38.649	-1,531.134**	-414.683**
	(353.647)	(130.138)	(181.326)	(59.471)	(618.482)	(199.254)
Fixed effects	District + Year		District + Year		District + Year	
Ho: Rainfall shock x Pro-employer state - Rainfall shock x Pro-worker state = 0	**-253.7**	**-77.69**	**-361.5**	**-123.1**	**-1314***	**-412.3**
	(658.40)	**(248.20)**	**(231.20)**	**(78.78)**	**(665.50)**	**(253.50)**
Number of observations	1000	1000	1000	1000	1000	1000

Notes: *** p<0.01; ** p<0.05; * p<0.1; robust standard errors are reported in parentheses below the coefficient estimates and allow for correlation in the error term within state-year groupings; states are classified as pro-worker, pro-employer, or neutral based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; "Rainfall shock" = 1 if annual rainfall < 20th percentile of historical distribution, = 0 if > 20th and < 80th percentile of historical distribution, and = -1 if > 80th percentile of historical distribution

TABLE 7
Triple interaction tests of effect of rainfall shock on employment by factory size

	District panel	
Dependent variables:	Number of workers	Man-days (thousands)
Rainfall shock x		
Pro-worker state x large factory	904.778	397.124
	(991.547)	(340.900)
Pro-employer state x large factory	-1,066.301	-250.515
	(725.691)	(198.294)
Pro-worker state x medium factory	779.527	320.800
	(520.120)	(198.687)
Pro-employer state x medium factory	192.345	104.331
	(474.487)	(172.514)
Pro-worker state	-461.118	-199.593
	(531.667)	(202.639)
Pro-employer state	-256.908	-121.290
	(526.870)	(184.876)
Fixed effects	District x size + Rainfall shock x size + Year	
Ho(1): Rainfall shock x Pro-employer state x large - Rainfall shock x Pro-worker state x large = 0	**-1971***	**-647.6***
	(1050.00)	**(347.60)**
Ho(2): Rainfall shock x Pro-employer state x medium - Rainfall shock x Pro-worker state x medium = 0	**-587.2**	**-216.5**
	(621.60)	**(238.60)**
Number of observations	3000	3000

Notes: *** p<0.01; ** p<0.05; * p<0.1; robust standard errors are reported in parentheses below the coefficient estimates and allow for correlation in the error term within state-year groupings; states are classified as pro-worker, pro-employer, or neutral based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; "Rainfall shock" = 1 if annual rainfall < 20th percentile of historical distribution, = 0 if > 20th and < 80th percentile of historical distribution, and = -1 if > 80th percentile of historical distribution; "large" indicates factories with > 100 workers, "medium" indicates factories with > 50 and < 100 workers, and "small" indicates factories with < 50 workers; the excluded category is "small"; hypotheses Ho(1) and Ho(2) compare the differential response to rainfall shock across pro-worker and pro-employer states between large v. small and medium v. small factories, respectively

TABLE 8
Effect of rainfall shock on employment by industry type

	Agricultural & Natural Industrial Products (NIC codes 200-299)				*Commercial & Tech-sector Products (NIC codes 300-399)*			
Dependent variables:	Number of workers	Number of employees	Number of workers	Number of employees	Number of workers	Number of employees	Number of workers	Number of employees
Rainfall shock	-221.3**	-256.2***	-49.978	-67.053	-99.45**	-133.2**	-40.911	-43.516
	(86.11)	(95.39)	(73.212)	(84.886)	(41.04)	(58.22)	(43.285)	(58.977)
Rainfall shock x								
Pro-worker state			-60.643	-65.311			-74.780	-134.368
			(139.176)	(154.429)			(93.462)	(137.519)
Pro-employer state			-563.978***	-624.938***			-124.279*	-164.266*
			(209.060)	(227.318)			(63.819)	(83.909)
Fixed effects	State x 3-digit industry code + Year				State x 3-digit industry code + Year			
Ho: Rainfall shock x Pro-employer state - Rainfall shock x Pro-worker state = 0			**-503.3****	**-559.6****			**-49.5**	**-29.90**
			(229.3)	**(248.5)**			**(97.3)**	**(141.4)**
Number of observations	11414	11414	11414	11414	12960	12960	12960	12960

Notes: *** p<0.01; ** p<0.05; * p<0.1; robust standard errors are reported in parentheses below the coefficient estimates and allow for correlation in the error term within state-year groupings; states are classified as pro-worker, pro-employer, or neutral based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; "Rainfall shock" = 1 if annual rainfall < 20th percentile of historical distribution, = 0 if > 20th and < 80th percentile of historical distribution, and = -1 if > 80th percentile of historical distribution

TABLE 9
Triple interaction tests of effect of rainfall shock on employment by industry type

	State-industry panel			
Dependent variables:	Number of workers	Number of employees	Number of workers	Number of employees
Rainfall shock	-134.9***	-188.5***	-74.559	-92.748
	(43.71)	(59.13)	(51.235)	(66.873)
Rainfall shock x				
Pro-worker state x Dummy for NIC code in 200-299			13.997	61.193
			(162.228)	(201.425)
Pro-employer state x Dummy for NIC code in 200-299			-396.686**	-395.340*
			(195.389)	(209.532)
Pro-worker state			-72.661	-127.894
			(93.549)	(136.934)
Pro-employer state			-141.428*	-190.976*
			(76.473)	(99.181)
Dummy for NIC code in 200-299	-48.88	-7.771	57.412	75.079
	(75.87)	(87.01)	(71.976)	(90.595)
Fixed effects	State x 3-digit industry code + Year			
Ho: Rainfall shock x Pro-employer state x NIC code in 200-299 - Rainfall shock x Pro-worker state x NIC code in 200-299 = 0			**-410.7***	**-456.5***
			(232.4)	**(260.7)**
Number of observations	24374	24374	24374	24374

Notes: *** p<0.01; ** p<0.05; * p<0.1; robust standard errors are reported in parentheses below the coefficient estimates and allow for correlation in the error term within state-year groupings; states are classified as pro-worker, pro-employer, or neutral based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; "Rainfall shock" = 1 if annual rainfall < 20th percentile of historical distribution, = 0 if > 20th and < 80th percentile of historical distribution, and = -1 if > 80th percentile of historical distribution

TABLE 10
Effect of rainfall shock on industrial employment, by labor regulation strictness

	State-industry panel			
Dependent variables:	Number of workers	Number of employees	Number of workers	Number of employees
Rainfall shock	-48.317	-58.478	-	-
	(44.427)	(55.372)		
Rainfall shock x				
Pro-worker state	-64.980	-97.386	-49.858	-88.318
	(85.740)	(109.308)	(90.005)	(114.357)
Pro-employer state	-327.849***	-376.578***	-315.975***	-371.403***
	(115.713)	(130.690)	(109.138)	(125.910)
Fixed effects	State x 3-digit industry code + Year		Rainfall shock x 3-digit industry code + State x 3-digit industry code + Year	
Ho: Rainfall shock x Pro-employer state - Rainfall shock x Pro-worker state = 0	**-262.9**** **(132.70)**	**-279.2*** **(156.00)**	**-266.1**** **(131.90)**	**-283.1*** **(155.40)**
Number of observations	24374	24374	24374	24374

Notes: *** p<0.01; ** p<0.05; * p<0.1; robust standard errors are reported in parentheses below the coefficient estimates and allow for correlation in the error term within state-year groupings; states are classified as pro-worker, pro-employer, or neutral based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; "Rainfall shock" = 1 if annual rainfall < 20th percentile of historical distribution, = 0 if > 20th and < 80th percentile of historical distribution, and = -1 if > 80th percentile of historical distribution; Rainfall shock main effects are absorbed by Rainfall shock x 3-digit industry code fixed effects, and so are not reported in columns 3 and 4

TABLE 11
Effect of rainfall shock on output and profits, by labor regulation strictness

	District-level panel		
Dependent variables:	Total Output	Value Added	Profits
Rainfall shock	-162.308**	-28.430*	-17.637
	(64.337)	(15.163)	(12.505)
Rainfall shock x			
Pro-worker state	-1.420	13.916	9.555
	(64.446)	(14.876)	(11.306)
Pro-employer state	56.534	12.051	8.242
	(40.841)	(10.790)	(8.073)
Fixed effects		District + Year	
Ho: Rainfall shock x Pro-employer state - Rainfall shock x Pro-worker state = 0	**57.95**	**-1.865**	**-1.313**
	(78.19)	**(18.89)**	**(13.84)**
Number of observations	1000	1000	1000

Notes: *** p<0.01; ** p<0.05; * p<0.1; robust standard errors are reported in parentheses below the coefficient estimates and allow for correlation in the error term within state-year groupings; states are classified as pro-worker, pro-employer, or neutral based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; "Rainfall shock" = 1 if annual rainfall < 20th percentile of historical distribution, = 0 if > 20th and < 80th percentile of historical distribution, and = -1 if > 80th percentile of historical distribution; "Value added" is the pecuniary value of total output minus intermediate inputs; capital stock, materials, fuel, total output, value added and profits have been converted to thousands of 2009 US dollars; for details, please refer to the Data section

TABLE 12
Effect of rainfall shock on non-labor inputs, wages and labor intensity, by labor regulation strictness

	District-level panel							
Dependent variables:	Capital	Materials	Fuel	Electricity	Number of factories	Wage per worker	Man-days per worker (thousands)	Value of output per worker
Rainfall shock	0.081	-83.780*	1.385	9.032**	-107.298***	-0.052	0.017*	0.000
	(46.271)	(44.745)	(5.053)	(3.498)	(36.703)	(0.137)	(0.009)	(0.006)
Rainfall shock x								
Pro-worker state	12.852	-24.569	-4.862	-1.628	15.187	-0.046	-0.005	-0.004
	(36.193)	(42.329)	(3.973)	(2.332)	(42.116)	(0.116)	(0.008)	(0.004)
Pro-employer state	23.473	29.692	4.855	0.679	0.679	0.128	-0.009	-0.003
	(43.843)	(27.186)	(4.298)	(1.845)	(28.177)	(0.112)	(0.008)	(0.004)
Fixed effects	----- District + Year -----							
Ho: Rainfall shock x Pro-employer state - Rainfall shock x Pro-worker state = 0	**10.62**	**54.26**	**9.717**	**2.307**	**-14.51**	**0.175**	**-0.00416**	**0.00164**
	(57.06)	**(49.47)**	**(5.80)**	**(2.13)**	**(51.80)**	**(0.13)**	**(0.01)**	**(0.00)**
Number of observations	1000	1000	1000	1000	1000	1000	1000	1000

Notes: *** p<0.01; ** p<0.05; * p<0.1; robust standard errors are reported in parentheses below the coefficient estimates and allow for correlation in the error term within state-year groupings; states are classified as pro-worker, pro-employer, or neutral based on adding the number of pro-worker amendments and subtracting the number of pro-employer amendments passed after Indian independence in 1947; "Rainfall shock" = 1 if annual rainfall < 20th percentile of historical distribution, = 0 if > 20th and < 80th percentile of historical distribution, and = -1 if > 80th percentile of historical distribution; "Capital" is the value of fixed capital stock at close of business year; "Materials" and "Fuel" are annual values of intermediate inputs used; "Wage per worker" is the wage bill (total amount paid to workers in 2009 USD) divided by number of workers; "Man-days per worker" is the number of mandays divided by the number of workers; "Value of output per worker" is value of total output in thousands of 2009 USD divided by number of workers