Contract labour and insurance within the establishment

Lalit Contractor [*,†]

September 15, 2022

Abstract

Using a panel of Indian manufacturing sector establishments, I document that establishments which rely more intensively on contract labour provide greater insurance, in terms of lower wage pass-through of productivity shocks, to ('full-time') workers they hire directly. I also find that capital-intensive establishments provide more insurance to full-time workers. A model of wage contracting under limited commitment with different worker types and tasks can explain these findings: establishments employ contract labour to carry out less skill-intensive tasks, while full-time workers carry out more skill-intensive tasks that require the use of capital, making them less substitutable with contract labour. This weakens the establishment's outside option, leading to the provision of greater insurance to full-time workers.

[*]Department of Economics, Ashoka University, Rajiv Gandhi Education City, Sonepat, Haryana, 131029, India. Email: lalit.contractor@ashoka.edu.in

[†]I would like to thank Kanika Mahajan for generously sharing her data, and thank Bhanu Gupta, Kanika Mahajan and S.K. Ritadhi for helpful discussions. All errors are mine.

1 Introduction

Risk averse workers wish to smooth consumption when facing volatility in earnings that cannot be insured away (see e.g. Krueger and Perri [2003], Heathcote et al. [2008]). While a vast literature (surveyed in, e.g. Heathcote et al. [2009]) using the framework of standard incomplete markets (Bewley-Aiyagari-Huggett) models has studied how agents can insure themselves against uncertain labor earnings, there is also a strand of the literature that focuses on insurance provided to workers within the firm. This is an exploration of the sources of earnings volatility, which has tended to focus on, for instance, the types of workers who are more likely to be insured (Lagakos and Ordonez [2011]); or to better identify uninsurable risk passed on to workers by firms which in turn affects financial decision-making (e.g. Fagereng et al. [2018]).

This paper examines how insurance within the firm for certain types of workers might be affected by alternative hiring options for firms in the labour market. In particular, I study earnings volatility faced by workers who are directly hired by an employer (hereafter referred to as 'full-time' workers, as in Bertrand et al. [2021]) when the employer also has the option to hire workers indirectly on shorter-term contracts (hereafter referred to as 'contract workers'). I primarily consider how firm-level productivity shocks are passed through to the wages of full-time workers across firms with different levels of reliance on contract labour or capital.

For this purpose, I apply the framework of Guiso et al. [2005] and Lagakos and Ordonez [2011] to panel data of Indian manufacturing sector establishments (plants) obtained from the Annual Survey of Industries (ASI). The rising use of contract labour by firms in India, particularly since the late 1990s, has been well documented (see e.g. Chaurey [2015], Srivastava [2016], Kapoor and Krishnapriya [2019], Bertrand

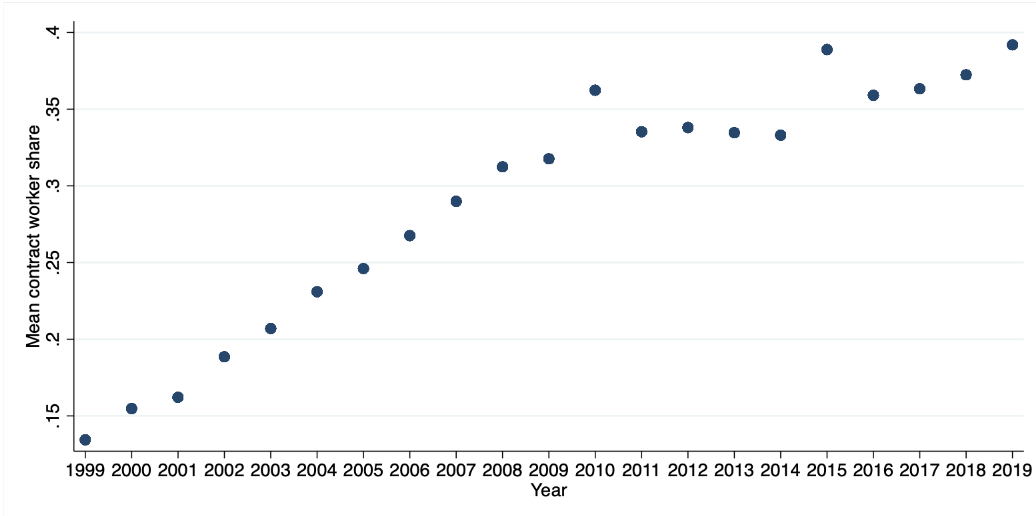

Figure 1: The increasing use of contract labour. ***Mean contract worker share is the average of the shares of contract workers in the total workforce, at the 3 digit industry level.***

et al. [2021]). Figure 1 corroborates this trend in our sample. The implications of the increasing reliance on contract labour for misallocation, productivity and firm growth, and the relative wages of full-time and contract workers etc. have been analysed in the aforementioned literature. If the use of contract labour serves to reduce the bargaining power of full-time workers, as some of those papers document, then this should have implications for the provision of insurance within the firm as well. The analysis of this question is the main focus of this paper.

I use establishment-level panel data to measure the extent to which the average full-time worker's wages responds to shocks to plant[1] productivity, i.e. the extent to which productivity shocks are passed through to full-time workers' wages. The measure of *wage insurance* is the elasticity of the average full-time worker wage to shocks to a plant's productivity. The *higher* is this elasticity, the more responsive are full-time worker's wages to productivity shocks, or the *lower* is the degree of wage insurance. Analysing the panel data, my main finding is that establishments

[1]I use plant and establishment interchangeably throughout the paper.

employing a larger share of contract workers have lower wage-productivity elasticities. Thus, wage insurance for full-time workers is greater in establishments that employ relatively more contract labour. I also find that establishments that are more capital-intensive provide greater wage insurance against productivity shocks than do labour-intensive firms. This is unsurprising given the first result, as Kapoor and Krishnapriya [2019] have shown that growth in contract worker usage has been greater in capital-intensive industries.

I explain these results with the aid of a model of wage contracting between a risk-averse full-time worker and risk-neutral firm under limited commitment, originally proposed by Thomas and Worrall [1988]. I reinterpret the firm's outside option of hiring labour on the spot market in that paper as the option to hire contract labour on short-term contracts, subject to a fixed cost being borne. There are two types of tasks at a firm, differentiated by skill requirement and capital intensity. Full-time workers are more productive at performing high-skill tasks than are contract workers.

The optimal contract specifies wage smoothing: wages do not fluctuate significantly with productivity shocks to ensure that both contracting parties do not wish to terminate their contract. I show that higher fixed costs associated with hiring contract labour in high-skill tasks and the lower productivity of contract workers in high skill tasks lead to greater wage insurance for full-time workers in high-skill tasks. Intuitively, the outside option of contract labour for firms in high-skill tasks is less attractive, making firms more inclined to insure full-time workers performing high-skill tasks. On the other hand, a lower training cost in low-skill tasks makes firms more inclined to hire contract labour for performing such tasks. Hence, firms with a larger share of contract workers mainly engage full-time workers to perform high-skill, capital-complementary tasks, where such workers receive greater insurance.

1.1 Literature review

This paper is most closely related to Lagakos and Ordonez [2011]. While those authors show that more skilled workers receive more insurance within the firm as their outside options are less attractive, I show that full-time workers receive more insurance from employers hiring more contract labour, driven by differences in skill-intensity of tasks and the employer's outside option across tasks.

The empirical approach follows Guiso et al. [2005] and Fagereng et al. [2018], and the broader literature on insurance within the firm surveyed by Guiso and Pistaferri [2020]. While I cannot use matched employee and firm data, the availability of establishment-level data on average wages by worker type allows me to use a similar empirical approach to estimate the pass-through of productivity shocks to wages by worker type. Lagakos and Ordonez [2011] have industry level time series of wages and value added that they use to estimate the elasticity of wages to productivity. The ASI panel contains more granular information on the same variables (and by worker type for wages), albeit over a shorter time span. Hence, the empirical approach of Guiso et al. [2005] and Fagereng et al. [2018] is more suitable for our purpose.

Finally, my paper contributes to the aforementioned literature on the impact of contract labour use in India (see also Bertrand et al. [2021] and the references therein). A prominent reason cited for rising contract labour use has been stringent labour regulation in India. I examine an indirect effect of such regulations, on wage insurance for full-time workers.

2 Insurance for full-time workers within Indian establishments

2.1 ASI dataset and key variables

The source of establishment level data is the Annual Survey of Industries (ASI) from 1998 to 2015, conducted by the National Sample Survey Organization (NSSO). The ASI is a census of formal Indian manufacturing establishments with more than 100 workers and a random survey of formal firms with less than 100 workers. Data is collected over the fiscal year, which runs from April 1 to March 31 of the following year.

The key variables I rely on for the analysis are value-added, employment, labor compensation, and main industry of the establishment. The ASI provides information on the number of workers directly employed by the establishment and workers hired through contractors (henceforth referred to as 'full-time' and 'contract' workers). A breakdown of wages between full-time and contract workers is provided throughout the sample, while a similar breakdown for bonuses and benefits is available from 1998 to 2007. Hence, the bulk of the analysis relies on the measure of wages provided in the ASI data[2]. Average wages of full-time workers in a firm are computed by dividing the total wage bill of full-time workers by the number of full-time workers hired by the firm. The measure of labor productivity at the firm level is Gross Value Added[3].

I group industries at the three digit level based on the NIC 2008 classification. I use

[2] I check the robustness to an expanded definition including bonuses and benefits in appendix B.

[3] This variable is defined as in the ASI's concept document as Total Output less Total Inputs.

the concordance tables provided by the ASI to convert the NIC 1998 and NIC 2004 industrial classifications to the NIC 2008 classification.

The full-time workers' wage series is deflated by the Consumer Price Index for Industrial Workers (CPI-IW). The value added and net value of plant and machinery series are both deflated using a constructed Wholesale Price Index (WPI) at the 2 digit industry (NIC 2008) level. To do so, I first group manufacturing goods categories in the WPI into corresponding 2 digit NIC codes. I then construct a time series of the WPI by 2 digit industry, normalizing the index using a suitable linking factor to account for changes in the base year.

Thus constructed, our establishment-level panel comprises 63 industrial groups classified as per the NIC 2008 3 digit codes over a period from 1998 to 2015.

2.1.1 Constructing plant-level productivity shocks

I follow Guiso et al. [2005] and Fagereng et al. [2018] in constructing shocks to plant-level value added.

Productivity shocks: I model plant performance according to the following process:

$$y_{jkt} = \gamma Z_{kt} + f_j + \nu_{jkt} \tag{1}$$

where j, k and t are subscripts for the jth plant in industry k at time t. y_{jkt} is the logarithm of real gross value added; Z_{kt} are industry-year and location fixed effects; f_j is a plant fixed effect; and ν_{jkt} is the shock against which the firm provides insurance.

The residual from estimating equation (1) will be our estimate of plant-level productivity shocks.

Wage responsiveness to productivity shocks: The ASI has establishment level data on the total wage bill by worker type and the number of workers of each type. This allows me to compute the wages paid by an establishment to the average full-time and contract worker. Hence, I cannot study how a *particular* worker's compensation varies with plant performance, but only how the *average* full-time worker's compensation would vary with the same.

I study wage responsiveness for the average full-time worker to productivity shocks using the following equation:

$$w_{jkt} = \delta \, X_{kt} + \epsilon \, \nu_{jkt} + g_j + \psi_{jkt} \tag{2}$$

where j, k and t are subscripts for the jth firm in industry k at time t. w_{jkt} is the logarithm of real average full-time worker wage; X_{kt} are industry-year fixed effects; ν_{jkt} is the plant-level productivity shock from equation (1); g_j is a plant fixed effect; and ψ_{jkt} is the residual. The amount of within-establishment insurance for the average full-time worker in plant j is measured, following Guiso et al. [2005], as the pass-through of plant level productivity shocks to the average full-time worker's wages[4]. Lower values of the pass-through coefficient ϵ correspond to greater within-establishment wage insurance for the average full-time worker. The pass-through of firm-level productivity shocks to full-time worker's wages will

[4]Below, I shall occasionally refer to the pass-through coefficient as simply the pass through of firm-level productivity shocks to full-time worker's wages.

hereafter be referred to as *wage insurance*. As Guiso et al. [2005] note, a positive and significant pass-through coefficient implies imperfect wage insurance for the average full-time worker against plant-level productivity shocks.

2.2 Wage insurance for full-time workers: variation with contract labour and capital intensity

I study the variation of this measure of insurance within the establishment with contract labour employment and the capital intensity of a plant. Hence, I consider regressions of the form:

$$w_{jkt} = \delta X_{kt} + \epsilon\, \nu_{jkt} + \xi\, I_{jkt} + \lambda\, \nu_{jkt} * I_{jkt} + g_j + e_{jkt} \tag{3}$$

where w_{jkt} is the average full-time worker's wage; ν_{jkt} is firm j's productivity shock as defined in equation (1); I_{jkt} represents the share of contract worker employed by a plant or the capital intensity of a plant; e_{jkt} is an error term, and all other variables are defined as above.

The primary coefficient of interest is λ, the coefficient on the interaction term in equation (3). A significant positive (negative) coefficient λ indicates that there is greater (lesser) pass-through of productivity shocks to the average full-time worker's wage in plants that employ more contract labour or in plants which are more capital intensive.

2.3 Empirical results

I first present results from estimating equation (3) for various measures of the share of contract workers in an industry in table 1. Column 1 uses a dummy for whether the share of contract workers in the total plant workforce exceeds 50%, while column 2 uses a dummy for whether a plant hires any contract workers. Both specifications reveal that wage insurance for full-time workers, representing the pass-through of plant productivity shocks to the average full-time worker's wages, is *greater* in plants employing more contract labour.

The other two columns document that wage insurance for full-time workers is greater in capital intensive plants. I measure capital intensity using: (i) the plant's labour share, defined as the ratio of the total wage bill to Gross Value Added; (ii) whether an establishment has a per-worker net value of plant and machinery that exceeds the corresponding three-digit industry mean in every year for which establishment data is available[5].

As specification (3) shows, an establishment that has a labour share exceeding a threshold of 50% provides less wage insurance to full-time workers, or has a greater pass-through of productivity shocks to full-time workers' wages[6].

Specification (4) uses the alternative definition of capital intensity (definition (ii) above) to show that capital-intensive plants provide greater wage insurance to full-time workers, or have a lower pass-through of productivity shocks to full-time workers' wages.

The appendix includes various robustness checks, which serve to confirm the basic

[5] These measures of capital-intensity are drawn from Lagakos and Ordonez [2011] and Kapoor and Krishnapriya [2019] respectively.

[6] I considered alternative thresholds above 50% but the main results were not affected.

Table 1: Wage insurance for full-time workers: variation with contract labour use and capital intensity

	(1)	(2)	(3)	(4)
	w	w	w	w
Establishment productivity shock (ν)	0.120***	0.128***	0.121***	0.116***
	(0.00171)	(0.00187)	(0.00209)	(0.00163)
$\mathbb{I}_{\text{Contract share}\geq 50\%}$	0.0556***			
	(0.00323)			
$\nu * \mathbb{I}_{\text{Contract share}\geq 50\%}$	-0.0413***			
	(0.00402)			
$\mathbb{I}_{\text{Contract share positive}}$		0.0241***		
		(0.00262)		
$\nu * \mathbb{I}_{\text{Contract share positive}}$		-0.0503***		
		(0.00342)		
$\mathbb{I}_{\text{Labour share}\geq 50\%}$			0.149***	
			(0.00208)	
$\nu * \mathbb{I}_{\text{Labour share}\geq 50\%}$			0.0595***	
			(0.00374)	
$\nu * \mathbb{I}_{\text{net value of plant \& machinery}\geq\text{Industry mean throughout}}$				-0.0126**
				(0.00541)
Constant	10.35***	10.35***	10.28***	10.35***
	(0.0726)	(0.0725)	(0.0721)	(0.0726)
N	515348	515348	515348	515348
adj. R^2	0.117	0.117	0.136	0.115

Note: w represents log real wages for the average full-time worker. ν represents firm productivity shocks as defined in equation (1). Share of contract workers is the fraction of contract workers in total workforce. $\mathbb{I}_{\text{Contract share}\geq 50\%}$ and $\mathbb{I}_{\text{Contract share positive}}$ are indicators for whether contract workers' share is at least 50% or if the firm hires any contract workers. $\mathbb{I}_{\text{Labour share}\geq 50\%}$ is an indicator for whether the ratio of the wage bill to Gross Value Added exceeds 50%. $\mathbb{I}_{\text{net value of plant \& machinery}\geq\text{Industry mean throughout}}$ is an indicator for whether a firm's real net value of plant and machinery per worker exceeds the corresponding industry mean throughout the sample period.

All regressions include industry-year and state fixed effects. Robust standard errors (clustered at establishment level) in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

findings. These include using alternative measures of intensity of contract labour use and labour compensation, and variation by size and ownership type. The appendix also documents a positive relationship between capital intensity and contract worker shares in establishments.

3 A limited-commitment model of risk-sharing within the firm with contract labour

3.1 Framework

This section considers a model of risk sharing within the firm[7], based on the two-sided[8] limited commitment model of Thomas and Worrall [1988] and Lagakos and Ordonez [2011]. The model will yield predictions about wage insurance for full-time workers which are consistent with the empirical evidence presented. In particular, the model should explain why firms hiring more contract workers and firms which are more capital intensive provide greater insurance to full-time workers.

There are two types of workers: (i) full-time, and (ii) contract workers. There are two types of tasks that firms employ workers for: (i) *low-skill* tasks and (ii) *high-skill* or *skill-intensive* tasks, which can be thought of as requiring the use of capital as well as skilled labour.

Firms hire full-time workers on long term contracts but neither side can commit to honouring the contract. The model also allows for separations between full-time workers and firms. Risk sharing occurs when a worker receives a wage that is smoother than the value of their output on a task.

I assume that firms moving away from full-time workers toward contract labour must incur a fixed cost, which can be interpreted as an adjustment or training cost (Bertrand et al. [2021]). The fixed cost differs across tasks, with low-skill tasks

[7]I shall use firm and establishment interchangeably here, to relate the model to the empirical analysis above.

[8]Models with one-sided (for workers) limited commitment predict that wages only rise over time.

requiring less training to accomplish than high-skill tasks, implying that the fixed cost is lower for low-skill tasks than for high-skill tasks. I have assumed here that high-skill tasks are capital intensive. Hence, one could motivate the higher fixed cost for high-skill tasks in terms of the greater training time and cost new hires must incur in order to familiarise themselves with capital and machinery in order to perform those tasks.

In this framework, a reduction in the fixed cost leads to contract workers displacing full-time workers in performing tasks. As will be seen below, contract workers are more attractive hires for firms in order to perform low-skill tasks, while full-time workers at firms are now concentrated in high-skill, capital intensive tasks, where they are less substitutable. Thus, the model helps explain why industries that rely more intensively on contract labour and capital tend to feature more wage smoothing for full-time workers. Proofs of propositions are contained in Appendix A.

Motivating the model framework and assumptions about contract labour

Alternative frameworks

One could potentially explain the empirical findings in section 2 using a model where all of the inputs (capital and both worker types) are complements in the production process. If contract workers complement full-time workers in the production process, then hiring more contract workers might actually make full-time workers more valuable to the firm, leading to the provision of greater insurance. A similar argument can be made to explain why full-time workers receive greater insurance in capital-intensive firms. However, it would be harder to explain why capital intensive industries have seen the largest growth in contract worker shares in such a model, as noted by Kapoor and Krishnapriya [2019]. Further, among the establishments in our dataset that witnessed a decline in full-time worker shares during the sample period, over half also witnessed a decline in the absolute number of full-time workers hired, indicating a strong degree of substitutability between full-time and contract workers.

Another alternative could be to assume that capital and contract labour alone are complements in the production process, which would explain the positive correlation between capital intensity and growth in contract worker shares. However, the wage insurance results now become difficult to explain using such a model.

By distinguishing tasks based on skill requirement and capital intensity, the model used here can explain the wage insurance results while permitting plausible explanations for the correlation between capital intensity and growth in contract labour shares.

Contract labour

While data on job tenures of full-time and contract workers in the Indian context is not available, contract labour is typically engaged by employers to accomplish specific tasks, which makes their tenure short term relative to full-time workers who typically perform a wide variety of tasks[9] (Kapoor and Krishnapriya [2019]). Furthermore, labour regulations governing the firing of full-time workers are not strictly applied to contract labour, once again leading to *de facto* shorter term work arrangements for contract workers.

[9] A case study of two industries by Srivastava [2016] found that the turnover rate for contract workers was very high, which suggests either short-term work arrangements or low contract termination costs, both of which imply *de facto* short-term contracts.

It is similarly difficult to obtain data on the skill-intensity of tasks performed by full-time and contract workers. To the extent that using capital requires some training and skill, which might be costly to impart to contract workers present for short tenures, this would result in capital and skill-intensive tasks largely being carried out by (skilled) full-time workers.

3.2 Environment

There is an infinite sequence of dates, $t = 1, 2, ..., \infty$. At the beginning of each period t the aggregate state $s_t \in \mathbb{S} = \{s^1, s^2, ..., s^S\}$ is realized. The set of aggregate states S is ordered such that $s^i < s^j$ for $i < j$. The aggregate state evolves as a first-order Markov chain, where $\alpha_{s,s'}$ is the probability of transitioning from state s to state s'.

There are three types of agents: firms, full-time (f) workers and contract (c) workers. Firms employ one worker at each date, and all contracts are negotiated individually.

Contract workers are hired by the firm on the spot market, taking the contract wage $w_t^c(s_t)$ as given. As convention, $w^c(s) > w^c(s-1)$. Agents have perfect foresight, and they know the spot market contract wage at every date and in every state.

A risk-averse full-time worker is matched with a risk-neutral firm. Full-time workers have expected discounted utility:

$$U_0 = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t) \tag{4}$$

where $\mathbb{E}_0$ is the expectations operator at time 0, c_t is consumption, and $\beta \in (0, 1)$ is the common discount factor for all workers and firms. All workers (full-time and contract) are endowed with one unit of labor each period which they supply inelastically to the firms. There are no asset markets or storage possibilities, so the worker's consumption each period equals her wage. Workers have constant relative risk aversion (CRRA) preferences: $u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}$, where σ represents the degree of relative risk aversion.

The firm's overall numeraire output $y_t = g(y_{lt}, y_{ht})$ combines the output across low and high-skill tasks ($\tau = \{l, h\}$), as in Acemoglu and Autor [2011]. Firms use labor as the only input for low-skill tasks, while high-skill tasks require both capital and labour. Each firm has an exogenous capital stock k. The firm keeps the output produced from each task and pays the worker a wage w_t from task-specific output.

The firm's objective when negotiating contracts with full-time workers for each task $\tau = \{l, h\}$ is to maximize expected discounted profits from that task:

$$\Pi_0^\tau = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t (y_{\tau t} - w_{\tau t}) \tag{5}$$

The aggregate state is related to output produced from each task through the production functions $y_l = \theta_l(s + \epsilon)$ and $y_h = \theta_h(s + \epsilon)$. I assume that $\theta_l = 1,\ \theta_h = \theta(k) > 1,\ \theta_h' > 0$. Thus, workers engaged in high-skill tasks are more productive than workers engaged in low-skill tasks, and this productivity differential is greater for capital-intensive firms. $\epsilon \in \mathbb{R}^+$ is the current realization of an idiosyncratic firm specific productivity shock at the beginning of each period. We assume that $\epsilon = 0$ for contract workers. ϵ is drawn from a time invariant distribution with cumulative distribution function $F(\epsilon)$ and support on $[\underline{\epsilon}, \overline{\epsilon}]$. Idiosyncratic productivity ϵ is independently and identically distributed across time.

If both the firm and the full-time worker (f) decide to honour the contract, then output y_τ is produced, and the full-time worker gets wage w_τ. Either party may leave the match after observing the realization of the aggregate state s and idiosyncratic productivity ϵ, in which case they both get their respective outside options. For contract workers hired on the spot market, there is no option for either party to break the contract.

3.3 Wage contracting with full-time workers

I now consider the wage contracting problem with type f workers engaged in performing task τ.

Outside options of full-time workers and firms

A full-time worker's outside option is to enter the spot labour market as a contract worker. Full-time workers know s at the moment of separating, but do not know the idiosyncratic productivity ϵ that they will have in the new match.

Let $\bar{V}(s)$ denote the outside option of a type f worker engaged on either task in state s. Following Thomas and Worrall [1988], workers who leave their current match are employed on the spot market at wage w^c. Her outside options in state s can then be expressed as:

$$\bar{V}(s) = u\big(w^c(s)\big) + \beta E_{s'|s}\, V^c(s') \tag{6}$$

Let $\bar{\Pi}^\tau(s)$ denote the value of the firm's outside option for task τ in state s. The firm is then matched with a contract worker but incurs the adjustment cost c_τ.

The outside option of a firm for task τ in state s can be expressed as:

$$\bar{\Pi}^{\tau}(s) = s - w^{c}(s) - c_{\tau} + \beta E_{s'|s}\,\bar{\Pi}^{\tau}(s') \tag{7}$$

I assume that contract workers can perform high-skill tasks, but their productivity in these tasks is not as great as that of full-time workers. This is because, although contract workers can be trained to perform high-skill tasks, they are employed on short-term contracts and hence cannot reach the same level of productivity in these tasks as their full-time counterparts.

Note also from (7) that firms hiring contract workers on task τ incur a fixed cost c_{τ} in every period where contract labour is engaged. This can be interpreted as a training cost associated with engaging contract workers to perform tasks previously being carried out by type f workers.

It has been argued that the costs associated with firing full-time workers under the Industrial Disputes Act (IDA) have driven firms to hire more contractual labour (see the discussion in e.g. Bertrand et al. [2021]). The firing cost is related to the administrative or legal costs to a firm associated with severing a full-time contract. One can incorporate this into the analysis by assuming that the cost $c_{\tau} = c_1 + c_{2\tau}$, where c_1 represents the firing cost that is common to all full-time workers. The comparison between type f workers engaged in different tasks is then driven entirely by the task-specific training cost component.

Wage contracts

I now describe the firm's profit maximization problem for task τ and characterize its solution. Suppose that in the initial period of the contract the type f worker is entitled to a particular utility promise v. Following Thomas and Worrall [1988], there is limited commitment from both parties towards honouring the contract.

Let $\Pi^{\tau}\big(v, s, \epsilon, \sigma\big)$ be the firm's value function which represents the maximized expected discounted profits from the match. This depends on the promised utility v for a type f worker in case of continuation, idiosyncratic productivity ϵ, state s and separation choice $\sigma_\tau(s,\epsilon)$, The firm's problem can be written as:

$$\Pi^{\tau}(v_\tau, s, \epsilon, \sigma) = \max_{w_\tau, \{v'_\tau(s',\epsilon')\}, \{\sigma_\tau(s',\epsilon')\}} \sigma\bar{\Pi}^{\tau}(s) + (1-\sigma)\Big[\theta_\tau(s+\epsilon) - w_\tau + \beta E_{s',\epsilon'}\ \Pi^{\tau}(v'_\tau(s',\epsilon'), s', \epsilon')\Big] \tag{8}$$

subject to the promise-keeping constraint:

$$v_\tau = u(w_\tau) + \beta E_{s',\epsilon'}\ v'_\tau(s',\epsilon') \tag{9}$$

and subject to the full-time worker's self-enforcement constraints for all future states and productivity realizations:

$$V^{\tau\prime}(s',\epsilon') = \sigma'_\tau(s',\epsilon')\bar{V}^{\tau}(s') + \big(1 - \sigma'_\tau(s',\epsilon')\big)v'_\tau(s',\epsilon') \geq \bar{V}^{\tau}(s') \ \ \forall s', \epsilon' \tag{10}$$

and subject to firm self-enforcement constraints for all future states and productivity realizations:

$$\Pi^{\tau}(v'_\tau(s',\epsilon'), s', \epsilon', \sigma'_\tau) \geq \bar{\Pi}^{\tau}(s') \ \ \forall s', \epsilon' \tag{11}$$

I represent the vector of the state of nature by $h = (s, \epsilon)$, comprising the aggregate state s and idiosyncratic productivity ϵ. The firm chooses the current period wage w_τ, plus continuation values and separation decisions for the full-time worker in all future states, in order to maximize profits. The optimal wages in the contract will be functions of current and one-period-prior histories (h, h_{-1}), and the optimal wages will be smoothed.

Proposition 1 (Thomas and Worrall [1988]): Let (h_{-1}, h, h') be any history of aggregate and idiosyncratic productivities, and let $w_\tau = w_\tau(h, h_{-1})$ and $w'_\tau = w_\tau(h', h)$ be the optimal wage after history (h, h_{-1}) and (h', h) respectively. Then, if the contract is not severed $(\sigma'_\tau(s', \epsilon') = 0)$:

1. If $w'_\tau > w_\tau$, then $V'^\tau(s', \epsilon') = \bar{V}^\tau(s')$
2. If $w'_\tau = w_\tau$, then $V'^\tau(s', \epsilon') \geq \bar{V}^\tau(s')$ and $\Pi^\tau\left(v'_\tau, s', \epsilon', \sigma'_\tau\right) \geq \bar{\Pi}^\tau(s')$
3. If $w'_\tau < w_\tau$, then $\Pi^\tau\left(v'_\tau, s', \epsilon', \sigma'_\tau\right) = \bar{\Pi}^\tau(s')$

The proposition says that if wages rise from one period to the next, they do so until the type f worker's self-enforcement constraint binds. Similarly, if wages fall they do so until the firm's self enforcement constraint binds. Finally, if wages stay the same then it must be the case that both parties at least weakly prefer the match to their respective outside options. Thus, wages are smoothed as much as possible such that both parties honour their contracts (when continuation is chosen, i.e. $\sigma'_\tau(s', \epsilon') = 0$).

In some states of nature (s', ϵ'), the match separates $\left(\sigma'_\tau(s', \epsilon') = 1\right)$. For an aggregate state s', there may be idiosyncratic productivity levels ϵ' low enough such that equation (11) does not hold. This defines a threshold $\epsilon^*_{s'\tau}$ for each aggregate state s', below which the match will separate. Then $F(\epsilon^*_{s'\tau})$ defines the ex-ante probability of separation for each aggregate state s'.

Proposition 2: As the fixed cost c_τ decreases, the probability of separation $\left(F(\epsilon^*_{s\tau})\right)$ increases for all aggregate states s.

The intuition is that lower fixed costs raise the firm's outside options for hiring workers to perform tasks in all possible states of nature, which increases the set of states leading to a separation[10]. Note that a reduction in c_τ in the model leads to more separations on average, which would tend to increase the use of contract labour. This implies that, since $c_l < c_h$, it is in low-skill tasks that contract labour is more likely to be found.

The pass-through of firm level productivity shocks (ϵ) to wages w_τ , $\varepsilon_{w_\tau,\epsilon} = \frac{\Delta w_\tau}{\Delta \epsilon}$ is the measure of wage insurance I shall focus on. The following proposition provides the main theoretical results about wage insurance.

Proposition 3: Wage insurance is:

(i) Increasing in the fixed cost c_τ

(ii) Increasing in the productivity coefficient θ_h

Lower fixed costs reduce wage insurance as they raise the value of the firm's outside option $\left(\bar{\Pi}^\tau(s')\right)$ for all possible future aggregate states s'. In addition, they reduce the expected tenure in the match, as shown in Proposition 2. Similarly, an increase in the productivity coefficient raises the benefits of keeping a full-time worker engaged on a skill-intensive task, lowering the value of the firm's outside option for those tasks. In addition, I also show in the proof that they increase the expected tenure in the match.

[10]Bertrand et al. [2021] have argued that a Supreme Court decision in 2001 made the task of employing contract labour cheaper and easier, which led to the rapid increase in contract labour use by large firms.

3.4 Understanding the empirical results using the model

Proposition 3 enables us to compare risk-sharing within the firm across the two tasks, and across firms:

Corollaries: Wage insurance is greater for full-time workers in:

(i) high-skill tasks

(ii) firms that are more capital intensive (have a higher k)

From proposition 3, low-skill tasks with fixed cost $c_l < c_h$ have lower wage smoothing than high-skill tasks. Also from proposition 3, the productivity coefficient $\theta_h = \theta(k),\ \theta' > 0$. Hence, more capital intensive firms have a higher θ_h and, from proposition 3, feature more wage smoothing for full-time workers than do firms with lower k.

Relation to the empirical findings on wage insurance

In section 2, I documented that firms that have a larger share of contract labour and which are more capital-intensive offer greater insurance to their full-time workers. The corollary above can explain the latter finding for full-time workers engaged in high-skill tasks, but it could be the case that such workers comprise a small fraction of the total full-time workers hired by a firm.

In the model, the growing share of contract workers in the workforce that has been observed in Indian manufacturing firms (and depicted in figure 1) can be modeled through a reduction in c_l. This follows Bertrand et al. [2021], who model the Supreme court decision against the requirement to convert contract workers into full-time workers as a reduction in the fixed adjustment cost of using contract labour. This would interact with the heterogeneity in c_l across firms, as some firms would be able to integrate contract workers into the production process more smoothly. In other words, the impetus towards hiring contract workers that an aggregate event like Bertrand et al. [2021] highlight could be realised differently by firms.

Proposition 2 implies that a lower c_l leads to more full-time workers being displaced from low-skill tasks by contract workers. A lower c_l also decreases wage smoothing for full-time workers engaged in low-skill tasks, but there would be progressively fewer such workers as a share of the total full-time workforce. The relatively high c_h though implies that full-time workers would continue to be largely engaged in high-skill tasks, as opposed to contract labour. Thus, among the full-time workers *remaining at firms*, relatively more are engaged in high-skill than in low-skill tasks. From the corollary to proposition 3, this implies that risk-sharing would be higher for full-time workers in firms with a higher share of contract workers[11].

The argument can be summarized as follows: suppose the total number of full-time workers engaged on task τ is $n_{f\tau}$, with the total number of full-time workers at the firm being given by $n_f = n_{fl} + n_{fh}$. Denote the pass-through of productivity shock ϵ to the wage of a full-time worker performing task τ by $\varepsilon_{w_\tau,\epsilon}$. Then, the pass-through of productivity shock ϵ to the *average* full-time worker is:

$$\varepsilon^f_{w,\epsilon} = \frac{n_{fl}}{n_f}\,\varepsilon_{w_l,\epsilon} + \frac{n_{fh}}{n_f}\,\varepsilon_{w_h,\epsilon}$$

[11]Even if c_h did decline and some full-time workers performing high-skill tasks were displaced by contract labour, the relatively lower substitutability of full-time workers performing high-skill tasks (due to $\theta_h > 1$ and in capital intensive firms) would explain why wage insurance would be greater for the remaining full-time workers

The assumptions about c_l, c_h and θ_h imply that $\varepsilon_{w_l,\epsilon} \geq \varepsilon_{w_h,\epsilon}$. Further, firms with a lower c_l would have a higher $\varepsilon_{w_l,\epsilon}$ and lower $\frac{n_{fl}}{n_f}$. As contract workers would consequently dominate low skill tasks, the overall pass-through of productivity shocks to full-time workers would be driven by full-time workers performing high-skill tasks. Thus, firms that are more capital intensive and which tend to employ more contract labour provide greater wage insurance to full-time workers.

The argument made above does rely on contract workers being more likely to displace full-time workers in low-skill tasks. Even if the presence of significant firing costs makes displacement of type f workers difficult, it is still more likely to occur in low-skill tasks. Furthermore, if the firm expands its workforce, the empirical patterns for Indian manufacturing plants are not inconsistent with the argument made here of firms hiring largely contract labour and some full-time workers for tasks which contract labour cannot readily perform, i.e. skill-intensive tasks. This too would lead to a fall in $\frac{n_{fl}}{n_f}$, and help explain the wage pass-through results from section 2.

Contract labour usage and capital intensity of firms

Given this trend toward increasing 'contractualisation' of the workforce, Kapoor and Krishnapriya [2019] find that capital intensive industries have seen a larger increase in contract worker use.

In the context of the model, this would imply that a lower c_l is more likely in industries with a higher k and thus a higher θ_h[12]. Our model is agnostic about the

[12]The limited commitment model treats each wage contract individually, hence it is not typically used to study aggregate firm choices when firms have multiple tasks and departments. However, one hypothesis for this pattern could be that firms using relatively more expensive capital are more likely to switch to using contract labour in an attempt to reduce the overall labour compensation, including benefits and bonuses that are often paid to full-time workers.

precise mechanism that could induce a lower c_l in more capital-intensive firms. The alternative modeling frameworks discussed earlier would face greater difficulties in reconciling the wage insurance results by capital intensity and contract labour usage with the positive correlation between growth in contract labour usage and capital intensity.

4 Conclusion

I provide evidence that wage insurance for full-time workers, measured as the pass-through of firm productivity shocks to the average full-time worker's wages, in Indian manufacturing sector establishments is higher among establishments that employ more contract workers and are more capital-intensive. This can be understood using a model of limited commitment in which firms hire workers to perform two types of tasks differentiated by skill requirement and capital use. Contract labour is more (less) substitutable with full-time labour in less (more) skill and capital-intensive tasks. By making the firm's outside option of engaging contract labour more (less) attractive for low (high)-skill tasks, this promotes more risk-sharing within firms where full-time workers are largely engaged in high-skill tasks that require the use of capital and contract labour is used to perform low-skill tasks.

Appendices

The appendix contains proofs of the propositions in the paper in section A, and robustness checks and estimation of alternative specifications in section B.

A Proofs of propositions

The proofs are based on the corresponding proofs in Lagakos and Ordonez [2011] with suitable modifications: the key difference is that a reduction in the fixed cost c_τ raises the firm's outside option here, while a reduction in the worker's displacement cost in Lagakos and Ordonez [2011] raises the worker's outside option.

A.1 Proposition 1

Proof. Fix a state (v, s, ϵ) where continuation occurs $(\sigma_\tau = 0)$ and let η_τ be the Lagrange multiplier on the promise keeping constraint (9). For the worker's and firm's self-enforcing constraints (10) and (11), let the multipliers be $\beta\alpha_{s'|s}\phi(\epsilon')\lambda_{e\tau}(s', \epsilon')$ and $\beta\alpha_{s'|s}\phi(\epsilon')\lambda_{f\tau}(s', \epsilon')$, where ϕ is the probability density function associated with the cdf of the idiosyncratic productivity, F.

The first order condition for w_τ is $\eta_\tau = \frac{1}{u'(w_\tau)}$; and for each $v'(s', \epsilon')$ when continuation is chosen $(\sigma_\tau(s', \epsilon') = 0)$ is:

$$\eta_\tau'\big(1 + \lambda_{f\tau}(s', \epsilon')\big) - \lambda_{e\tau}(s', \epsilon') = \eta_\tau \tag{12}$$

Together, they imply:

$$\frac{1}{u'(w_\tau)} = \frac{1}{u'(w'_\tau)}\Big(1 + \lambda_{f\tau}(s',\epsilon')\Big) - \lambda_{e\tau}(s',\epsilon') \;\; \forall s',\epsilon' \tag{13}$$

If $w'_\tau = w_\tau$ then it must be the case that $\lambda_{f\tau}(s',\epsilon') = \lambda_{e\tau}(s',\epsilon') = 0$, as we are considering the case where separations do not occur. This implies that the self-enforcement constraints do not bind, i.e. $v(s',\epsilon') > \bar{V}^\tau(s')$ and $\Pi^{f\tau}(v',s',\epsilon',\sigma'_\tau) > \bar{\Pi}^\tau(s')$.

If $w'_\tau > w_\tau$ then $u'(w'_\tau) < u'(w_\tau)$ by concavity, which by (13) implies that $\lambda_{e\tau}(s',\epsilon') > 0$ and hence that $v(s',\epsilon') = \bar{V}^\tau(s')$.

Similarly, $w'_\tau < w_\tau$ implies that $\lambda_{f\tau}(s',\epsilon') > 0$, and hence that $\Pi^{f\tau}(v',s',\epsilon',\sigma_t a u') = \bar{\Pi}^\tau(s')$.

□

A.2 Proposition 2

Proof. The Envelope Condition of the firm's maximization problem is $\frac{\partial \Pi^\tau(v,s,\epsilon,\sigma_\tau)}{\partial v(s,\epsilon)} = -\frac{1}{u'(w_\tau)} < 0$.

Given an aggregate state s and a promised utility v, $\frac{\partial \Pi^\tau(s,\epsilon)}{\partial \epsilon} > 0$. Hence, as the idiosyncratic shock ϵ increases, so does the firm's profits.

From the firm's outside option in equation (7), $\frac{\partial \bar{\Pi}^\tau(s)}{\partial c_\tau} < 0$.

Fix a state of nature (s,ϵ). The threshold $\epsilon^*_{s\tau}$ is obtained from the equation: $\Pi^\tau(\bar{V}^\tau(s),\epsilon^*_{s\tau}) = \bar{\Pi}^\tau(s)$.

Evaluated at the state of the nature where the worker's self-enforcement constraint binds,

$$\frac{\partial \Pi^\tau(s,\epsilon^*_{s\tau})}{\partial \bar{V}^\tau(s)}\frac{\partial \bar{V}^\tau(s)}{\partial c_\tau} + \frac{\partial \Pi(s,\epsilon^*_{s\tau})}{\partial \epsilon^*_{s\tau}}\frac{\partial \epsilon^*_{s\tau}}{\partial c_\tau} = \frac{\partial \bar{\Pi}^\tau(s)}{\partial c_\tau}$$

The first term on the LHS vanishes, while the signs of the other terms discussed above imply that $\frac{\partial \epsilon^*_{s\tau}}{\partial c_\tau} < 0$.

Hence, as the fixed cost c_τ decreases, the separation probability $F(\epsilon^*_{s\tau})$ increases.

$\square$

A.3 Proposition 3

Proof. I first prove part (i), and then discuss the main changes that need to be made in order to prove part (ii).

I will use Lemma 2 of Thomas and Worrall [1988] and Proposition 2 of Lagakos and Ordonez [2011] in the proof below. This states that: for a given task τ, for all $s \in S$ and $\epsilon \in [\underline{\epsilon}, \bar{\epsilon}]$, there exists an interval $[\underline{w}_{s,\epsilon,\tau}, \bar{w}_{s,\epsilon,\tau}]$ such that:

1. $w_\tau(s, \epsilon, h_{-1}) \in [\underline{w}_{s,\epsilon,\tau}, \bar{w}_{s,\epsilon,\tau}] \ \forall h_{-1}$
2. When $w_\tau(s, \epsilon, h_{-1}) = \underline{w}_{s,\epsilon,\tau}$, then $V^\tau(s, \epsilon) = \bar{V}^\tau(s)$
3. When $w_\tau(s, \epsilon, h_{-1}) = \bar{w}_{s,\epsilon,\tau}$, then $\Pi^\tau(v_\tau, s, \epsilon, \sigma_\tau) = \bar{\Pi}^\tau(s)$

Part 1 can be obtained by using the first-order condition $\eta_\tau = \frac{1}{u'(w_\tau)}$, the envelope condition $\eta_\tau = \Pi^\tau_v$ and noting that Π^τ is bounded above (otherwise the firm would renege on the contract). Parts 2 and 3 come from plugging $\frac{1}{u'(w_\tau)} = \Pi^\tau_v$ into equation (12) and using the results in Proposition 1.

Proof of part (i): I proceed in three steps. First, considering an initial wage $w_{-1\tau}$ I will prove that as c_τ decreases, in states where wages increase, they increase by more and in states where wages decrease, they also decrease by more, sustaining less smoothing. Second I will show that the number of states in which wages do not change is smaller. Finally, I show how these properties translate into less wage smoothing by implying a lower elasticity.

Given a state of nature (s_{-1}, ϵ_{-1}) and a wage $w_{-1\tau}$ in the previous period, one can split all possible current states into four cases:

1. States of nature with $\epsilon < \epsilon^*_{s\tau}$ lead to separation $\big(\sigma_\tau(s,\epsilon)\big)$, where the self-enforcement constraints for both parties bind

2. States of nature with $\epsilon > \epsilon^*_{s\tau}$ where only the worker's self-enforcement constraint binds: $v_\tau(s,\epsilon) = \bar{V}^\tau(s)$ and $\Pi^\tau(v_\tau, s, \epsilon, \sigma_\tau = 0) > \bar{\Pi}^\tau(s)$

3. States of nature with $\epsilon > \epsilon^*_{s\tau}$ where only the firm's self-enforcement constraint binds: $\Pi(v_\tau, s, \epsilon, \sigma_\tau = 0) = \bar{\Pi}^\tau(s)$ and $v_\tau(s,\epsilon) > \bar{V}^\tau(s)$

4. States of nature with $\epsilon > \epsilon^*_{s\tau}$ where neither party's self-enforcement constraint binds: $\Pi(v_\tau, s, \epsilon, \sigma_\tau = 0) > \bar{\Pi}^\tau(s)$ and $v_\tau(s,\epsilon) > \bar{V}^\tau(s)$

First, I show that a reduction in c_τ increases (weakly) wage changes at each state of nature, i.e. $\frac{\partial(|w_\tau - w_{-1\tau}|)}{\partial c_\tau} \leq 0$. For all states of nature in case (2) above, $w_\tau = \underline{w}_{s,\epsilon,\tau} \geq w_{-1\tau}$. Similarly, for all states of nature in case (3) above, $w_\tau = \bar{w}_{s,\epsilon,\tau} \leq w_{-1\tau}$.

Consider a reduction in fixed cost c_τ without changing wages in any state of nature. This has two implications on the outside options: directly, and via a change in $\epsilon^*_{s\tau}$. Regarding the former, a reduction in c_τ raises the firm's outside option. This does not affect the enforcement constraints in case (2), but now all binding constraints in case (3) stop binding. Hence, it is optimal for the firm to reduce wages further in some states under case (3). The same is true for all future aggregate states s' in equilibrium. The indirect effect arises as a reduction in c_τ raises $F(\epsilon^*_{s\tau})$, which weakly reduces the expected profits to a firm, $E_{s',\epsilon'}\ \Pi'^{\tau}(s',\epsilon')$. This further lowers $\bar{w}_{s,\epsilon,\tau}$ in all states falling under case (3) above.

Together, these imply that $\frac{\partial\left(|w_{\tau}(s,\epsilon)-w_{-1\tau}|\right)}{\partial c_{\tau}} \leq 0$ for all states (s,ϵ).

The next step is to show that the number of states of nature in which wages do not change shrinks with a reduction in c_{τ}. Consider first the subset of states falling under case (3), i.e. where the firm's self-enforcement constraint binds. I showed above that a reduction in c_{τ} lowers $\bar{w}_{s,\epsilon,\tau}$ in all states falling under case (3). Case (3) is defined by all states of nature in which $w_{-1\tau} > \bar{w}_{s,\epsilon,\tau}$. Hence, a reduction in c_{τ} expands the subset of states of nature falling under case (3), which lead to a wage change. For the subset of states falling under case (4), $\bar{\Pi}^{\tau}(s)$ increases with a reduction in c_{τ}, hence there are some cases where the firm's self enforcement constraint that previously didn't bind now becomes a binding constraint, shrinking the subset of states falling under case (4), where wages are unchanged. Overall then, there is a reduction in the set of states for which wages are unchanged.

Tying these strands together, the previous steps have shown that a reduction in c_{τ}:

(i) Increases the change from $w_{-1\tau}$ to $\bar{w}_{s,\epsilon,\tau}$ in states of nature where wages decrease

(ii) Reduces the subset of states of nature (s,ϵ) in which wages do not change

The elasticity of wages to firm shocks is defined as $\varepsilon_{w_{\tau},\epsilon} = \frac{\Delta w_{\tau}}{\Delta \epsilon}$. As I have shown that $\frac{\partial\left(|w_{\tau}(s,\epsilon)-w_{-1\tau}|\right)}{\partial c_{\tau}} \leq 0$ for all states (s,ϵ), then $\frac{\partial \varepsilon_{w_{\tau},\epsilon}}{\partial c_{\tau}} \leq 0$. Hence, wage smoothing is reduced as the fixed cost c_{τ} falls.

Proof of part (ii): First, I show that an increase in θ_{τ} reduces (weakly) wage changes at each state of nature, i.e. $\frac{\partial(|w_{\tau}-w_{-1\tau}|)}{\partial \theta_{\tau}} \leq 0$. For all states of nature in case (2) above, $w_\tau = \underline{w}_{s,\epsilon,\tau} \geq w_{-1\tau}$. Similarly, for all states of nature in case (3) above, $w_\tau = \bar{w}_{s,\epsilon,\tau} \leq w_{-1\tau}$.

Consider an increase in productivity coefficient θ_h without changing wages in any state of nature. For all states of nature in case (3), the increase in θ_h increases expected profits to a firm, $E_{s',\epsilon'}\ \Pi'^{\tau}(s',\epsilon')$, which increases $\bar{w}_{s,\epsilon,\tau}$ in those states falling under case (3). The increase in θ_h affects the outside options via a change in $\epsilon^*_{s\tau}$. The threshold $\epsilon^*_{s\tau}$ is obtained from the equation: $\Pi^\tau(\bar{V}^\tau(s), \epsilon^*_{s\tau}) = \bar{\Pi}^\tau(s)$. Differentiating w.r.t θ_h, one obtains that $\frac{\partial \epsilon^*_{s\tau}}{\partial \theta_\tau} < 0$. A rise in θ_τ therefore lowers $F(\epsilon^*_{s\tau})$, which weakly increases the expected profits to a firm, $E_{s',\epsilon'}\ \Pi'^{\tau}(s',\epsilon')$. This raises $\bar{w}_{s,\epsilon,\tau}$ in all states falling under case (3) above.This implies that $\frac{\partial\left(|w_\tau(s,\epsilon) - w_{-1\tau}|\right)}{\partial \theta_\tau} \leq 0$ for all states (s,ϵ).

The next step is to show that the number of states of nature in which wages do not change rises with an increase in θ_τ. Consider first the subset of states falling under case (3), i.e. where the firm's self-enforcement constraint binds. I showed above that a rise in θ_τ raises $\bar{w}_{s,\epsilon,\tau}$ in all states falling under case (3). Case (3) is defined by all states of nature in which $w_{-1\tau} > \bar{w}_{s,\epsilon,\tau}$. Hence, a rise in θ_τ shrinks the subset of states of nature falling under case (3), which lead to a wage change. Overall then, there is a rise in the set of states for which wages are unchanged.

Tying these strands together, the previous steps have shown that a rise in θ_τ:

(i) Shrinks the change from $w_{-1\tau}$ to $\bar{w}_{s,\epsilon,\tau}$ in states of nature where wages decrease

(ii) Increases the subset of states of nature (s,ϵ) in which wages do not change

As I have shown that $\frac{\partial\left(|w_\tau(s,\epsilon) - w_{-1\tau}|\right)}{\partial \theta_\tau} \leq 0$ for all states (s,ϵ), then $\frac{\partial \varepsilon_{w_\tau,\epsilon}}{\partial \theta_\tau} \leq 0$. Hence, wage smoothing is enhanced as the productivity coefficient θ_τ rises.

□

B Robustness and additional specifications

I consider some alternative specifications of the wage-productivity shock elasticity regression from equation (3), in order to check the robustness of our main findings about wage insurance being greater in establishments hiring a larger share of contract workers or in more capital-intensive establishments. I note that in all the tables below, robust standard errors are clustered at the level of the establishment, as in table 1.

I also checked the robustness of the results when standard errors are clustered: (i) at the 3 digit industry level; or (ii) at state level. Regarding (i), the sample is modified owing to the imperfect correspondence between NIC industrial classifications across revisions (in 1998, 2004 and 2008). Similarly, (ii) also requires a modification to the sample to be consistent for establishments over the years. In both cases, the results are largely unchanged (and shall be included in an online appendix).

B.1 Using an augmented definition of wages

Lagakos and Ordonez [2011] use a measure of wages that includes all salaries, bonuses, contributions to medical and pension plans, and any other compensation that is not in-kind. The ASI dataset provides wages, bonuses, contributions to provident funds and workmen and staff welfare expenses (the last from 2005 to 2008), separately by worker type, for the period 1998-2008.

Table 2 shows that our results are unaffected when we use this augmented measure of full-time worker wages over the reduced sample period from 1998-2008.

Table 2: Wage smoothing and contract labour use: augmented wage measure

	(1)	(2)	(3)
	w_{ext}	w_{ext}	w_{ext}
Establishment productivity shock (ν)	0.398***	0.423***	0.390***
	(0.00430)	(0.00476)	(0.00547)
$\mathbb{I}_{\text{Contract share}\geq 50\%}$	-0.602***		
	(0.0107)		
$\nu * \mathbb{I}_{\text{Contract share}\geq 50\%}$	-0.0918***		
	(0.0122)		
$\mathbb{I}_{\text{Contract share positive}}$		-0.308***	
		(0.00816)	
$\nu * \mathbb{I}_{\text{Contract share positive}}$		-0.154***	
		(0.00913)	
$\mathbb{I}_{\text{Labour share}\geq 50\%}$			0.440***
			(0.00506)
$\nu * \mathbb{I}_{\text{Labour share}\geq 50\%}$			0.208***
			(0.00909)
Constant	13.01***	12.98***	12.70***
	(0.427)	(0.465)	(0.466)
N	255718	255718	255718
adj. R^2	0.267	0.233	0.273

Note: Sample is from 1998-2008. Dependent variable is the logarithm of the sum of real wages, bonuses and benefits for full-time workers. All explanatory variables defined as in notes to table 1.

All regressions include industry-year and state fixed effects.
Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B.2 Using the consistent district-state sub-sample

Clustering standard errors by district is complicated in our data set as the state and district identifiers are often not consistent for the same establishment over time. Table 3 shows that the main finding of wage insurance against establishment-level productivity shocks for full-time workers being greater in establishments using contract labour more intensively; and in establishments which are more capital intensive, holds in a (smaller) sample that ensures consistency of state and district by establishment identifiers.

B.3 Industries comprising only private sector firms

Our sample consists of industries which are dominated by private sector establishments (classified as either 'Private' or 'Joint Sector Private' by the ASI). Therefore, one should expect that dropping industries which have some non-private establishments shouldn't significantly alter the main findings, which is confirmed in table 4.

B.4 Wage insurance with some alternative specifications of contract labour usage

Table 5 shows that the finding that wage insurance for full-time workers is greater in establishments employing more contract labour is robust to alternative specifications of contract labour use. These measures are: (i) whether the average contract worker share for each establishment over the respective sample period exceeds a threshold (either 50% or being positive); (ii) whether the contract worker share for

Table 3: Wage insurance, contract labour and capital intensity: restricted sample

	(1)	(2)	(3)
	w	w	w
Establishment productivity shock (ν)	0.145***	0.152***	0.138***
	(0.00783)	(0.00860)	(0.00931)
$\mathbb{I}_{\text{Contract share}\geq 50\%}$	0.0344***		
	(0.0101)		
$\nu * \mathbb{I}_{\text{Contract share}\geq 50\%}$	-0.0327**		
	(0.0148)		
$\mathbb{I}_{\text{Contract share positive}}$		0.0193**	
		(0.00947)	
$\nu * \mathbb{I}_{\text{Contract share positive}}$		-0.0492***	
		(0.0116)	
$\mathbb{I}_{\text{Labour share}\geq 50\%}$			0.155***
			(0.00784)
$\nu * \mathbb{I}_{\text{Labour share}\geq 50\%}$			0.0839***
			(0.0138)
Constant	10.98***	11.00***	10.82***
	(0.122)	(0.122)	(0.114)
N	131744	131744	131744
adj. R^2	0.119	0.120	0.142

Note: All variables defined as in notes to table 1.
All regressions include state and industry-year fixed effects.

Standard errors clustered at district level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Wage insurance for full-time workers in private establishments

	(1)	(2)	(3)
	w	w	w
Establishment productivity shock (ν)	0.121***	0.129***	0.123***
	(0.00174)	(0.00189)	(0.00213)
$\mathbb{I}_{\text{Contract share}\geq 50\%}$	0.0544***		
	(0.00326)		
$\nu * \mathbb{I}_{\text{Contract share}\geq 50\%}$	-0.0394***		
	(0.00407)		
$\mathbb{I}_{\text{Contract share positive}}$		0.0241***	
		(0.00265)	
$\nu * \mathbb{I}_{\text{Contract share positive}}$		-0.0491***	
		(0.00351)	
$\mathbb{I}_{\text{Labour share}\geq 50\%}$			0.147***
			(0.00209)
$\nu * \mathbb{I}_{\text{Labour share}\geq 50\%}$			0.0584***
			(0.00381)
Constant	10.33***	10.34***	10.28***
	(0.0749)	(0.0748)	(0.0743)
N	502613	502613	502613
adj. R^2	0.119	0.119	0.137

Note: All variables defined as in notes to table 1. In specification (3), sample is trimmed to reduce outliers.

All regressions include industry-year and state fixed effects. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Wage insurance: variation with alternative contract labour usage measures

	(1)	(2)	(3)	(4)
	w	w	w	w
Establishment productivity shock (ν)	0.118***	0.135***	0.119***	0.125***
	(0.00164)	(0.00216)	(0.00171)	(0.00183)
$\nu * \mathbb{I}_{\text{Mean contract share} \geq 50\%}$	-0.0266***			
	(0.00508)			
$\nu * \mathbb{I}_{\text{Mean contract share positive}}$		-0.0392***		
		(0.00310)		
$\nu * \mathbb{I}_{\text{Contract share in final year} \geq 50\%}$			-0.0243***	
			(0.00413)	
$\nu * \mathbb{I}_{\text{Contract share in initial year} \geq 0}$				-0.0416***
				(0.00343)
Constant	10.35***	10.35***	10.35***	10.35***
	(0.0725)	(0.0724)	(0.0726)	(0.0725)
N	515348	515348	515348	515348
adj. R^2	0.115	0.116	0.115	0.116

Note: w and ν are defined as in notes to table 1. $\mathbb{I}_{\text{Mean contract share} \geq 50\%}$ and $\mathbb{I}_{\text{Mean contract share} \geq 0\%}$ are indicators for whether the contract workers' share is at least 50% or if the establishment hires any contract workers. $\mathbb{I}_{\text{Contract share in final year} \geq 50\%}$ is an indicator for whether the contract workers' share in the final year recorded in sample is at least 50%. $\mathbb{I}_{\text{Contract share in initial year} \geq 0}$ is an indicator for whether the contract workers' share in the initial year recorded in sample is positive.
All regressions include industry-year and state fixed effects.
Robust standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

each establishment in the first recorded year of the sample period was positive; and (iii) whether the contract worker share for each establishment in the final recorded year of the sample period exceeds a threshold of 50%.

While measure (i) represents consistency of contract labour use over the sample period, measure (ii) subsets the sample using a measure that captures how suited an establishment would be to employing contract labour. The notion here is that establishments which hired contract labour initially found contract labour to be more easy to integrate (i.e. they had a lower c_l in the terminology of the model), leading to the replacement of low-skilled full-time workers and the provision of greater wage insurance to the (skilled) full-time workers remaining employed.

Measure (iii) captures those establishments which, according to our model, would have eventually transitioned away from using full-time workers for low-skill tasks. One might expect the argument in section 3 to be relevant for establishments that have successfully transitioned to using contract labour for low-skill tasks, and if this transition occurs over the length of the sample period, one might expect the results from the final period of a firm's operation to conform more closely to the transition away from using full-time workers to perform low-skill tasks that was highlighted in subsection 3.4.

B.5 Restricting the sample to exclude large establishments

Bertrand et al. [2021] argue that a Supreme Court ruling[13] in 2001 contributed greatly to the expansion in use of contract workers, particularly among large establishments (with more than 500 employees).

[13] The Supreme Court Case is "Steel Authority of India Ltd. vs. National Union Water Front Workers."

Table 6: Wage insurance, contract labour usage and capital intensity: excluding large establishments

	(1)	(2)	(3)	(4)
	w	w	w	w
Establishment productivity shock (ν)	0.134***	0.139***	0.126***	0.127***
	(0.00207)	(0.00272)	(0.00179)	(0.00224)
$\mathbb{I}_{\text{Contract share}\geq 50\%}$	0.0632***		0.0578***	
	(0.00460)		(0.00341)	
$\nu * \mathbb{I}_{\text{Contract share}\geq 50\%}$	-0.0445***		-0.0458***	
	(0.00749)		(0.00439)	
$\mathbb{I}_{\text{Labour share}\geq 50\%}$		0.166***		0.156***
		(0.00248)		(0.00214)
$\nu * \mathbb{I}_{\text{Labour share}\geq 50\%}$		0.0700***		0.0659***
		(0.00482)		(0.00401)
Constant	10.14***	10.07***	10.31***	10.24***
	(0.0725)	(0.0722)	(0.0733)	(0.0722)
Excludes establishments with size:	≥ 100	≥ 100	≥ 500	≥ 500
N	343494	343494	474017	474017
adj. R^2	0.142	0.168	0.127	0.149

Note: All variables are defined as in notes to table 1.
Each specification notes the measure of large establishments excluded from the sample, with size referring to total number of employees.
All regressions include industry-year and state fixed effects. Robust standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

I consider here whether the wage insurance findings for full-time workers, by contract labour usage and capital intensity of establishments, is driven by large establishments with total employees exceeding 100 and 500 individuals[14]. I restrict the sample to exclude large establishments and table 6 shows that the patterns described in the paper continue to hold.

[14] The panel begins in 1998, hence I do not have a large enough sample to test whether there is a break in contract labour usage post 2001.

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