Asymmetric Business Cycles in Segmented Labour Markets

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Abstract

We document the asymmetric business cycles in both regular and contract labour markets in India and investigate the role of nominal wage rigidities in accounting for the employment and output dynamics. Using data from Annual Survey of Industries, we find that the output growth is negatively skewed. More importantly, we observe that the growth in regular employment is negatively skewed while that of contract employment is positively skewed. On the other hand, the nominal wage growth of regular workers exhibit positive skewness while that of contract workers exhibit negative skewness. Using a standard business cycle model augmented with two different kinds of labour and asymmetric wage adjustment costs, we show that the nominal wage rigidities of regular and contract labour does a good job of explaining the asymmetries in output and employment cycles. We find that the presence of contract labour reduces the asymmetry in output cycle and the nominal wage rigidites can explain about 40% of the increase in the share of contract employment in India.

JEL codes: E24, E32, J42

Keywords: Asymmetry, Wage Rigidity, Segmented Markets

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1 Introduction

Despite a rapid advancement of emerging market business cycle research, [1] we have a limited understanding of labour market dynamics and its implications for business cycle fluctuations. For instance, a characteristic of the Indian labour markets has been rise in the use of contract workers - workers on temporary contracts hired through an intermediary or contractor. The share of contract labourers in organized manufacturing has increased from about 15% in 1999 to a substantial 35% in 2015.

This observation raises important questions that needs to be addressed in Indian business cycle context. Does contract employment and wages exhibit any distinctive patterns over the business cycle compared to regular workers? If so, how does the presence of contract employment impact the business cycle? How should we modify the business cycle framework to account for the dynamics of contract employment? This paper aims to answer these questions.

In India, laws regarding employment compensation and conditions is given under Industrial Disputes Act (IDA) of 1947. However, the scope of this law is only for regular (permanent) workers and contract workers aren't under its jurisdiction. Under IDA, the employers are constrained by several restrictions regarding conditions of employment, workhours, wages and pension to workers, layoffs, retrenchments and closures. [2] Indian labour laws are considered to be more protective compared to international average, or even among large developing countries according to World Bank's rigidity of employment index. [3]

Hiring of contract labour was legalized in 1970 through a central legislation. The contract workers are not directly employed by the firms but are hired through contractors. Because of this, IDA does not apply to contract workers. The wages of contract workers are usually lesser than the regular workers and they are not a part of trade unions. Firms

[1] See the works by Neumeyer and Perri (2005), Uribe and Yue (2006), Aguiar and Gopinath (2007),Mendoza (2010),Garcia-Cicco et al. (2010), Chang and Fernández (2013) among others.

[2] Under chapter VB of the IDA labor courts and tribunals can set aside any discharge or dismissal referred to them as unjustified. For retrenchment, authorization has to be sought from the state government, which is rarely granted (Saha (2006)).

[3] Out of 34 OECD and emerging market economies, India's employment protection Legislation was the third most stringent with respect to permanent contracts and the most stringent with respect to collective dismissals (Dougherty (2008)).

have the flexibility to hire and fire contract workers without being restrained by IDA. Some of the papers like Saha et al. (2013), Chaurey (2015) argue that, this higher flexibility has led to an increased share of contract workers in the labour force.

Our interest in this paper is to examine the implications of this segmented labour market featuring both contract and regular workers on business cycles in India. We begin by systematically documenting the wage and employment dynamics exhibited by regular and contract workers using data from Annual Survey of Industries (ASI) for the period of 1997-2014. Firstly, we find that contract employment is more volatile compared to regular employment over the business cycle. This is consistent with the earlier observation that the firms have flexibility to hire and fire contract workers but not regular workers. Secondly, we find that employment and wages of both regular and contract workers exhibit asymmetric fluctuations over the business cycle.

Specifically, we find that the employment of regular workers is negatively skewed while their nominal wages is positively skewed. Over the business cycle, regular employment tends to fall faster than increase while the nominal wages of regular workers adjust upwards more rapidly than downwards. These empirical patterns are consistent with other developed economies as reported by Abbritti and Fahr (2013) and Kim and Ruge-Murcia (2009). The distinctive feature of Indian business cycles is the dynamics of contract employment and wages. We find that the employment of contract workers is positively skewed while their nominal wages is negatively skewed. This is exactly opposite to the behaviour of regular employment and wages. While the fall in regular employment is faster rate compared to its rise, contract employment on the other hand expands at a faster rate and falls sluggishly. This is consistent with the increased share of contract workers that we see in the data.

To address these empirical findings, we extend the standard New-Keynesian framework to include dual labour markets and asymmetric wage adjustment costs. The model economy is composed of households, intermediate goods firms, final goods firm and the central bank.

Monopolistically competitive households receive utility from consumption of the final good, supply differentiated regular and contract labour to the intermediate firm and have access to complete markets. Importantly, wage setting by households are subject to an asymmetric wage adjustment costs that are calibrated to capture the distinctive wage dynamics of regular and contract labour.

Intermediate goods producers use both regular and contract labour to produce differentiated goods and face price adjustment costs. The final good producer aggregates the intermediate goods and sells the composite good in perfectly competitive markets. Finally, the central bank implements monetary policy by setting the short-term interest rate according to a Taylor-type feedback policy rule. The only source of uncertainty in the model is a shock to aggregate TFP.

The model is calibrated to Indian manufacturing data. The parameters of the asymmetric wage adjustment cost functions for both regular and contract labour are chosen to match the standard deviation and skewness of their nominal wage inflation. Upon matching the nominal wage dynamics, our model does a good job of generating the asymmetries in both regular and contract employment. The simulated data exhibits both negatively skewed regular employment and positively skewed contract employment as found in the data. We are able to capture the negative skewness in aggregate output as well. We also find that, introducing contract labour into the model reduces the skewness of aggregate output by about 80%, thereby implying that the presence of contract labour reduces the asymmetry of the business cycle.

Intuitively, this result can be explained by firms substituting between contract and regular labour over the business cycle. Consider for example an economy with only regular workers who face downward nominal wage rigidity. When hit with a negative shock to productivity such an economy experiences a dramatic fall in both employment and output owing to downwardly rigid nominal wages. In the event of positive shocks to productivity, nominal wages rise and thereby prevent a substantial increase in output and employment. Such an economy would therefore be characterized by negatively skewed output and employment and positively skewed wages. The introduction of the more flexible contract labour in this environment mitigates the impact of shocks by allowing firms to substitute away from regular labour. Output therefore falls less dramatically in downturns and rises more in upturns thereby reducing the asymmetry of the business cycle.

Our work in this paper is related to multiple strands of literature. There is a growing body of literature that studies business cycle asymmetries for advanced economies (see Ball and Mankiw (1994); Acemoglu and Scott (1997); Hansen and Prescott (2005);

Jovanovic (2006); Van Nieuwerburgh and Veldkamp (2006); Devereux and Siu (2007); McKay and Reis (2008); Görtz and Tsoukalas (2013); Ordonez (2013)). The paper closest to our study is Abbritti and Fahr (2013). They argue that the presence of downward nominal wage rigidities can lead to asymmetries in business cycle fluctuations. We extend this study by introducing a segmented labour market to analyse business cycle asymmetries from the context of an emerging economy, namely India.

This paper is organized as follows. Section 2 presents empirical evidence on business cycle fluctuations. Section 3 describes the model framework. Section 4 presents the calibration strategy while the main results of the paper are presented in section 5. Section 6 discusses the results and presents the counterfactual exercises while section 7 concludes.

2 Empirical Evidence

In this section, we document the business cycle facts for India using data from Annual Survey of Industries. Primarily, we show that growth rate of employment for regular workers is negatively skewed while that of contract workers is positively skewed. On the other hand, the growth rate of nominal wages for regular workers is positively skewed (downwardly rigid) while that of contract workers is negatively skewed (upwardly rigid).

2.1 Annual Survey of Industries

Annual Survey of Industries (ASI) is an yearly census of registered manufacturing plants in India. Conducted by the National Sample Survey Office (NSSO), all registered manufacturing plants with more than hundred (200 or more between 1997 to 2003) workers ("Census Scheme") are surveyed yearly. In addition, a random one-fifth sample of smaller registered plants (one-third utill 2004) ("Sample Scheme") is surveyed yearly.

In order to construct the aggregate data, we use the data cleaning procedure adopted by Allcott et al. (2016). To be specific, we first remove all the observations that have an invalid state code. Next, we only consider factories that are open in that assessment year. And finally, we remove all the firms that have non-manufacturing NIC codes. More details on the data preparation can be found in the Appendix. At the end of this procedure, we have data on about 35,000 firms per year for a period of 1999 to 2015. We use the sampling weights provided by the ASI to construct the aggregate data.

Cyclicality of Annual Growth Rates		
	Regular Worker	Contract Worker
$\rho(x, Y)$	0.5594	0.8296
$\rho(x, Y \vert Expansion)$	0.4818	0.8285
$\rho(x, Y \vert Recession)$	0.7409	0.8826
$\rho(x, Regular\ Employment)$	1	0.2812

Table 1: Cyclicality of Annual Growth Rates

The variables in the ASI that we use are output, employment and wages. Following Hsieh and Klenow (2009) and Allcott et al. (2016), we measure output by the revenue earned by firms. We use CPI Industrial Worker index as our measure of inflation. One of the important advantages of ASI is, it provides labour market information separately for both regular and contract workers. We measure employment by total number of regular and contract workers employed. Similarly, we measure the nominal wages by calculating nominal wages per manday for both regular and contract workers. We use annual growth rates of macroeconomic variables to calculate the business cycle statistics.

2.2 Cyclicality

We start with our empirical results with the cyclicality of labour market variables provided in table 1. We find that employment is procyclical for both regular and contract workers. The result holds even after controlling for expansions and recessions separately. The correlation of contract employment is higher than the regular employment implying that the contract employment traces the business cycle more closely compared to the regular employment. We also find a positive correlation between contract and regular employment which indicates that both regular and contract employment move together over the cycle.

2.3 Standard Deviations

Table 2 documents the standard deviations of annual growth rates of output and labour market variables. The output volatility is much higher compared to other developed countries. This confirms the findings of Aguiar and Gopinath (2007) and emerging market

Standard Deviation of Annual Growth Rates		
Output	0.068	
Price	0.028	
	Regular Worker	Contract Worker
Nominal Wage	0.036	0.050
Real Wage	0.027	0.034
Employment	0.044	0.067

Table 2: Standard Deviations of Annual Growth Rates

business cycle research in general.

The volatility of contract employment is about 50% higher than that of regular employment. Another interesting finding is, the wages (both real and nominal) of contract workers is also more volatile compared to the wages of regular workers. This seems to indicate that the labour market of contract workers is more flexible compared to the regular workers, both in terms of labour adjustment and wage setting process.

2.4 Skewness

Even though the previous section documented the adjustment of output and labour market variables over the business cycle, it doesn't talk about the asymmetric nature of the adjustment. Table 3 documents the skewness of annual growth rates of output and labour market variables, which is the main interest of our study. We find that the employment of regular workers is negatively skewed while their nominal wages is positively skewed. Over the business cycle, regular employment tend to fall faster than increase while the nominal wages of regular workers adjust upwards more rapidly than downwards. We also find that the output growth is negatively skewed. These empirical patterns are consistent with those in other developed economies such as France, Germany, US, UK and the Euro Area as documented by Abbritti and Fahr (2013).

The distinctive feature of Indian business cycles is the dynamics of contract employment and wages. We find that the employment of contract workers is positively skewed while their nominal wages is negatively skewed. This is exactly opposite to the behaviour

Skewness of Annual Growth Rates		
Output	-0.047	
Price	0.435	
Nominal Wage (Aggregate)	0.252	
Real Wage (Aggregate)	0.330	
Employment (Aggregate)	-0.329	
	Regular Worker	Contract Worker
Nominal Wage	0.331	-0.599
Real Wage	0.014	-0.406
Employment	-0.420	0.196

Table 3: Skewness of Annual Growth Rates

Kelley Skewness of Annual Growth Rates		
Output	-0.413	
Price	0.195	
Employment (Aggregate)	-0.126	
Nominal Wage (Aggregate)	0.027	
Real Wage (Aggregate)	0.295	
	Regular Worker	Contract Worker
Nominal Wage	0.121	-0.398
Real Wage	0.121	-0.253
Employment	-0.371	0.016

Table 4: Kelley Skewness of Annual Growth Rates

of regular employment and wages. While the regular employment contracts at a faster rate compared to its expansion, contract employment on the other hand expands at a faster rate whereas its decline is in smaller steps. This is consistent with the increased share of contract workers that we see in the data. A positive nominal wage skewness for regular workers is suggestive of downward nominal wage rigidity, while we observe the opposite for contract workers. These skewness measures indicate the underlying dichotomy that exists between regular and contract labour markets.

The second measure of skewness given in table 4 is the Kelley skewness. Kelley skewness is based on the distribution's percentiles. It is defined as

$$k(x) = \frac{x^{p90} + x^{p50} - 2x^{p10}}{x^{p90} - x^{p10}} \tag{1}$$

where x^{pN} denotes the Nth percentile of the distribution for the random variable x. As one can note, Kelley's measure of skewness doesn't consider outliers which can bias the results, hence it is more robust. Comparing, 4 with 3 we observe, the signs and directions of skewness is same.

In this paper, we investigate the role of nominal wage rigidities of both regular and contract workers in explaining the asymmetric movements of output and employment over the business cycle.

3 Model Framework

The model extends the workhorse New Keynesian model with wage and price rigidities to include segmented labor markets with asymmetric wage adjustment costs. Our objective is to capture the asymmetric features associated with both the regular and contract labor markets and examine its implications for business cycles in India.

3.1 Households

The economy is populated by a continuum of infinitely lived identical households indexed by $i \in [0, 1]$ and each household has a continuum of members. Within each household, a fraction s of its members particpates in regular employment while the remaining fraction $(1 - s)$ participates in contract employment. Each household i maximizes the following utility function

$$U_t = \mathrm{E}_0 \sum_{t=1}^{\infty} \beta^t \left[\frac{c_t(i)^{1-\sigma}}{1-\sigma} - \frac{s n_t^r(i)^{1+\rho}}{1+\rho} - \frac{(1-s) n_t^c(i)^{1+\rho}}{1+\rho} \right] \tag{2}$$

where $c_t(i)$ is the consumption of the final good. As monopolistic competitors, households choose their wage and supply differentiated regular labor n_t^r and contract labor n_t^c to the intermediate good sector. Importantly, nominal wages, W_t^r and W_t^c set by households for the regular and the contract sectors are subject to asymmetric wage adjustment costs. Following Kim and Ruge-Murcia (2009) and Abbritti and Fahr (2013), we model the wage adjustment cost for a j worker where $j \in \{r, c\}$ as follows

$$\Phi_t^j = \phi_w^j \left(\frac{exp(-\psi^j(\Omega_t^j - 1)) + \psi^j(\Omega_t^j - 1) - 1}{(\psi^j)^2} \right) \tag{3}$$

Here ψ^j captures the degree of asymmetry in the adjustment cost while Ω_t^j denotes the wage inflation of j worker. When $\psi^j > 0$, a wage increase faces linear costs while a wage decrease is subjected to convex costs. Hence a decrease in nominal wage is costlier compared to a corresponding increase. On the other hand, if $\psi^j < 0$, increase in nominal wage is costlier than a decrease, as now wage increase is subjected to convex costs. This functional form [4] captures the contrasting nominal wage rigidities of regular and contract labour, which is the main mechanism that we want to examine in this study.

Households can smooth consumption using a nominal one-period private discount bond, B_t which pays a nominal interest rate, i_t every period. Using income earned from wages, interests and profits, households finance the current period consumption and next periods bond holdings.The household's budget constraint is therefore given by

$$c_t(i) + \frac{B_{t+1}}{P_t} \leq (1 + i_{t-1})\frac{B_t}{p_t} + \frac{W_t^r(i) n_t^r(i)(1 - \Phi_t^r(i))}{P_t} + \frac{W_t^c(i) n_t^c(i)(1 - \Phi_t^c(i))}{P_t} + \frac{\Pi_t}{P_t} \tag{4}$$

where Π_t are the firms profits in the intermediate good sector and P_t, is the aggregate price index. Each period households maximize their utility by choosing $\{c_t, B_{t+1}, n_t^r, n_t^c, W_t^r, W_t^c\}$ subject to the initial asset holdings and the sequence of wages, labour demand, budget constraints, and a no-Ponzi-game condition. The first order conditions are as follows:

$$c_t^{-\sigma}(i) = \eta_t \tag{5}$$

[4] Refer to Kim and Ruge-Murcia (2009) for a discussion on the attractiveness of this functional form.

implying that at an optimum, the marginal utility of consumption is equal to the marginal utilty of wealth

$$i_t = \frac{1}{\beta} E_t \left[\frac{P_{t+1}}{P_t} \frac{\eta_t}{\eta_{t+1}} \right] \tag{6}$$

Equation (6) is the standard Euler equation that equalises the cost of postponing consumption with its expected marginal benefit. The wages of regular workers ($W_t^r(i)$) satisfy

$$\begin{aligned} & s \frac{(n_t^r(i))^{1+\rho}}{W_t^r(i)} \varepsilon_w + E_t \beta \frac{\eta_{t+1}}{P_{t+1}} \left[\left(\frac{W_{t+1}^r(i)}{W_t^r(i)} \right)^2 n_{t+1}^r(i) (\Phi_{t+1}^r(i))' \right] + \\ & (1-\varepsilon_w)\eta_t \frac{1}{P_t} (1-\Phi_t^r(i)) n_t^r(i) - \frac{W_t^r(i)}{W_{t-1}^r(i)} (\Phi_t^r)' \frac{\eta_t}{P_t} n_t^r(i) = 0 \end{aligned} \tag{7}$$

Equation (7) equates the cost of raising wages to its benefits. The costs would include an increase in wage adjustment costs and decrease in the hours worked as firms substitute in favor of a cheaper input. The gains would include higher hourly wage income and a reduction in future expected wage adjustment costs. Analogously, the wages of contract workers ($W_t^c(i)$) satisfy

$$\begin{aligned} & (1-s) \frac{(n_t^c(i))^{1+\rho}}{W_t^c(i)} \varepsilon_w + E_t \beta \frac{\eta_{t+1}}{P_{t+1}} \left[\left(\frac{W_{t+1}^c(i)}{W_t^c(i)} \right)^2 n_{t+1}^c(i) (\Phi_{t+1}^c(i))' \right] + \\ & (1-\varepsilon_w)\eta_t \frac{1}{P_t} (1-\Phi_t^c(i)) n_t^c(i) - \frac{W_t^c(i)}{W_{t-1}^c(i)} (\Phi_t^c)' \frac{\eta_t}{P_t} n_t^c(i) = 0 \end{aligned} \tag{8}$$

3.2 Final Goods Firm

There is a final goods firm which aggregates the intermediate goods, $y_t(z)$, according to a CES technology and sells the composite good y_t in a perfectly competitive market. Formally, this can be represented by

$$y_t = \left(\int_0^1 (y_t(z))^{\frac{\varepsilon_p - 1}{\varepsilon_p}} \, dz \right)^{\frac{\varepsilon_p}{\varepsilon_p - 1}} \tag{9}$$

where $\varepsilon_p > 1$ is the elasticity of substitution of goods. The demand function of intermediate firm's products is given by:

$$y_t(z) = \left(\frac{P_t(z)}{P_t} \right)^{-\varepsilon_p} y_t \tag{10}$$

The aggregate price index P_t is given by:

$$P_t = \left(\int_0^1 (P_t(z))^{(1-\varepsilon_p)} \, dz \right)^{\frac{1}{1-\varepsilon_p}} \tag{11}$$

3.3 Intermediate Goods Firm

The intermediate goods sector is characterized by monopolistically competitive firms. Each intermediate goods firm produces a differentiated good $z \in [0,1]$ using the production function

$$y_t(z) = a_t(h_t(z))^{1-\alpha} \tag{12}$$

where $y_t(z)$ is output of firm z, $h_t(z)$ is the aggregate labour input to firm z, α is a production function parameter and a_t is an exogenous productivity shock that follows an AR(1) process

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a \tag{13}$$

The firm hires both regular and contract labour and aggregates them into a homogeneous labour input $h_t(z)$ using a CES aggregator of the form

$$h_t(z) = \left[\gamma^{\frac{1}{\delta}} (n_t^r(z))^{\frac{\delta-1}{\delta}} + (1-\gamma)^{\frac{1}{\delta}} (n_t^c(z))^{\frac{\delta-1}{\delta}} \right]^{\frac{\delta}{\delta-1}} \tag{14}$$

The problem of an intermediate firm can be solved in two steps. In the first step firm optimally chooses demand for regular and contract worker by carrying out a simple static cost minimization problem. In the second step the agent chooses prices solving a typical dynamic programming problem. Formally, each firm minimizes its total cost given by

$$Min \;\; (W_t^r n_t^r(z) + W_t^c n_t^c(z)) \tag{15}$$

subject to the production constraint

$$h_t(z) \geq \left[\gamma^{\frac{1}{\delta}} (n_t^r(z))^{\frac{\delta-1}{\delta}} + (1-\gamma)^{\frac{1}{\delta}} (n_t^c(z))^{\frac{\delta-1}{\delta}} \right]^{\frac{\delta}{\delta-1}} \tag{16}$$

where n_t^h and n_t^l are the aggregate amount of regular and contract labour and are given by

$$n_t^j(z) = [\int_0^1 (n_t^j(i,z))^{\frac{\varepsilon_w - 1}{\varepsilon_w}} di]^{\frac{\varepsilon_w}{\varepsilon_w - 1}} j \in \{r, c\} \tag{17}$$

ε_w is the elasticity of substitution among labour. The resultant labour demand functions for regular and contract workers are given by

$$W_t^r = W_t \left[\gamma^{\frac{1}{\delta}} \left(\frac{h_t(z)}{n_t^r(z)} \right)^{\frac{1}{\delta}} \right] \tag{18}$$

$$W_t^c = W_t \left[(1-\gamma)^{\frac{1}{\delta}} \left(\frac{h_t(z)}{n_t^c(z)} \right)^{\frac{1}{\delta}} \right] \tag{19}$$

where W_t, the aggregate wage is obtained as a weighted average of regular and contract wages

$$W_t = \left[\gamma (W_t^r)^{1-\delta} + (1-\gamma)(W_t^c)^{1-\delta} \right]^{\frac{1}{1-\delta}} \tag{20}$$

Equations (18) and (19) imply the demand for each type of labour varies inversely with its wage rate and directly with the aggregate labour demand. Finally, $MC_t(z)$ the marginal cost of the intermediate firm z is given by

$$MC_t(z) = \frac{W_t}{a_t(1-\alpha)(h_t(z))^{-\alpha}} \tag{21}$$

Monopolistically competitive firms choose their own price and maximizes the discounted sum of real profits:

$$\mathrm{E}_0 \sum_{t=1}^{\infty} \frac{\beta^t \eta_t}{P_t} \left[P_t(z)(1-\Gamma_t^z) y_t(z) - W_t h_t(z) \right] \tag{22}$$

subject to the downward-sloping demand function of the final good producer (10), and a price adjustment cost Γ_t^z of the form Rotemberg (1982).

$$\Gamma_t^z = \frac{\phi_p}{2} \left[\pi_t - 1 \right]^2 \tag{23}$$

where π_t refers to the price inflation and ϕ_p is an adjustment cost parameter. The first order condition yields the standard price Phillips equation for the firm and is given by

$$\frac{1}{P_t} \left[(1-\epsilon_p)(1-\Gamma_t^z) y_t(z) - \Gamma_t^{z\prime} \frac{P_t(z)}{P_{t-1}(z)} y_t(z) + \frac{1}{P_t(z)} y_t(z) \epsilon_p MC_t(z) \right] + \\ E_t \left[\beta \frac{\eta_{t+1}}{\eta_t} {\Gamma_{t+1}^z}' \frac{y_{t+1}(z)}{P_{t+1}} \left(\frac{P_{t+1}(z)}{P_t(z)} \right)^2 \right] = 0 \tag{24}$$

3.4 Monetary Policy and Aggregate Resource Constraint

The central bank implements monetary policy by setting the short-term interest rate according to a Taylor-type feedback rule. The central bank sets the nominal interest rate depending on the lagged values of interest rates and any deviation of inflation from its steady state. That is,

$$ln(i_t/i) = \phi_i ln(i_{t-1}/i) + \phi_\pi ln(\pi_t/\pi) \tag{25}$$

where i and π refers to the steady state values of interest rate and inflation respectively.

3.5 Symmetric Equilibrium

Since households are assumed to be identical, it follows that under a symmetric equilibrium, it follows that their equilibrium choices will be same, and therefore the i subscripts can be dropped without loss of generality. Analogously, all firm are identical and hence would charge the same price and produce the same quantity. This implies that substituting profits of the intermediate firm into the household budget constraint and assuming without loss of generality that equilibrium bond holdings are zero, we get the aggregate resource constraint as follows.

$$c_t = \frac{W_t^r n_t^r (1-\Phi_t^r)}{P_t} + \frac{W_t^c n_t^c (1-\Phi_t^c)}{P_t} + (1-\Gamma_t) y_t - \frac{W_t h_t}{P_t} \tag{26}$$

4 Calibration

We calibrate the parameters of the model to quantitatively investigate the impact of nominal wage rigidities on business cycle asymmetries. Table 5 shows the values chosen for the parameters externally. The discount factor β is set to reflect a real interest rate of 4%. The share of regular workers s and their relative income share γ are directly obtained from the ASI data. The elasticity of substitution between regular and contract workers δ is set to 1.03 following the findings of Basu et al. The price adjustment cost parameter ϕ_p and elasticity of substitution among differentiated goods ϵ_p are taken from Anand and Prasad (2010). For the monetary policy rule, we set the elasticity of interest rates to inflation ϕ_π and lagged interest rates ϕ_i at 1.47 and 0.86 respectively following the

Parameter description	Value	Source
Price adjustment cost parameter, ϕ_p	100	Anand and Prasad (2010)
Relative income share, γ	0.61	ASI
Elasticity of substitution of labour, δ	1.03	Basu et al.
Share of labour in production function, α	0.29	ASI
Discount factor, β	0.96	Real interest rate at 4%
Inter-temporal elasticity of consumption, σ	2	Anand and Prasad (2010)
Persistence of productivity shock, ρ_a	0.85	ASI
Elasticity of Substitution among goods, ϵ_p	10	Anand and Prasad (2010)
Elasticity of Substitution among labour, ϵ_w	7	Laxton and Pesenti (2003)
Share of regular worker among total workers, s	0.72	ASI
Inverse of Frisch elasticity, ρ	2	Banerjee and Basu (2017)
Coeff. of lag interest rate in Taylor rule, ϕ_i	0.86	Banerjee and Basu (2017)
Coeff. of inflation in Taylor rule, ϕ_π	1.47	Banerjee and Basu (2017)
Standard deviation of productivity shock, σ_a	0.05	ASI

Table 5: Externally Chosen Parameters

Parameter	Description	Value	Target
ϕ_w^r	Wage rigidity of regular workers	4370	Standard deviation of regular wage
ψ^r	Wage asymmetry of regular workers	19000	Skewness of regular wage
ϕ_w^c	Wage rigidity of contract workers	3950	Standard deviation of contract wage
ψ^c	Wage asymmetry of contract workers	-10500	Skewness of contract wage

Table 6: Calibration Targets

	Parameters		Moments			
	ϕ_w^j Wage rigidity	ψ_j Wage asymmetry	Data Std Dev	Model Std Dev	Data Skewness	Model Skewness
Regular Workers	4370	19000	0.036	0.041	0.331	0.449
Contract Workers	3950	-10500	0.050	0.028	-0.599	-0.679

Table 7: Matching the Targets

findings in Banerjee and Basu (2017). We estimate the TFP shock process using Solow residuals to obtain a persistence ρ_a of 0.85 and a standard deviation σ_a of 0.05.

We calibrate the asymmetric wage adjustment costs by matching the model generated moments with their corresponding data counterparts. Table 6 shows the strategy followed to calibrate the asymmetric wage adjustment costs. The wage rigidity parameters of regular ϕ_w^r and contract workers ϕ_w^c are chosen to match the standard deviations of wages. The wage asymmetry parameters of regular ψ^r and contract labour ψ^c are chosen to match the skewness of wages.

Table 7 shows the calibrated values of the wage adjustment parameters. The main mechanism of our paper is reflected in the calibrated values of wage asymmetry parameters. The asymmetry parameter of regular wages ψ^r is positive, meaning that any increase in regular wages face a linear cost while a decrease is subject to convex costs, leading to downward nominal wage rigidity for regular workers. On the other hand, asymmetry parameter of contract wages ψ^c is calibrated to be negative. This penalizes any wage increase with a convex cost leading to an upwardly rigid nominal wages for contract workers.

Cyclicality of Growth Rates		
	Data	Model
$\rho(Y, Reg.Emp.)$	0.559	0.390
$\rho(Y, Cont.Emp.)$	0.830	0.454
$\rho(Reg.Emp, Cont.Emp.)$	0.281	0.084

Table 8: Cyclicality: Model and Data

5 Results

This section discusses the performance of our calibrated model in matching the business cycle dynamics of India. We find that the model does a good job of generating asymmetries in output and employment growth rates, which is the main question that we ask in this paper.

5.1 Cyclicality

Table 8 shows the cyclicality of model generated data and the corresponding ones from the original data. Even though the model is not calibrated to capture the cyclicality of the labour market variables, it does well by capturing the salient features of the data. The model is able to generate procyclical employment for both regular and contract workers. It also captures the higher procyclicality of contract labour compared to the regular labour. Finally, the model produces a positive co-movement between regular and contract labour even though the magnitude of co-movement is smaller compared to what we find in the data.

5.2 Standard Deviations

Table 9 shows the model generated standard deviations and the corresponding data moments. The model does a good job of matching the standard deviations of output. Even though the model does well to match the standard deviation of contract employment, it falls short with respect to regular employment. Model produces regular employment to be more volatile than the contract employment, which is opposite of what we find in the data.

Standard Deviation of Growth Rates		
	Data	Model
Regular Employment	0.044	0.060
Contract Employment	0.067	0.038
Output	0.068	0.066
Price	0.028	0.010
Nominal Wages (Regular)	0.036	0.041
Nominal Wages (Contract)	0.050	0.028
Real Wages (Regular)	0.027	0.040
Real Wages (Contract)	0.034	0.031

Table 9: Standard Deviations: Model and Data

5.3 Skewness

The model does a very good job of generating skewness close to data as shown in Table 10. The output is negatively skewed while the price is positively skewed as we see in the data. We are also able to generate regular employment to be negatively skewed while the contract employment to be positively skewed.

These results can be explained by the wage dynamics of contract and regular workers over the business cycle. When the economy is hit with a negative productivity shock, ideally nominal wages should fall to reflect the fall in productivity. But the nominal wages of regular workers will not fall by much as a wage decrease is costly for regular workers. Firms, with no other option resort to reducing regular labour during the downturn. On the other hand, contract wages can be reduced relatively costlessly and hence contract employment is not affected by much in the event of a negative productivity shock. Similarly, when the economy faces a positive productivity shock, regular wages increase a lot and this restricts any increase in regular employment. But, contract wages do not increase by much as it faces convex adjustment costs. This facilitates a rapid increase in contract employment during upturns. These dynamics combine to generate a negatively skewed regular employment and a positively skewed contract employment.

Skewness of Growth Rates		
	Data	Model
Regular Employment	-0.420	-0.224
Contract Employment	0.196	0.115
Output	-0.047	-0.028
Price	0.435	0.109
Nominal Wages (Regular)	0.331	0.449
Nominal Wages (Contract)	-0.599	-0.679
Real Wages (Regular)	0.014	0.481
Real Wages (Contract)	-0.406	-0.493

Table 10: Skewness: Model and Data

5.4 Impulse Responses

Figure 1 shows the impulse responses for a unit standard deviation productivity shock. When the economy faces a negative productivity shock, regular wages falls a bit and for a short period of time. But, the regular employment decreases and is persistently below the steady state for a long period of time. In contrast, for the same negative productivity shock, contract wages fall a lot and hence contract employment doesn't get affected by much. Similarly, when the economy is hit with a positive productivity shock, the regular nominal wages increase by a lot which causes a very muted increase in regular employment. On the other hand, for the same positive productivity shock, contract wages do not increase by much and hence there is a sustained increase in contract employment. This mechanism delivers the skewness in both regular and contract employment over the business cycle.

6 Discussion

In this section we perform two counterfactual experiments. First, we replace the asymmetric wage adjustment costs with quadratic wage adjustment costs. For the second conterfactual, we remove the contract labour and treat the economy as if it is made up of only regular workers. Finally, we also talk about the implications for the increasing share

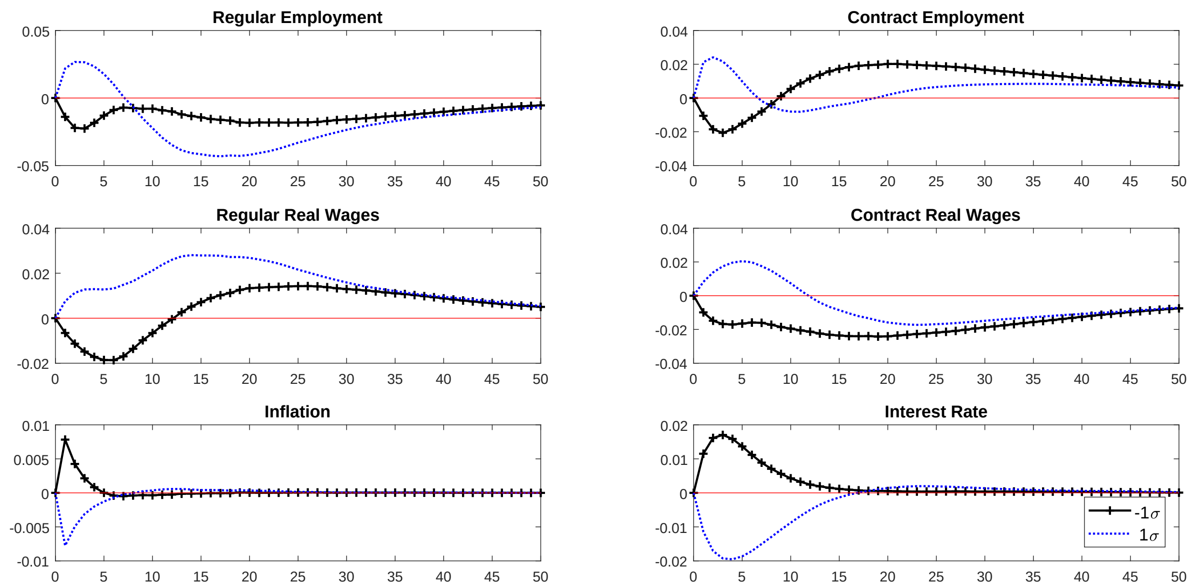

Figure 1: Impulse Responses

	Parameter	Moments	
	Wage rigidity	Data	Simulated
	ϕ_w^j	Std. Dev	Std. Dev
Regular Workers	2.5	0.036	0.022
Contract Workers	1.3	0.050	0.022

Table 11: Calibration: Quadratic Costs

of contract employment in India.

6.1 Quadratic Wage Adjustments

In this exercise, we assess the importance of asymmetric wage adjustments in order to generate the business cycle dynamics. In order to achieve that, we solve a version of the benchmark model with quadratic wage adjustment cost function for both regular and contract workers.

The parameters of the quadratic costs are chosen to match the standard deviations of wage inflation as shown in table 11.

Standard Deviation of Growth Rates			
	Data	Asymmetric	Quadratic
Regular Employment	0.044	0.060	0.023
Contract Employment	0.067	0.038	0.024
Output	0.068	0.066	0.036
Price	0.028	0.010	0.005
Regular Wages	0.036	0.041	0.022
Contract Wages	0.050	0.028	0.022

Table 12: Standard deviations: Asymmetric and Quadratic costs

Skewness of Growth Rates			
	Data	Asymmetric	Quadratic
Regular Employment	-0.420	-0.224	0.147
Contract Employment	0.196	0.115	0.140
Output	-0.047	-0.028	0.058
Price	0.435	0.109	0.216
Regular Wages	0.331	0.449	0.232
Contract Wages	-0.599	-0.679	0.243

Table 13: Skewness: Asymmetric and Quadratic Costs

	Parameters		Moments			
	ϕ_w^r	ψ^r	Data	Simulated	Data	Simulated
	Wage rigidity	Wage asymmetry	Std. Dev	Std. Dev	Skewness	Skewness
Regular Worker	3700	17000	0.036	0.046	0.331	0.357

Table 14: Calibration: Only Regular Workers

Standard Deviation of Growth Rates		
	Segmented Labour Market	Only Regular Labour
Regular emp	0.060	0.107
Output	0.066	0.093
Price	0.010	0.019
Regular nom. wages	0.041	0.046

Table 15: Standard Deviations: Dual and Single Sector

Tables 12 and 13 show the standard deviation and skewness obtained under quadratic adjustment costs. As can be seen, the model performs poorly under quadratic adjustment costs. Importantly we are not able to generate the negative skewness in either output or regular employment, which is the main focus of our study.

6.2 Only Regular Workers

The purpose of this experiment is to assess the role of contract labour in driving the business cycle dynamics. Assuming that the economy is just made up of regular workers, we solve a one sector version of our benchmark model. The regular workers are still subject to asymmetric wage adjustment costs. The parameters of the wage adjustment costs are calibrated to match the standard deviation and skewness of regular wages as shown in table 14.

Tables 15 and 16 show the standard deviation and skewness under the one sector model. One interesting finding is, introducing contract labour reduces the skewness of output from -0.246 to -0.028. Regular employment is negatively skewed because of the downward nominal wage rigidity of regular wages. And this causes output to be negatively skewed as well. But the introduction of the more flexible contract labour in this

Skewness of Growth Rates		
	Segmented Labour Market	Only Regular Labour
Regular emp	-0.224	-0.327
Output	-0.028	-0.246
Price	0.109	-0.044
Regular Wages	0.449	0.357

Table 16: Skewness: Dual and Single Sector

environment mitigates the impact of shocks by allowing firms to substitute away from regular labour. Output therefore falls less dramatically in downturns and rises more in upturns thereby reducing the asymmetry over the business cycle.

6.3 Share of Contract Labour

In India, we do observe a secular increase in the share of contract labour. The contract workers constituted around 16% of the total labour force in 1999. This has increased to 35% in 2015 as shown in figure 2. The nominal wage rigidities of regular and contract labour explains about 40% of this increase in contract share. The evolution of model generated share are shown using dotted line in figure 2.

Since regular workers face downward nominal wage rigidity, regular employment is negatively skewed over the cycle. On the other hand, the nominal wages of contract workers are rigid upwards and this a positively skewed employment cycle for the contract workers. This asymmetric adjustment regular and contract employment generates a trend increase in the share of contract employment as we see in the data.

7 Conclusion

In this paper we analyze the impact of contract labour on the business cycle dynamics. We show that regular employment is negatively skewed while contract employment is positively skewed over the business cycle. We also find that the nominal wage growth of both regular and contract workers are asymmetric. To study the impact of nominal wage rigidities on business cycle asymmetries, we build a business cycle model with two kinds

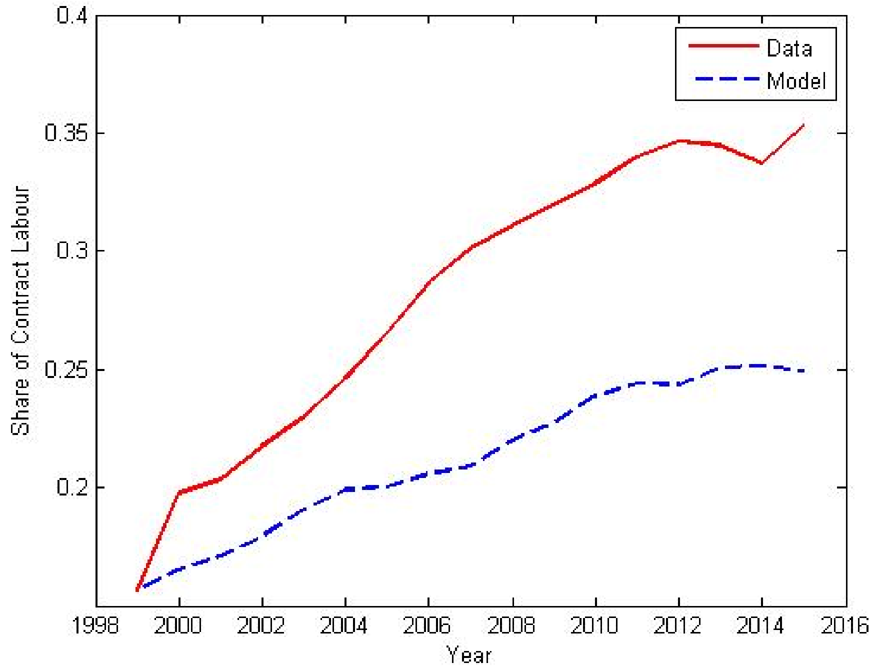

Figure 2: Share of Contract Labour

of labour and asymmetric adjustment costs for wages. We show that the nominal wage rigidities of regular and contract labour does a good job of explaining the business cycle asymmetries we find in the data. We also show that the asymmetric wage adjustment costs are integral to match the data and the presence of a more flexible contract labour reduces the asymmetries in the business cycle.

References

Abbritti, M. and Fahr, S. (2013). Downward wage rigidity and business cycle asymmetries. *Journal of Monetary Economics*, 60(7):871–886.

Acemoglu, D. and Scott, A. (1997). Asymmetric business cycles: Theory and time-series evidence. *Journal of Monetary Economics*, 40(3):501–533.

Aguiar, M. and Gopinath, G. (2007). Emerging market business cycles: The cycle is the trend. *Journal of political Economy*, 115(1):69–102.

Allcott, H., Collard-Wexler, A., and O'Connell, S. D. (2016). How do electricity shortages affect industry? evidence from india. *American Economic Review*, 106(3):587–624.

Anand, R. and Prasad, E. S. (2010). Optimal price indices for targeting inflation under incomplete markets. Technical report, National Bureau of Economic Research.

Ball, L. and Mankiw, N. G. (1994). Asymmetric price adjustment and economic fluctuations. *The Economic Journal*, 104(423):247–261.

Banerjee, S. and Basu, P. (2017). Technology shocks and business cycles in india. *Macroeconomic Dynamics*, pages 1–36.

Basu, A. K., Chau, N. H., and Soundararajan, V. Wage polarization and contract employment.

Chang, R. and Fernández, A. (2013). On the sources of aggregate fluctuations in emerging economies. *International Economic Review*, 54(4):1265–1293.

Chaurey, R. (2015). Labor regulations and contract labor use: Evidence from indian firms. *Journal of Development Economics*, 114:224–232.

Devereux, M. B. and Siu, H. E. (2007). State dependent pricing and business cycle asymmetries. *International Economic Review*, 48(1):281–310.

Dougherty, S. M. (2008). Labour regulation and employment dynamics at the state level in india.

Garcia-Cicco, J., Pancrazi, R., and Uribe, M. (2010). Real business cycles in emerging countries? *American Economic Review*, 100(5):2510–31.

Görtz, C. and Tsoukalas, J. D. (2013). Learning, capital-embodied technology and aggregate fluctuations. *Review of Economic Dynamics*, 16(4):708–723.

Hansen, G. D. and Prescott, E. C. (2005). Capacity constraints, asymmetries, and the business cycle. *Review of Economic Dynamics*, 8(4):850–865.

Hsieh, C.-T. and Klenow, P. J. (2009). Misallocation and manufacturing tfp in china and india. *The Quarterly journal of economics*, 124(4):1403–1448.

Jovanovic, B. (2006). Asymmetric cycles. *The Review of Economic Studies*, 73(1):145–162.

Kim, J. and Ruge-Murcia, F. J. (2009). How much inflation is necessary to grease the wheels? *Journal of Monetary Economics*, 56(3):365–377.

Laxton, D. and Pesenti, P. (2003). Monetary rules for small, open, emerging economies. *Journal of Monetary Economics*, 50(5):1109–1146.

McKay, A. and Reis, R. (2008). The brevity and violence of contractions and expansions. *Journal of Monetary Economics*, 55(4):738–751.

Mendoza, E. G. (2010). Sudden stops, financial crises, and leverage. *American Economic Review*, 100(5):1941–66.

Neumeyer, P. A. and Perri, F. (2005). Business cycles in emerging economies: the role of interest rates. *Journal of monetary Economics*, 52(2):345–380.

Ordonez, G. (2013). The asymmetric effects of financial frictions. *Journal of Political Economy*, 121(5):844–895.

Rotemberg, J. J. (1982). Sticky prices in the united states. *Journal of Political Economy*, 90(6):1187–1211.

Saha, B. (2006). Labour institutions in china and india: A tale of two nations. *Journal of South Asian Development*, 1(2):179–205.

Saha, B., Sen, K., and Maiti, D. (2013). Trade openness, labour institutions and flexibilisation: Theory and evidence from india. *Labour economics*, 24:180–195.

Uribe, M. and Yue, V. Z. (2006). Country spreads and emerging countries: Who drives whom? *Journal of international Economics*, 69(1):6–36.

Van Nieuwerburgh, S. and Veldkamp, L. (2006). Learning asymmetries in real business cycles. *Journal of monetary Economics*, 53(4):753–772.

Appendices

A Derivation

A.1 Households

Each household's discounted lifetime utility is given by:

$$\sum_{t=0}^{\infty}\beta^t\left[\frac{c_t^{(1-\sigma)}(i)}{(1-\sigma)} - s\frac{(n_t^r(i))^{1+\rho}}{(1+\rho)} - \frac{(1-s)((n_t^c(i))^{1+\rho})}{(1+\rho)}\right] \tag{27}$$

The household maximizes 27 subject to its budget constraint which is given by

$$c_t(i) + \frac{B_{t+1} - i_{t-1}B_t}{P_t} \leq \frac{W_t^r(i)n_t^r(i)(1-\Phi_t^r(i))}{P_t} + \frac{W_t^c(i)n_t^c(i)(1-\Phi_t^c(i))}{P_t}/ + \frac{\Pi_t}{P_t} \tag{28}$$

The utility maximization problem subject to the budget constraint gives:

$$L = \sum_{t=0}^{\infty}\beta^t\left[\frac{c_t^{(1-\sigma)}(i)}{(1-\sigma)} - s\frac{(n_t^h(i))^{1+\rho}}{(1+\rho)} - \frac{(1-s)((n_t^l(i))^{1+\rho})}{(1+\rho)}\right] +$$
$$\beta^t\eta_t\left[\frac{W_t^r(i)n_t^r(i)(1-\Phi_t^r(i))}{P_t} + \frac{W_t^c(i)n_t^c(i)(1-\Phi_t^c(i))}{P_t} + \frac{\Pi_t}{P_t} - c_t(i) - \frac{B_{t+1} - i_{t-1}B_t}{P_t}\right] \tag{29}$$

The household maximizes its utility every period choosing c_t,B_{t+1}, W_t^r, W_t^c

1. W.r.t c_t

$$c_t^{-\sigma}(i) = \eta_t \tag{30}$$

implying that at an optimum, the marginal utility of consumption is equal to the marginal utilty of wealth

2. W.r.t B_{t+1}

$$i_t = \frac{1}{\beta}E_t\left[\frac{P_{t+1}}{P_t}\frac{\eta_t}{\eta_{t+1}}\right] \tag{31}$$

3. W.r.t W_t^r

$$s\frac{(n_t^r(i))^{1+\rho}}{W_t^r(i)}\varepsilon_w + E_t\beta\frac{\eta_{t+1}}{P_{t+1}}\left[\left(\frac{W_{t+1}^r(i)}{W_t^r(i)}\right)^2 n_{t+1}^r(i)(\Phi_{t+1}^r(i))'\right] +$$
$$(1-\varepsilon_w)\eta_t\frac{1}{P_t}(1-\Phi_t^r(i))n_t^r(i) - \frac{W_t^r(i)}{W_{t-1}^r(i)}(\Phi_t^r)'\frac{\eta_t}{P_t}n_t^r(i) = 0 \tag{32}$$

4. W.r.t W_t^c

$$(1-s)\frac{(n_t^c(i))^{1+\rho}}{W_t^c(i)}\varepsilon_w + E_t\beta\frac{\eta_{t+1}}{P_{t+1}}\left[\left(\frac{W_{t+1}^c(i)}{W_t^c(i)}\right)^2 n_{t+1}^c(i)(\Phi_{t+1}^c(i))'\right]+$$
$$(1-\varepsilon_w)\eta_t\frac{1}{P_t}(1-\Phi_t^c(i))n_t^c(i) - \frac{W_t^c(i)}{W_{t-1}^c(i)}(\Phi_t^c)'\frac{\eta_t}{P_t}n_t^c(i) = 0 \tag{33}$$

A.2 Intermediate Firms

A.2.1 Labour Demand Function

Cost of the firm:

$$W_t^r n_t^r(z) + W_t^c n_t^c(z) \tag{34}$$

The intermediate firm minimizes its cost subject to constraint

$$h_t(z) \geq [\gamma^{\frac{1}{\delta}}(n_t^r(z))^{\frac{(\delta-1)}{\delta}} + (1-\gamma)^{\frac{1}{\delta}}(n_t^c(z))^{\frac{\delta-1}{\delta}}]^{\frac{\delta}{\delta-1}} \tag{35}$$

Lagrange for this minimization

$$L = W_t^r n_t^r(z) + W_t^c n_t^c(z) + \lambda_{1t}[h_t(z) - [\gamma^{\frac{1}{\delta}}(n_t^r(z))^{\frac{(\delta-1)}{\delta}} + (1-\gamma)^{\frac{1}{\delta}}(n_t^c(z))^{\frac{\delta-1}{\delta}}]^{\frac{\delta}{\delta-1}} \tag{36}$$

1. FOC w.r.t $n_t^r(z)$

$$W_t^r = \lambda_{1t}\left[\gamma^{\frac{1}{\delta}}\frac{h_t(z)}{n_t^r(z)}^{\frac{1}{\delta}}\right] \tag{37}$$

2. FOC w.r.t $n_t^c(z)$

$$W_t^c = \lambda_{1t}\left[(1-\gamma)^{\frac{1}{\delta}}\frac{h_t(z)}{n_t^c(z)}^{\frac{1}{\delta}}\right] \tag{38}$$

Using the definition of $h_t(z)$ and substituting $n_t^r(z)$ and $n_t^c(z)$ from equation 37 and 38 respectively, we get

$$\lambda_{1t}^{-\delta} = [\gamma(W_t^r(z))^{(1-\delta)} + (1-\gamma)(W_t^c(z))^{1-\delta}]^{\frac{\delta}{\delta-1}} \tag{39}$$

Also,

$$W_t h_t = W_t^r n_t^r + W_t^c n_t^c \tag{40}$$

Substituting $n_t^r(z)$ and $n_t^c(z)$ in the above equation from equation 37 and 38 respectively, we get

$$W_t\lambda_{1t}^{-\delta} = [\gamma(W_t^r(z))^{(1-\delta)} + (1-\gamma)(W_t^c(z))^{1-\delta}] \tag{41}$$

From 39 and 41,

$$W_t = [\gamma(W_t^r)^{1-\delta} + (1-\gamma)(W_t^c(z))^{1-\delta}]^{\frac{1}{1-\delta}} \tag{42}$$

and,

$$\lambda_{1t} = W_t \tag{43}$$

and hence substituting λ_{1t} in 37 and 38

Demand for regular labour,

$$n_t^r = \gamma h_t \left[\frac{W_t(z)}{W_t^r(z)}\right]^\delta \tag{44}$$

Demand for contract labour,

$$n_t^c = (1-\gamma) h_t \left[\frac{W_t(z)}{W_t^c(z)}\right]^\delta \tag{45}$$

A.2.2 Marginal Cost

The intermediate firm also minimises its subject to the constraint of producing enough goods to meet demand Cost of the firm:

$$W_t^r n_t^r(z) + W_t^c n_t^c(z) \tag{46}$$

subject to producing enough to meet the demand for its goods,

$$y_t(z) \geq a_t[[\gamma^{\frac{1}{\delta}}(n_t^r(z))^{\frac{(\delta-1)}{\delta}} + (1-\gamma)^{\frac{1}{\delta}}(n_t^c(z))^{\frac{\delta-1}{\delta}}]^{\frac{\delta}{\delta-1}}]^{(1-\alpha)} \tag{47}$$

Lagrange for this minimization:

$$L = W_t^r n_t^r(z) + W_t^c n_t^l(z) + \lambda_t[y_t(z) - a_t[(\gamma^{\frac{1}{\delta}}(n_t^r(z))^{\frac{(\delta-1)}{\delta}} + (1-\gamma)^{\frac{1}{\delta}}(n_t^c(z))^{\frac{\delta-1}{\delta}})^{\frac{\delta}{\delta-1}}]^{(1-\alpha)}] \tag{48}$$

FOC w.r.t $n_t^r(z)$

$$\gamma^{\frac{1}{\delta}} \left(\frac{h_t(z)}{n_t^r(z)}\right)^{\frac{1}{\delta}} \lambda_t = \frac{W_t^r}{a_t(1-\alpha)(h_t(z))^{-\alpha}} \tag{49}$$

Using 44, we get marginal cost, MC_t, of the firm as

$$MC_t = \frac{W_t}{a_t(1-\alpha)(h_t(z))^{-\alpha}} \tag{50}$$

A.2.3 Profit Maximisation

Monopolistically competitive firms choose their own price and maximizes the discounted sum of real profits:

$$\mathrm{E}_0 \sum_{t=1}^{\infty} \frac{\beta^t \eta_t}{P_t} \left[P_t(z)(1-\Gamma_t^z) y_t(z) - W_t h_t(z) \right] \tag{51}$$

subject to the downward-sloping demand function of the final good producer (10), and a price adjustment cost Γ_t^z of the form

$$\Gamma_t^z = \frac{\phi_p}{2} \left[\pi_t - 1 \right]^2 \tag{52}$$

The first order condition yields the standard price Phillips equation for the firm and is given by

$$\begin{aligned} \frac{1}{P_t} \left[(1-\epsilon_p)(1-\Gamma_t^z) y_t(z) - \Gamma_t^{z\prime} \frac{P_t(z)}{P_{t-1}(z)} y_t(z) + \frac{1}{P_t(z)} y_t(z) \epsilon_p MC_t(z) \right] + \\ E_t \left[\beta \frac{\eta_{t+1}}{\eta_t} \Gamma_{t+1}^{z\,\prime} \frac{y_{t+1}(z)}{P_{t+1}} \left(\frac{P_{t+1}(z)}{P_t(z)} \right)^2 \right] = 0 \end{aligned} \tag{53}$$

A.3 Equilibrium and Aggregation

As mentioned before, household budget constraint is

$$c_t(i) + \frac{B_{t+1} - i_{t-1} B_t}{P_t} \leq \frac{W_t^r(i) n_t^r(i)(1-\Phi_t^r(i))}{P_t} + \frac{W_t^c(i) n_t^c(i)(1-\Phi_t^c(i)}{P_t} + \frac{\Pi_t}{P_t} \tag{54}$$

in equilibrium, $B_t = 0$

$$c_t(i) = \frac{W_t^r(i) n_t^r(i)(1-\Phi_t^r(i))}{P_t} + \frac{W_t^c(i) n_t^c(i)(1-\Phi_t^c(i))}{P_t} + \frac{\Pi_t}{P_t} \tag{55}$$

Integrating 55 over i

$$\int_0^1 c_t(i) di = \int_0^1 \frac{W_t^r(i) n_t^r(i)(1-\Phi_t^r(i))}{P_t} di + \int_0^1 \frac{W_t^c(i) n_t^c(i)(1-\Phi_t^c(i))}{P_t} di + \frac{\Pi_t}{P_t} \tag{56}$$

Here, the overall firm profits are given by

$$\begin{aligned} \int_0^1 \frac{\Pi_t}{P_t} dz &= \int_0^1 \frac{P_t(z)(1-\Gamma_t^z) y_t(z) - W_t h_t(z)}{P_t} dz \\ &= (1-\Gamma_t) y_t - \frac{W_t h_t}{P_t} \end{aligned} \tag{57}$$

Using this 57 in 56 we get:

$$c_t = \int_0^1 \frac{W_t^r(i) n_t^r(i)(1 - \Phi_t^r(i))}{P_t} di + \int_0^1 \frac{W_t^c(i) n_t^c(i)(1 - \Phi_t^c(i))}{(P_t)} di + (1 - \Gamma_t) y_t - \frac{W_t h_t}{P_t} \quad (58)$$

which on integrating gives us the resource constraint,

$$c_t = \frac{W_t^r n_t^r (1 - \Phi_t^r)}{P_t} + \frac{W_t^c n_t^c (1 - \Phi_t^c)}{(P_t)} + (1 - \Gamma_t) y_t - \frac{W_t h_t}{P_t} \quad (59)$$

B Solving the Model

B.1 First Order conditions

We consider all firms and households to be identical, hence we drop (i) and (z) notations. We also simplify the equations by considering the following:

1. $\frac{P_t(z)}{P_{t-1}(z)} = \pi_t$
2. $\eta_t = c_t^{-\sigma}$
3. $mc_t = \frac{MC_1}{P_t}$
4. $w_t = \frac{W_t}{P_t}$, i.e real aggregate wage
5. $w_t^r = \frac{W_t^r}{P_t}$, i.e real regular worker wage
6. $w_t^c = \frac{W_t^c}{P_t}$, i.e real contract worker wage
7. $\Omega_t^r = \frac{W_t^r}{W_{t-1}^r}$, i.e. nominal regular wage inflation
8. $\Omega_t^c = \frac{W_t^c}{W_{t-1}^c}$, i.e. nominal contract wage inflation

The simplified first order conditions are:

1. FOC w.r.t $P_t z$

$$\left[(1-\epsilon_p)(1-\Gamma_t)y_t - {\Gamma_t}'\pi_t y_t + y_t\epsilon_p mc_t\right] + E_t\left[\beta\frac{c_{t+1}^{-\sigma}}{c_t^{-\sigma}}{\Gamma_{t+1}}' y_{t+1}\pi_{t+1}\right] = 0 \tag{60}$$

2. FOC w.r.t B_{t+1}

$$i_t = \frac{1}{\beta}E_t\left[\pi_{t+1}\frac{c_t^{-\sigma}}{c_{t+1}^{-\sigma}}\right] \tag{61}$$

3. FOC w.r.t W_t^r

$$s\frac{(n_t^r)^{1+\rho}}{w_t^r}\varepsilon_w + E_t\beta c_{t+1}\left[\left(\Omega_{t+1}^r\right)^2 n_{t+1}^r \left(\Phi_{t+1}^r\right)'\right] + \\ (1-\varepsilon_w)c_t^{-\sigma}(1-\Phi_t^r)n_t^r - \Omega_t^r\left(\Phi_t^r\right)' c_t n_t^r = 0 \tag{62}$$

4. FOC w.r.t W_t^c

$$(1-s)\frac{(n_t^c)^{1+\rho}}{w_t^c}\varepsilon_w + E_t\beta c_{t+1}\left[\left(\Omega_{t+1}^c\right)^2 n_{t+1}^c \left(\Phi_{t+1}^c\right)'\right] + \\ (1-\varepsilon_w)c_t^{-\sigma}(1-\Phi_t^c)n_t^c - \Omega_t^c\left(\Phi_t^c\right)' c_t n_t^c = 0 \tag{63}$$

5. Resource constraint

$$c_t = w_t^r n_t^r(1-\Phi_t^r) + w_t^c n_t^c(1-\Phi_t^c) + (1-\Gamma_t)y_t - w_t h_t \tag{64}$$

6. AR(1) shock process for technology shock

$$a_t = \rho_a a_{t-1} + \epsilon_t^a \tag{65}$$

7. Production function:

$$y_t = a_t h_t^{1-\alpha} \tag{66}$$

8. Demand function for regular worker

$$n_t^r = \gamma h_t \left[\frac{w_t(z)}{w_t^r(z)}\right]^{\delta} \tag{67}$$

9. Demand function for contract worker

$$n_t^c = (1-\gamma) h_t \left[\frac{w_t(z)}{w_t^c(z)}\right]^{\delta} \tag{68}$$

10. Aggregate wage

$$w_t = [\gamma (w_t^r)^{1-\delta} + (1-\gamma)(w_t^c(z))^{1-\delta}]^{\frac{1}{1-\delta}} \tag{69}$$

11. Wage evolution equation for regular workers

$$\frac{\Omega_t^r}{\pi_t} = \frac{w_t^r}{w_{t-1}^r} \tag{70}$$

12. Wage evolution equation for contract workers

$$\frac{\Omega_t^c}{\pi_t} = \frac{w_t^c}{w_{t-1}^c} \tag{71}$$

B.2 Steady State

After the model has been specified the next step involves solving for the steady state of the variables. As mentioned in table 17, for certain variables, a_t, ω_t^r, Ω_t^c and π_t we fix the steady state values.

Also, at steady state Γ_t, Γ_t', Φ_t^r, Φ_t^c, $\Phi_t^{r\prime}$, and $\Phi_t^{c\prime}$ equal 0.

Using the FOCs mentioned in the previous section, we arrive at the following steady state equations:

1. Equation 60 gives

$$[(1-\epsilon_p)(h)^{(1-\alpha)} + \frac{(h)^{(1-\alpha)}\epsilon_p}{(1-\alpha)(h)^{-\alpha}} = 0 \tag{72}$$

Variable	Steady state value
a	1
π	1
Ω_r	1
Ω_c	1

Table 17: Steady State Values

2. Equation 61 gives

$$i = \frac{1}{\beta} \tag{73}$$

3. Equation 62 gives

$$s\frac{(n_t^r)^{1+\rho}}{w^c}\epsilon_w + (1-\epsilon_w)c^{-\sigma}n_t^r = 0 \tag{74}$$

3. Equation 63 gives

$$(1-s)\frac{(n_t^c)^{1+\rho}}{w^c}\epsilon_w + (1-\epsilon_w)c^{-\sigma}n_t^h = 0 \tag{75}$$

5. Equation 64 gives

$$c = w^r n^r + w^c n^c + (h)^{(1-\alpha)} - w^{real}h_t \tag{76}$$

6. Equation 66 gives

$$y = h^{(1-\alpha)} \tag{77}$$

7. Equation 67 gives

$$n^r = \gamma\left[\frac{w}{w^r}\right]^\delta h \tag{78}$$

8. Equation 68 gives

$$n^c = (1-\gamma)\left[\frac{w}{w^c}\right]^\delta h \tag{79}$$

9. Equation 69 gives

$$w = [\gamma(w^r)^{1-\delta} + (1-\gamma)(w^c)^{1-\delta}]^{\frac{1}{1-\delta}} \tag{80}$$

The above 9 equations are solved to obtain the steady state. We obtain steady state values for n_t^r,n_t^c,w_t^r,w_t^c,w_t,π_t,c_t,y_t,i_t and h_t

Step	Dropped observation	Resulting sample size
Original dataset		868232
Factory closed	192334	675898
Missing state codes	114	675784
Non-manufacturing ASI codes	39207	636577
Total observations (# of firms)		636577

Table 18: Sample Size

C Annual Survey of Industries Data Appendix

Annual Survey of Industries (ASI) is conducted by National Sample Survey Office (NSSO). ASI is principal source of industrial statistics in India. The ASI extends to the entire country. It covers all factories registered under Sections 2m(i) and 2m(ii) of the Factories Act, 1948 i.e. those factories employing 10 or more workers using power; and those employing 20 or more workers without using power. The sample design of ASI divides the factories into two sets: Census sector and Sample sector. The sampling design adopted in ASI has undergone considerable changes from time to time. Census Sector is defined as units having 100 or more employees(200 or more between 1997 to 2003), whereas sample sector is selected from 1/5th of smaller establishment (1/3rd utill 2004). For a detailed discussion on ASI sampling and its limitations refer to Nagraj(2002).

C.1 Determination of Base Sample

Table 18 details how the sample in for our study is determined from the original set of observations in the ASI. The original ASI dataset spanning 1998-99 to 2014-15 ASI has 868,232 plant-year observations. Plants may still appear in the data even if they are closed or did not provide a survey response. We drop 192,334 plants reported as closed or non-responsive. An additional 114 observations are dropped which have missing state codes. We drop 39207 observations reporting non-manufacturing NIC codes. We remove a small number of observations which are exact duplicates in all fields, assuming these are erroneous multiple entries made from the same questionnaire form. The final sample includes 636,577 plant-year observations. On an average there are 35,000 firms every year.

C.2 Variables

The variables of our interest are number of workers both regular and contract, nominal wage per mandays of the workers and the output. ASI provides firm level details of the above. We use the multipliers in order to arrive at the aggregate yearly figure for the above. Following Alcott et. al. (2016) we use revenues as a measure of the output. The variable in the ASI schedule used for measuring the revenues is "gross sales value". Inflation (price growth) mentioned in the empirical section is computed using CPI (industrial workers).

Standard Deviation of Annual Growth Rates		
	Original Data	Consistent firm Panel
Employment		
Regular	0.044	0.045
Contract	0.067	0.136
Nominal Wage		
Regular	0.036	0.037
Contract	0.050	0.079

Table 19: Standard Deviations of Annual Growth Rates

Skewness of Annual Growth Rates		
	Original Data	Consistent firm Panel
Employment		
Regular	-0.420	-0.082
Contract	0.196	0.895
Nominal Wage		
Regular	0.331	0.069
Contract	-0.599	-1.172

Table 20: Skewness of Annual Growth Rates

D Additional Empirical Evidence

In our paper we use the data cleaning methodology described in the previous section to arrive at the yearly aggregate values of the variables. This appendix provides additional information on the empirical findings.

For robustness of our empirical results, we calculate the yearly aggregate values by only considering firms which are present for more than 5 years. We stick to this definition because in ASI, the classification of the units in census and sample sector frames is done in a 5-year cycle and is not changed during the period. Hence, firms having more than 5 years of data are consistent. Column 2 of Table 19 and 20 provide the standard deviation and skewness respectively, for consistent firm panel. We find that for regular workers, the employment growth remains negatively skewed while nominal wage growth is positively skewed. The signs of skewness of employment and nominal wage growth for contract workers is also similar to original dataset. The magnitudes vary as the samples considered are significantly different in column 1 and column 2. However with similar signs and directions we can be assured of consistency in our results.