Winners and Losers: Local Sectoral Minimum Wages and Informality in India *

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Abstract

Exploiting the unique dual-variation in Indian minimum wage along both state and sector lines, this paper explores its effect on workers wages and employment outcomes between 2004 and 2019. Using data from a nationally-representative labor force survey, I employ a staggered two-way fixed effect (TWFE) design for causal identification of the effect of a 1% increase in minimum wage on daily wages. Baseline results suggest a null average effect, which is found to be significant and positive for workers in the formal sector; but significant and negative for workers in the informal sector. I show that this is driven by a reallocation of working hours without an increase in compensation to informal workers, and a decrease in the use of formal workers. Overall, this underscores how high-variability in wage regulations can emphasize wage differentials between formal and informal markets and fails to create a lighthouse effect.

Keywords: Minimum Wage, Segmented Labor Markets, Labor Markets, Development

JEL Codes: J46 - Informal Labor Markets, J38 - Public Policy (Wages, Compensation, Labor Costs), J31 - Wage Level and Structre/Wage Differentials

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1 Introduction

Labor market regulations are a prominent instrument for safeguarding the interests of workers during economic transitions to manufacturing and service-led economies. Minimum wage regulations in particular provide an important wage floor that can protect the earnings of low-income workers, and can be particularly relevant for developing economies, where large segments of the labor force are vulnerable. But despite the large role for labor market regulation, the outcomes can be more complex given the larger role of informal labor markets, relative to industrialized economies. Minimum wage regulations are traditionally viewed through a lens of wage gains and employment tradeoffs; acknowledging that while wage gains are observed, some studies suggest increased wage rigidity can limit employment opportunities for low-wage workers (Neumark et al., 2006, Autor et al., 2016, Engbom and Moser, 2022). However, the variation of minimum wage setting systems and their existence alongside larger unregulated markets in developing economies spark unanswered questions, with recent works highlighting how strong informal labor markets can shape how worker outcomes respond to minimum wage (Comola and De Mello, 2011, Kim and Samaniego, 2023).

The broader literature on minimum wage focuses on hihg-income countries, and wage floors are found to be effective in raising both earnings and employment, particularly when labor markets are not defined by perfect competition (Stigler, 1946, Card and Krueger, 1994, Azar et al., 2023). However, the evidence from developing economies is less clear, with dualistic labor markets playing a large role in distinguishing the effects on worker outcomes. There are observed differences in how minimum wages are set (Eyraud and Saget, 2005) and enforced (Basu et al., 2010, Soundararajan, 2019, Gindling and Terrell, 2005), as well as their impacts on workers (Lemos, 2009, Engbom and Moser, 2022, Khurana et al., 2023); all of which keep informal labor markets as a central concern.

This study examines the effects of minimum wage regulation and informality in the context of India's *Minimum Wages Act of 1948* , which offers a unique institutional setting, relative to previously studied cases. Unlike many countries, developing and developed alike, where minimum wages are nationally-set (Engbom and Moser, 2022, Komatsu and Filho, Neumark et al., 2006), India's system gives minimum wage setting authority to states, which in in turn set wage floors at the sectoral level. This results in a complex system with over 300 distinct minimum wage rates per year across the country. Such a structure was intended to account for productivity differentials and reduce potential increases in informality by allowing adjustment of wage floors to the precise characteristics of a sector's local labor market. While multiple wage minima are not uncommon in developing countries for this reason, with Thailand, Indonesia, and many Latin American countries taking the same approach (Lathapipat and Poggi, 2016, Leckcivilize, 2015, Magruder, 2013, Alaniz et al., 2011, Basu et al., 2010), the dual-variation of India's system is unusually complex. Furthermore, with variation along both geographic and sectoral dimensions, identifying who counts as a low-wage worker becomes less straightforward making its effect on low-earners more complex. The

features of this law raise new questions about how minimum wages effect labor market outcomes of these workers, and how they interact with outcomes of informal sector workers. Previous literature studying this system has focused on the laws of specific sectors (Soundararajan, 2019, Khurana et al., 2023), or on their effections of consumption (Mansoor and O'Neill, 2021). However, little is known about the labor market effects and the interactions with the informal market in this case. This paper contributes to the literature by providing a broader analysis of the minimum wage regimes, exploiting the dual variation across states and sectors, and focusing the responses on the formal and informal labor markets.

This contribution provides important insights not only the interaction of labor market regulations and dual labor markets, but also looks at a number of proposed pathways in the literature; providing insight on the variation by local labor market and worker characteristics which underscores the unique dimensions of India's minimum wage regime. To situate my contribution in the broader literature, I review several strands of work that inform my approach in the following section. These works provide a foundation for analyzing and interpreting the effects of India's minimum wages, and the basis for my focus on formal versus informal labor markets and local labor market characteristics.

Related Literature: A large literature has examined the effectiveness of minimum wages in raising the incomes of low-wage workers. Foundational theory suggests minimum wages are efficient if they increase wages without substantial job loss (Stigler, 1946). A variety of empirical perspectives exist on this question, showing a positive effect on wage (Card and Krueger, 1994, Dustmann et al., 2022), a non-effect on wage outcomes (Autor et al., 2016), or a negative effect on wages (Neumark and Wascher, 1992). Additionally, many studies underline ambiguous average wage effects due to negative effects for higher earners and positive effects for low-earners leading to a compression of the wage distribution (Engbom and Moser, 2022, Dustmann et al., 2022, Basu et al., 2010, DiNardo et al., 1996). In developing economies, the question most directly implicated in this paper, the question more prominently considers compliance with the minimum wage as the higher rates of informality create a pathway for noncompliance for employers. This consideration is essential to uncovering the effect for the wages of the poorest workers as they are likely to be concentrated in the informal sector.

The existence of the informal labor markets has created two general fields of thought in the literature on labor market regulation. The first hypothesis, commonly called the Insider-Outsider hypothesis first outlined by Lindbeck and Snower (1989) argues that regulating the labor market will protect the workers already securely employed on the market but reduce opportunities for jobseekers and new entrants to the labor market. Minimum wage, a classic case in which regulations will increase the cost of labor for employers, may reduce hiring and job creation through this increase in cost, leading to improvements only for those who have already secured a job. In

the existence of dualistic labor markets and the coexistence of informal and formal work, wages for informally employed, so-called market outsiders will not increase due to a reduction of formal employment opportunities. However, another perspective argues that this is not necessarily the case as there may be a lighthouse effect for those employed outside of regulated labor markets as shown by Magruder (2013), driven by the increase in the overall level of wages.

Multiple minimum wage regimes, such as the case of India, are created as they are more adaptable to the local or sectoral labor market characteristics (Eyraud and Saget, 2005). The existing literature on such systems Gindling et al. (2015), Ham (2018) find positive effects for formal and informal workers alike, consistent with the lighthouse effect proposed by Magruder (2013). However, in both contexts, the minimum wages varied only along one dimension (sector or geographic area), whereas the Indian case is unique in that minimum wages vary across both dimensions. Thus, there is an important link between this question of informality and a secondary question on productivity and labor market characteristics. Badaoui and Walsh (2022), Leckcivilize (2015), Danziger (2010) suggest that positive wage effects with no disemployment are found among productive firms, but this is accompanied by a shrinking number of small firms who may be unable to afford the increased labor costs; implying a reallocation of their workers to more productive firms or into the informal sector. The increase in informality hypothesis is favored empirically by Comola and De Mello (2011) and Kim and Samaniego (2023) who find evidence of shrinking formal employment rates and growing informal sector employment rates in developing economies, both examining the case of Indonesia. However, these papers do not address the income effects of such shifts, and the variation between formal and informal workers wages. Thus, the relationship between informal-formal substitution following minimum wage increases remains an open question. Furthermore, the level at which the minimum wage is set allows far more adaptability to local productivity dynamics of a sector; which may indicate less adverse outcomes following labor reallocation, or may serve to underscore existing differences between sectors, or the formal and informal economies.

This paper uses the case of India to answer this question, contributing to a small literature on the effects of the Minimum Wage Act of 1948. This law has been analyzed previously in papers focusing on the minimum wages of a single sector (Khurana et al., 2023, Soundararajan, 2019); who find positive effects on wages overall and ambiguous effects on employment. Its effect on household consumption has also been studied by Mansoor and O'Neill (2021), which together with Soundararajan (2019) shows that effective enforcement of the *Minimum Wage Act* enhances the positive effects on income. This further underscores the importance of measuring the laws effects on informal workers for whom enforcement and compliance is nonexistent.

Based on the observations of existing literature and the institutional context on hand; I use data from nationally-representation labor force surveys in India, combined with a novel dataset of minimum wages by state and sector to analyze the effect of sector-state level minimum wages on labor

market outcomes. In sum, I am able to capture the wage responses to variation in the minimum wage from 2004 - 2019, controlling for sector-state unit characteristics and time trends.

Specifically, I employ a two-way fixed effects strategy to compare those exposed to changes in a minimum wage over time, controlling for confounding factors such as the productive characteristics of a sector-state unit and time shocks or trends on wages, using sector-state unit and year fixed effects. Using this set of fixed effects, I exploit within sector-state unit variation in wages to identify the average causal response (ACR) of wages to the minimum wage (Angrist and Imbens, 1995, Callaway et al., 2024). Furthermore, I extend the specification to examine the variation of the wage effect across formal and informal workers, by worker location in the wage distribution, and by local labor market characteristics. My strategy implicitly assumes that conditional on controlling for factors at the sector-state and year level, wages would not experience an increase if there were no increase in the minimum wage; this assumption is found to be robust to alternative control group specifications as defined by Dube et al. (2010) and a host of other controls. Furthermore, I adapt the *spatial approach* of Dustmann et al. (2016) to evaluate the potential of sector- and state-switchers driven by minimum wage increases, varying the fixed effects to identify the effects at multiple levels.

Using this identification strategy, I find that increases in the minimum wage have ambiguous wage effects for the full population. However, I show that this is driven by strong divergence in outcomes between formal and informal workers, as I find that on average, formal workers' wages increase 0.56% for a 1% increase in the minimum wage, while informal workers' wages decrease 0.956%. Furthermore, while I find no evidence of disemployment through layoffs of treated workers, I find evidence of adjustment on the hourly margin; with hours of work significantly increasing by 0.35% for informal workers while formal workers experience a decrease of 0.15% following a 1% increase in the minimum wage. These findings support the hypothesis of increasing use of informal workers, though it does not support the hypothesis that this corresponds to an increase in income as employers may seek to keep costs down, hiring cheaper, informal labor hours.

I conclude that this shows evidence that benefits for formal workers are relatively strong; however benefits do not extend to the informal sector, comprising some of the lowest earners. From this perspective, the lack of a lighthouse effect and adjustment of employment at the hourly margins implies that minimum wages at the sector-state unit level are more effective for labor market insiders, as predicted by Lindbeck and Snower (1989) without a corresponding lighthouse effect for outsiders as predicted by Magruder (2013). I claim that the flexibility this introduces leads away from the establishment of a universal wage-floor, which induces the positive effects for informal workers observed elsewhere.

The rest of the paper is organized as follows. Section 2 discusses the institutional context and data collection process. Section 3 discusses the empirical strategy and assumptions. Section 4

presents the analysis of baseline results and the heterogeneity of the baseline findings across the wage distribution and for formal versus informal workers. Section 5 addresses robustness checks for the baseline findings and Section 6 explores the mechanisms of the baseline results.

2 Context: Minimum Wage Setting in India

India established the Minimum Wage Act in March 1948 which gave power to the states to set minimum wages at the sectoral level (Parliament of India, 1948). Wage rates are defined according to an 8-hour reference work day; taking into account local cost of housing, basic and essential consumption, as well as healthcare and education costs (Paul, 2023, Mansoor and O'Neill, 2021). The rates may also take into account sectoral characteristics and productivity. The Act provides procedures for setting and amending the minimum wage as well as procedures for inspection and violation claims to encourage enforcement. Minimum wage rates are reported to the Central Labor Bureau by the state labor bureau authority every year, and published in the *Report on the Working of the Minimum Wage Act*. But revisions to minimum wage rates are required only every 5 years and the timing of these reforms varies across states and sectors. The *Reports* which include a list of all minimum wages by state and sector form the basis of the database created for this paper.

It is worth noting that the Minimum Wage of 1948 was repealed by the 2019 Code on Wages, which institutes a universally applicable minimum wage across all sectors. As of 2024, the new code has been notified and reports on the repealed 1948 Act are no longer published. However, implementation of the law was pushed until after the 2024 national elections. Nevertheless, the longstanding *Minimum Wages Act of 1948* provides a unique opportunity to study the impacts of localized, sectoral minimum wages on workers' outcomes. Though the scope of this paper is thus restricted to 2004 - 2019, avoiding any overlap with the new minimum wage legislation.

2.1 Construction of Minimum Wages Database

The minimum wage data for this paper comes from the *Report on the Working of the Minimum Wage Act*, discussed in the previous section, which provide the list of minimum wages by industry for each state. The reports are published in a text format and require translation into a database. This was done using a deep learning algorithm to detect text and tables from unstructured data such as the *Reports*. This raw data was processed and merged and passed through a secondary spell-checking algorithm to correct any character misreads that may have occurred during the data extraction process. The cleaning was repeated for available reports from 2004 to 2019, which was combined with individual-level data from the Indian Ministry of Statistics and Programme Implementation (MOSPI)'s labor force survey and firm-level data from their industrial survey.

To facilitate the combination of the constructed minimum wage data and MOSPI survey data, I used MOSPI's National Industrial Classification (NIC) codes to assign sector definitions to mini-

mum wages which are coherent with worker and firm classification in MOSPI surveys. To implement this, I used the bidirectional encoder representations from transformers (BERT) language model, trained on a 3-year subset of manually coded minimum wage rates, industries, and NIC Codes, to label the full database assigning to each report minimum wage a corresponding sector. The additional benefit of this system is the fine level of detail in NIC labeling which allows accurate matching with the sectors of the minimum wage report and the sectors in the labor force survey.

The resulting minimum wage database contains all minimum wage rates reported for 36 states and union territories from 2004 to 2019. The total number of minimum wages observed across all years is 18,885, with 2,350 unique rates as the same minimum wage rate can persist for a number of years. Figures 1 and 2 show the evolution of minimum wage in the manufacturing and agricultural sectors for all states over the study period. This provides an illustrative example of the variation in minimum wage across states and sectors, the incidence of missing data, and the differential timing of minimum wage introductions and amendments across states. The following section describes how my identification strategy exploits this source of variation to establish the causal response of wages to increases in a sector-state unit's minimum wage.

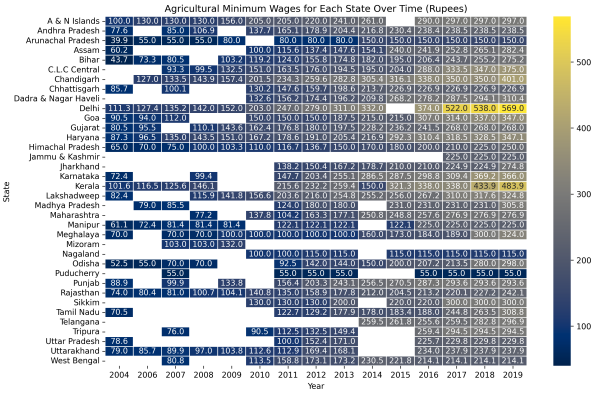


Figure 1: Minimum Wage Evolution by State, Agricultural Sector

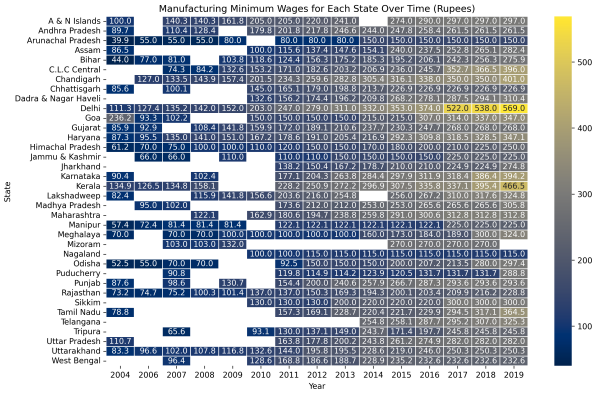


Figure 2: Minimum Wage Evolution by State, Manufacturing Sector

3 Empirical Strategy

My identification strategy exploits the variation of minimum wage rates at within states at the sector level. In this setting, it is important to control for the concerns of endogeneity introduced by the fact that minimum wages are set according to the characteristics of a sector-state unit. In this case, minimum wages are set according to local cost of living and sectoral characteristics, thus there is a primary concern of reverse causality, in which the effect is overestimated because sector-state units with higher average wages set higher minimum wages. Thus the correct identification strategy must control for such baseline characteristics. Furthermore, there may be additional factors influencing both minimum wage and daily wage outcomes which are not identified by the data

but relevant determinants of wages and minimum wages. These factors may include structural and institutional characteristics or shocks. Thus the appropriate identification strategy must also take into account potential omited variable bias. I combat both concerns by employing a two-way fixed effect (TWFE) specification, which is functionally equivalent to a difference-in-difference setting with continuous treatment. In this model, a sector-state fixed effect and a year fixed effect are included to control for treatment group characteristics and shocks throughout the period of analysis.

This specification exploits variation in minimum wage and daily wage within sector-state unit over time to identify the baseline treatment effect. Affected individuals are identified as those employed in a sector-state unit during a year when the minimum wage increases. Unaffected individuals are employed in sector-state units that do not increase the minimum wage in that year. Identifying the effect of increases in the minimum wage on wages requires isolating variation between the two groups; within the same sector-state and year, and beyond the variation attributable to sector-state unit specific characteristics and annual shocks common to all sector-state units. To further isolate the wage effect, I control for individual wage-determining characteristics such as age, gender, and education.

Using the TWFE approach with continuous treatment requires a number of identifying assumptions. The first asserts that absent changes in the minimum wage, there would be a similar evolution of wages between affected and unaffected workers, and thus, the divergence in outcomes is driven by a change in the minimum wage. The second assumption states that participants in the labor market do not anticipate increases in the minimum wage and alter wage-setting practices prior to the announcement of the new wage rates. Finally, TWFE requires that individuals cannot switch their sector-state unit of employment in order to receive a more favorable treatment (a higher minimum wage).

With respect to the first and second assumption; Figure **??** shows an event study specification with no significant effects in the pre-treatment years; and significant effects beginning in the year of treatment,. This illustrates that the identified effects are unlikely to be driven be existing trends or anticipated changes in behavior. While it is difficult to test the third assumption due to data restrictions for following individuals' sector of employment over time; following the specification of Dustmann et al. (2016), I am able to consider the implications of potential violations for my results. Thus, I argue that I am able to identify the causal response of wages to an increase in the minimum wage under these assumptions using this approach. The following section formalizes the empirical models used for my identifications strategy.

3.1 Empirical Models:

In the baseline model, I use the TWFE estimator to measure the average causal response (ACR) of individual wages to continuous increases in the minimum wage, following the "dosage" treatment

response identification of (Angrist and Imbens, 1995, Callaway et al., 2024). Sector-states that do not experience minimum wage increases in year t are the comparison group used to identify the ACR of wages. However, they may experience an increase in minimum wage in subsequent periods or have experienced increases in past periods. For all models, because minimum wage changes occur within states, within sectors; I cluster standard errors at the sector-state level following (Abadie et al., 2022). Formally, the baseline model is:

$$\begin{aligned}\log(\text{Wage})_{i(ks)t} = \alpha + \beta log(\text{Minimum Wage})_{k(s)t} \\ + X_{i(ks)}\beta + \gamma_t + \delta_{ks} + \epsilon_{ikst}\end{aligned} \tag{1}$$

Where wage is calculated as the average daily wage for individual i based on a standardized eight-hour work day and using the seven days of wages reported in the LFS. The dependent variable is defined as such to be consistent with the legislative definition of the minimum wage as a daily rate based on an eight-hour workday.

The TWFE estimator is $\hat{\beta}$ representing the ACR of wages in sector k and state s to changes in the minimum wage in ks for year t. $X_{i(ks)}\beta$ is a vector of individual controls likely to impact wages including gender, age, education status, and contract type. The baseline specification includes fixed effects for year (γ_t), state-year (λ_{st}), and sector-state unit (δ_{ks}).

Using sector-state and year requires that $\hat{\beta}$ is identified on the covariation of minimum wages and daily wages within sector-state units over time, conditional on controls. Specifically, the year fixed effect controls for wage determinants for a given year, including price and productivity shocks. The sector-state fixed effect further controls for wage-determining influences within sectors-in-states which do not vary over time. Additionally, controlling for the educational achievement, age, and gender of each individual insures that such variations are identified among comparable workers.

As indicated in the previous section, there is one identifying assumption for this approach that cannot be directly verified. A threat to this baseline model is the incidence of sector-state unit switching induced by the treatment. In other words, there is a concern that individuals may change sector and/or state of employment in order to receive a more favorable minimum wage. I cannot recover this information for workers based on the available data, and thus employ the strategy of Dustmann et al. (2016) which loosens the fixed effect specification to estimate the total wage effect across sectors within state (states within sectors). This estimation is conducted as follows:

$$\begin{aligned}\log(\text{Daily Wage})_{i(ks)t} = \alpha + \beta log(\text{Minimum Wage})_{k(s)t} \\ + X_{i(ks)}\beta + \lambda_{jt} + \epsilon_{ikst}\end{aligned} \tag{2}$$

Equation (2) replicates the spatial approach of Dustmann et al. (2016) and is henceforth referred to as the *total effects model*; where λ_{jt} is a vector of state-year or sector-year fixed effects. In the former, the effect is identified on within-state, across sector variations, while in the latter, β is identified on within-sector cross state variations in the minimum wage. According to the methodology of Dustmann et al. (2016), this approach estimates the *total effect* of a minimum wage increase, rather than the local effect within sector-state unit. The advantage of this model is that contrary to the baseline model, it allows for the possibility that workers change sector or state in pursuit of a higher minimum wage. Thus, I argue that using this variation of the fixed effects, is able to address the concern of sector-state switchers by illustrating what the effect on wages is if I allow switching to occur. This guarantees that the results of the my analysis are conistent when I loosen the identifying assumptions of the model.

This concern for identification is further explored in Section 5.2, which varies the identification strategy to consider more localized labor markets at the district level, using district pairs along a state border. The following section discusses the empirical model used to explore heterogeneity of the wage effect.

3.1.1 Heterogenous Effects

I investigate the heterogenous effects of the minimum wage by a worker's individual characteristics, sector of employment, or position in the wage distribution using an extended specification that interacts the log minimum wage with indicator variables [1]. Equation (3) generalizes the heterogenous effects model:

$$\begin{aligned}\log(\text{Wage})_{i(ks)t} = \alpha &+ \beta \log(\text{Minimum Wage})_{k(s)t} + Z_{i(ks)t} \\ &+ \chi \log(\text{Minimum Wage})_{k(s)t} \times Z_{i(ks)t} + \\ &+ X_{i(ks)}\phi + \gamma_t + \delta_{ks} + \epsilon_{ikst} \end{aligned} \tag{3}$$

Where $Z_{i(ks)t}$ represents a vector of characteristics for worker i in sector-state unit ks. This specification allows me to analyze how minimum-wage laws differentially affect workers based on their characteristics. This is particularly important for the investigation of the lighthouse effect, or the existence of insider-protecting wage regulations. As show in Section 3, descriptive evidence suggests a diverging effect based on participation in the formal or informal labor market. Additionally, the proposed redistributive effects of minimum wage laws in theory warrant their exploration across the wage distribution to illustrate for which workers minimum wages induce wage growth. In this

[1] Individual characteristics include gender, social group (caste), and formality status. Position in the wage distribution is captured by relative decile, calculated based on the daily wage for the population of workers in a state and state-sector. Additionally, I consider and alternative distribution relative to the minimum wage, to see the effects on those earning below, at, just above, and far above the minimum wage following Cengiz et al. (2019)

model, $\hat{\beta}$ continues to be identified on the variations in minimum wage and daily wage within a sector-state unit and year for subsets of the population defined using the interaction term.

I further consider heterogeneous effects by sectoral characteristics, using a third variation of the baseline specification. In this case, I take the annual average characteristics of employers a state-sector unit as an interaction term with the minimum wage. Following the literature of Basu et al. (2010), Manning (2010), Badaoui and Walsh (2022), Azar et al. (2023) and others; there is strong evidence that employer and occupational characteristics drive the response to the minimum wage. Thus, the following model tests this hypothesis using the baseline model (Equation (1)):

$$\begin{aligned}\log(\text{Wage})_{i(ks)t} = \alpha &+ \beta \log(\text{Minimum Wage})_{k(s)t} \\ &+ \overline{Q_{kst}} + \chi \log(\text{Minimum Wage})_{k(s)t} \times \overline{Q_{kst}} \\ &+ X_{i(ks)}\phi + \gamma_t + \delta_{ks} + \epsilon_{ikst} \end{aligned} \tag{4}$$

Where $\overline{Q_{kst}}$ represents the state-sector average of a vector of productive characteristics [2]. It also includes a categorical transformation average Herfindahl Hirschman Index (HHI) of firms in a sector-state unit [3]. Identification remains within sector-state unit over time, and I maintain the same set of individual controls as the baseline model; with variation of the wage effect identified on variations of the minimum wage and daily wage, for subsamples defined by average sectoral characteristics in the interaction term.

The following section describes the data used to measure worker outcomes and local labor market characteristics and presents the characteristics of the worker sample. The subsequent sections discuses the baseline results, heterogenous effects, detail further robustness checks, and analyze the mechanisms of the effect using the baseline framework of Equation (1).

4 Data

To measure worker outcomes, I combine data from multiple waves of two labor force surveys; Unemployment/Employment Survey (UE/E) and the Periodic Labor Force Survey (PLFS). Both surveys have served as India's primary source of labor force statistics (MOSPI, 2023). The PLFS succeeded the UE/E in 2017, therefore the survey content and formats, as well as the representative sampling designs functionally identical. The major difference between the two surveys is their frequencies. UE/E is a single-visit, repeated cross section survey while PLFS surveys are

[2] I proxy capital and technology intensity by their average cost share for employers in a sector-state unit. Trade intensity of production is proxied by share of foreign capital

[3] Following the thresholds of concentration defined in Azar et al. (2022): low concentration = HHI $<$ 2500, moderate low concentration = 2500 $<$ 5000, moderate high concentration = 5000 $<$ HHI $<$ 7500, high concentration = HHI $>$ 7500 where the HHI is the share of local employment a firm comprises, normalized to 10,000

repeated for the same individuals for 4 quarters, creating a intra-year panel. However, to study as long a period as possible; PLFS waves are treated as a repeated cross section in the majority of cases.

Using LFS data, I capture information on individual's demographic characteristics; age, gender, social group, and educational achievement. Furthermore, I capture wages earned and hours worked for up to two professional activities for a reference week, including the sector of employment and an individual's weekly status in each activity. Using this status variable, I am able to identify formal and informal workers; which I verify using variables measuring benefits eligibility and contract type, also reported in the survey. Additionally, using current weekly status; I restrict the sample to those employed in wage or salaried employment, as well as the unemployed. As minimum wage laws are unlikely to have a direct impact on self-employed individuals, I exclude them from the baseline result samples, but consider indirect effects in subsequent tests. As a large portion of informal workers are self-employed workers, not waged workers, this paper necessarily underestimates the total informality rate by considering only workers receiving wages or salaries (ILO, 2024). Table **??** compares the population characteristics of by exposure to a minimum wage increase and by status as an informal worker.

The labor force survey data is complemented by firm survey data from the Annual Survey of Industries (ASI) for formal firms and the Unorganised Enterprise Survey (UES) for informal firms. Using this data, I test sectoral labor market and production characteristics; exploring whether this is a significant driver of responses to the minimum wage. In particular, I capture the labor, capital, and land intensity of enterprises' activities, their labor costs and number of employees, their exposure to foreign capital, and their use of information and communication technology (ICT) in productive activities. These test the hypothesis of Basu et al. (2010), Badaoui and Walsh (2022) and channels recently illustrated by Harasztosi and Lindner (2019), Piek and von Fintel and (2020) that minimum wage response will depend on the productive activity of a firm. Additionally, I calculate the sectoral average Herfindahl-Hirschman Index (HHI) [4] measuring competitive dynamics of a sector-state units labor market. This is used to the test the hypothesis of Azar et al. (2023) that the minimum wage response is driven by the competitiveness of a labor market.

4.1 Descriptive Statistics

The final database is comprised of 2.96 million observations covering India's 28 states and 8 union territories from 2004 - 2019. It includes approximately 18,739 minimum wage rates per year across all states and sectors, with 2,350 unique minimum wage rates defined among them as minimum wages may remain the same for several years within the sample. The baseline specification includes this full sample using repeated cross-sections of state-sector pairs and years where the observational unit is employed and unemployed individuals within a sector-state unit. Those who are included in

[4] $HHI_{kst} = \frac{\sum_{j=1}^{J} S_{j(ks)t}}{J}$ where s is the share of firm j of employment in sector k and state s for year t.

Table 1: Summary Statistics by State-Sector Minimum Wage Status

	= 1 if Works in a State-Sector with Minimum Wage		
	0	1	Total
Sample Size	1,360,539 (45.9%)	1,602,746 (54.1%)	2,963,285 (100.0%)
Age (mean, SD)	30.691 (18.082)	31.227 (18.391)	30.977 (18.249)
Gender			
Male	824,749 (60.6%)	944,119 (58.9%)	1,768,868 (59.7%)
Female	535,726 (39.4%)	658,504 (41.1%)	1,194,230 (40.3%)
Formal Education (Years)	8.582 (5.445)	8.236 (5.122)	8.367 (5.248)
Secondary Employment			
No	1,244,547 (91.5%)	1,464,288 (91.4%)	2,708,835 (91.4%)
Yes	115,992 (8.5%)	138,458 (8.6%)	254,450 (8.6%)
Eligible for Paid Leave			
No	1,252,862 (92.1%)	1,500,702 (93.6%)	2,753,564 (92.9%)
Yes	107,677 (7.9%)	102,044 (6.4%)	209,721 (7.1%)
Migrated in Past 5 Years			
No	301,558 (97.4%)	227,504 (97.3%)	529,062 (97.3%)
Yes	8,119 (2.6%)	6,330 (2.7%)	14,449 (2.7%)
Informal Worker			
No	986,833 (72.5%)	1,163,735 (72.6%)	2,150,568 (72.6%)
Yes	373,706 (27.5%)	439,011 (27.4%)	812,717 (27.4%)
Days Worked in Reference Week	3.537 (2.054)	3.964 (2.168)	3.752 (2.123)

the labor force as self-employed workers are excluded as they are not directly exposed to minimum wage regulations. Additionally, those who are not active in the labor market are not considered.

Table 1 provides descriptive statistics on the demographic characteristics by treatment status. An individual is considered treated if the sector they are employed in experiences a positive change in the minimum wage for at least one year during the sample, this definition implicitly assumes that individual i remains employed throughout the year in the same industry they report in the labor force survey. This assumption is difficult to test as in the majority of the sample, individuals are not followed over time. In the PLFS, where individuals are followed over all four quarters, the survey design asks for a worker's industry of employment only in the initial survey. However, the simple fact that the panel survey follows this design suggests that it is sufficiently likely an individual will remain employed in the same industry throughout all survey rounds. Furthermore, this limitation is dealt with during empirical analysis following the approach of Dustmann et al. (2016), estimating the total approach of minimum wage increases.

Table 1 shows that 54% of the overall sample is treated with an increase in minimum wage during the study period. Treated individuals are more likely to be employed in the formal sector, which is intuitive. Informal, treated workers are working without regular contracts in a sector that experienced a positive minimum wage shock. Therefore, it is possible to test if there are *lighthouse effects*

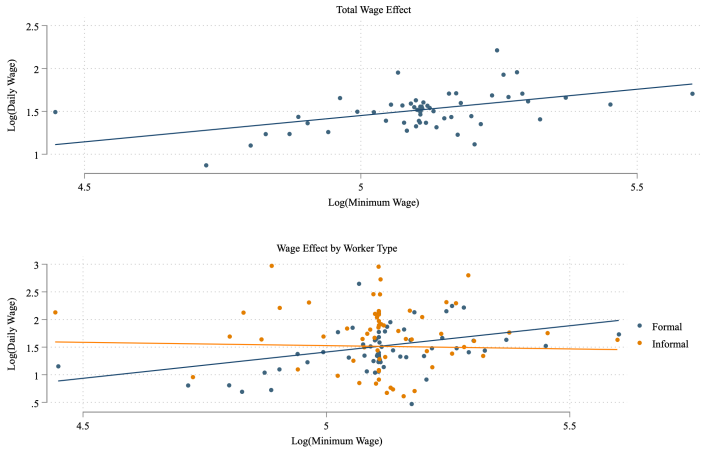


Figure 3: Binned Scatterplot: Wage-Minimum Wage Correlation

Note: Binned scatterplot calculated for 60 quantiles using UE/E and PLFS and minimum wage database. State-year fixed effects including in the calculation.

for informal workers as a result of the shocks (Magruder, 2013). In all other demographic characteristics, the population averages suggest that treated and untreated workers are highly similar wage-determining characteristics such as age, education, other benefit eligibility, migration status [5], and working time.

Figure 3 shows the covariation of the minimum wage rate with the daily wage rate for the overall database, absorbing state and year characteristics. Notably, I observe an overall positive correlation though there is a divergence in wage outcomes as the minimum wage rises between formal and informal workers. Furthermore, correlational event study analysis (shown in Figure ??); informal workers experience a consistently lower wage effects post-treatment compared to formal workers. This highlights the necessity of taking into account the dual labor markets in evaluating the wage effects of the minimum wage.

The following section discusses the econometric identification of the treatment effect using a two-way fixed-effects approach for sectoral, state, and year effects. It will also discuss the evolution of wages between the treated and untreated samples, providing further descriptive analysis of the treatment effect.

[5] To remark on the concern of minimum wage driven migration; given the socioeconomic and linguistic barriers to migration; it is not considered a large threat to identification in the other studies examining the same context (Khurana et al., 2023, Mansoor and O'Neill, 2021, Soundararajan, 2019). Furthermore, barriers create a selected sample of the population who choose to migrate, seen in Table A6, who are unlikely to be low-earners and motivated by the minimum wage when choosing a work destination.

5 Baseline Results

I begin my analysis by estimating the effect of minimum wage increases on the average daily wages of a sector-state unit using Equation (1). Table 2 shows the results of the baseline specification and the *total effect* specification described in Equation (2).

Table 2: Baseline Effect of Minimum Wage on Wages

	Baseline	Total Effect (Equation (2))	
	(1)	(2)	(3)
Log(MW)	0.0547	0.457*	0.423***
	(0.150)	(0.233)	(0.0614)
Observations	1,134,873	1,134,874	1,134,874
Fixed Effects	Sector-State, Year	State-Year	Sector-Year
Controls		Individual	

Standard errors clustered at the state-sector level. Individual controls include age, sex, education level, and worker status. * p<0.10, ** p<0.05, *** p<0.01

I report the percentage change in daily wage for a one-year period following a 1% increase in the minimum wage (at the beginning of the year). In the baseline model, I note no significant effect of minimum wage on daily wage outcomes within sector-state units on average. Thus, at first glance, there appears to be no effect of a minimum wage on wages for workers an affected sector-state unit.

As noted in Section 3, there is a concern of violation of the stable unit treatment value assumption (SUTVA) as workers may change sectors and/or states in favor of a better (minimum) wage rate. In Column (2), I calculate the total effect of a sector-state unit's minimum wage increase within states, and I find a positive, and marginally-significant effect on wages (significant at the 10% level). Thus, accounting for individuals who remain in the same state, but change sector motivated by a more favorable minimum wage; the effect of minimum wage becomes higher. In Column (3), I vary this by looking within sector, across state, considering the possibility of cross-state migration in order to find a more favorable minimum wage. I find that looking across individuals switching states within sector; however, this result is linked with the results on the migrant subsample discussed in Section 6.

Using the total effect model, I conclude that the effect of the minimum wage can vary based on the level of analysis, and the potential for switchers is an important consideration for analyzing the effect of one sector-state unit's minimum wage increase. However, the baseline results do not present a clear story for the average effect of minimum wage, with a null or marginally significant positive result making up a majority of the observed results. However, an ambiguous average effect of minimum wage is not necessarily surprising; the economic context of the regulations in a segmented labor market may offer one explanation for the results as the labor force survey sample considers both formal and informal workers. Furthermore, conventional theory on the

minimum wage suggests that as it is redistributive, it implies negative wage effects for higher earners and positive wage effects for low-earning workers. Thus, I test these two hypotheses in order to determine how each contributes to the observed baseline effect and whether the lack of an average effect masks divergence between groups of workers.

5.1 Divergence Across Worker Types

Table 3: Effect of Minimum Wage on Informal Workers: Various Wage Measures

	Baseline	Alternative Wage Measures	
	Daily Wage	Weekly Wage	Monthly Wage
	(1)	(2)	(3)
Log(MW)	0.544***	0.112**	0.148**
	(0.146)	(0.048)	(0.062)
Informal x Log(MW)	-1.486***	-0.499***	-0.646***
	(0.158)	(0.086)	(0.109)
Informal	7.527***	3.103***	4.001***
	(0.780)	(0.475)	(0.607)
Marginal Effects			
Formal Worker	0.544***	0.112**	0.148**
	(0.146)	(0.048)	(0.062)
Informal Worker	-0.942***	-0.387***	-0.498***
	(0.181)	(0.080)	(0.100)
Fixed Effects	Sector-State, Year	Sector-State, Year	Sector-State, Year
Controls	Individual	Individual	Individual
Observations	1,134,873	1,134,873	1,134,873

Standard errors clustered at the sector-state level. Individual controls include age, gender, and level of education

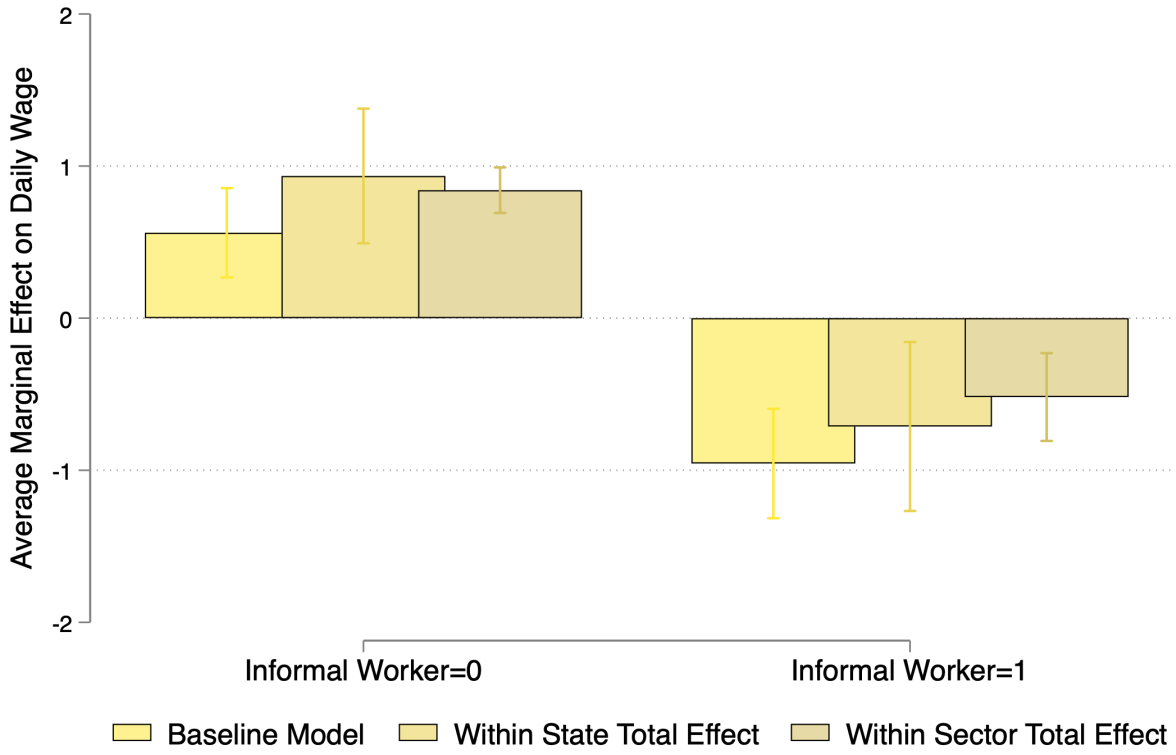
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The models presented in Table 3 are calculated using Equation (2) where indicator variables of worker characteristics are interacted with the minimum wage in order to study the variation of the ACR of wages to an increase in the minimum wage. This specification tests the hypotheses of the insider-outsider hypothesis and the lighthouse effect with respect to the impact of minimum wages for informal workers. The lighthouse effect hypothesis argues that an increase in minimum wage would have positive spillover effects for informal workers. However, the insider-outsider hypothesis argues that the increased cost of formal labor limits opportunities for workers trying to enter the formal sector. Column (1) of Table 3 does not find evidence in support of a lighthouse effect; finding instead that there are positive wage gains following a minimum wage hike for formal workers, but significant wage losses for formal workers. This divergence is coherent with a null baseline result, as the average effect masks the divergence in effects between formal and informal workers, who are

both included in the baseline sample.

The result for informal workers is found to be invariant to different fixed effects specifications, suggesting that there is not a significantly different total effect for informal workers that would be driven by sector- or state-switching. Even allowing for such adjustments to occur, there is a persistent divergence in the effect on wages for formal and informal workers. This is shown in Figure 4, which visualizes the average marginal effect shown in Column (1) under varying set of fixed effects.

Figure 4: Effect of a 1% Minimum Wage Hike on Workers' Wages: Informal versus Formal



Note: These figures represent the average marginal effect of minimum wages on individual wages by formality status. The coefficients are calculated from regressions interacting the minimum wage variable with an indicator variable for an individual's status where Informal == 1. The regression model is described in equation (2) and contains sector-state fixed effects per the baseline specification, or state-year (sector-year) fixed effects per the Total Effects specification. Controls for age, sex, and education level are included in the regression.

I further investigate whether the result is driven mainly by informality, or whether the true effect is a result of gender and caste-based discrimination in Table A8. In order to test this, I follow the Equation (2) interacting the minimum wage variable with indicator variables for being a female worker or being a worker in a scheduled caste [6]. The data coverage in the labor force surveys is

[6]Scheduled castes in India are broadly, members of castes that are considered the lowest in the historical caste

limited, with respect to the nuances of the caste system, thus, I underline that such results should not be taken as conclusive. In addition to the interaction, I do a triple interaction between gender (caste), informality, and the minimum wage, to test if the negative effect for informal workers disappears. Table A8 presents the results where I find that the divergence in outcomes does not appear to be driven by gender gaps or by caste-based labor market inequalities. Women in the informal sector experience the greatest magnitude of wage decrease (0.81%), while men in the formal sector experience the largest gains (0.94%), however, the coefficient for informal men is significant, negative and almost of equal magnitude to informal women, and the effect for formal women is null with a positive coefficient. There is no divergence in effect observed by scheduled caste status, though the coefficient for informal workers remains negative. Thus, I conclude that while it is true that women and scheduled caste members may be more represented among informal workers, the divergence in wage responses to the minimum wage is not driven by these factors. Or, the divide occurs more specifically on the status of workers as belonging to the informal sector, regardless of personal characteristics.

The divergent effects between formal and informal workers remains consistent when looking at wages over a longer time-span; with a significant negative effect of smaller magnitude seen for informal workers' computed weekly and monthly wages [7]. The results for formal workers remains positive and significant as well, however the magnitude decreases. Whereas a 1% increase leads to a 0.54% increase in daily wages, the increase for weekly wages is 0.112% and the increase in monthly wages is 0.148%. Notably, these results are also only significant at the 5% level, suggesting that the largest gains for workers may be on their daily wages, but that the longer-term impacts of this increase in wages is more variant. This warrants further exploration as it may suggest adjustment on the part of employers in response to an increase in the minimum wage.

The effect for informal workers follows a similar pattern, with the most negative effects on weekly wages; on average, informal workers daily wages decline by 0.94% following an increase of 1% in the minimum wage. The effect on the weekly wages is smaller, with a loss of 0.387% on average. The loss of monthly wages is slightly higher at 0.498% following a 1% increase in wages. Again, the variance in the magnitude may suggest a degree of adjustment on the part of employers in response to a minimum wage hike. This may be more in line with the insider-protection hypothesis, where formal employment opportunities are limited under more stringent labor regulations. However, this limiting of opportunities importantly does not negate the benefits for formal workers, who consistently experience wage gains, even after adjusting for average hours worked for a week or month. The effect on informal workers however is curious and warrants further exploration through the

classification system. Scheduled caste is a legal classification acknowledging the potential for socioeconomic discrimination or marginalization based on this classification. The grouping contains a great number of diverse caste groups containing upwards of 1,109 castes. Scheduled caste members represent around 16.5% of the Indian population

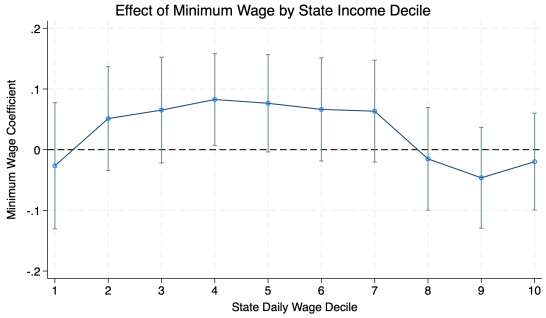
[7] Weekly and monthly wages are computing using the income data (wages or salary) on the reference week along with working time reported in the reference week

mechanism of disemployment and labor demand adjsutment which is discussed in Section **??**.

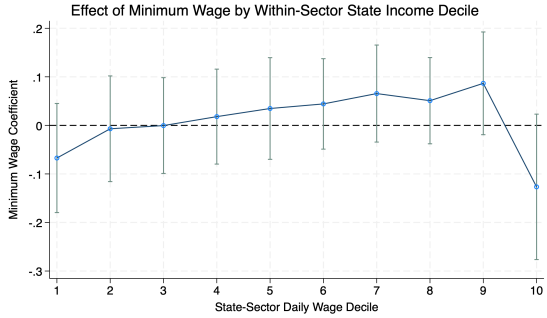
However, it is important to acknowledge that informality is not the only source of divergence in wage outcomes identified in the minimum wage literature. It is possible that there are stronger redistributive effects of the minimum wage. This hypothesis suggests that because minimum wages are a redistributive policy; they lead to a compression of the wage distribution by decreasing the wages of high-earners and increasing the wages of low-earners, which may report a null average effect. The following section discusses this hypothesis as an alternative argument to the results on informality presented above.

5.2 Redistribution Effects

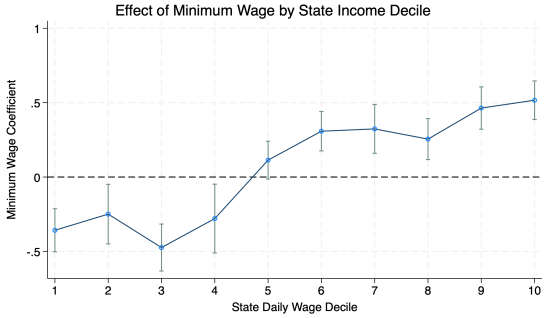
Figure 5: Panel A: Effect Across the Wage Distribution at the State and Sector-State Level



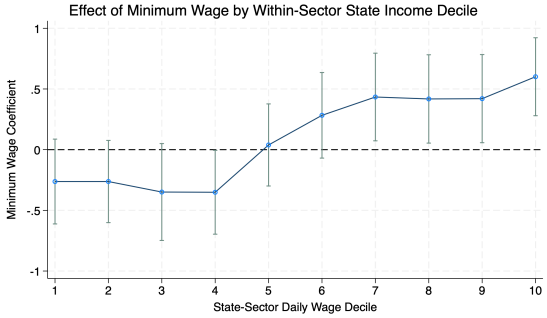
Panel A: Effect on Wage Workers, State Distribution



Panel B: Effect on Wage Workers, Sector-State Distribution



Panel C: Effect on All Workers, State-Distribution



Panel D: Effect on All Workers, Sector-State Distribution

Note: These figures represent the average marginal effect of minimum wages on individual wages within each decile. The coefficients are calculated from regressions interacting the minimum wage variable with an indicator variable for an individual's position in the overall wage distribution. The regression model is described in equation (2) and contains sector-state fixed effects per the baseline specification. Controls for age, sex, education level, and contract type are included in the regression.

The alternative hypothesis for a divergence in effects that may lead to a null overall effect is a compression of the wage distribution. In this instance, there are negative effects at the top of the wage distribution as income is redistributed from high earners towards the bottom of the distribution when a minimum wage is introduced or amended, raising the wage rates for only the lowest-earning workers. Thus, a potential explanation of the baseline result is a combination of these effects. Thus I estimate Equation (3), interacting an individual's place in the wage distribution with the minimum wage in order to calculate the response to an increase in minimum wage across the wage distribution. Figure 5 illustrates the outcome of the tests.

Analysis across deciles measured within state, or within sector-state (Panel A, Panel B) for the baseline sample of workers in the waged labor market shows no evidence of significant redistributional effects; indeed, the results for the poorest workers are largely predicted as negative; though it is not signficant. Panel C and Panel D look at the wage distribution across the whole sample population, taking into account those who are self-employed. In this case, the results are significant, but more consistent with a negative shock to workers on the lower end of the distribution than redistribution between high and low earners. While this may explain the null overall effect ultimately, as there is a consistent divergence of effects; this divergence is more consistent with the informality hypothesis, wherein more disadvantaged workers, concentrated in the informal sector, are negatively impacted by such laws.

One remaining question relates to the position of the minimum wage in the wage distribution. According to Cengiz et al. (2019), the effect of the minimum wage may be best seen in the deciles surrounding the minimum wage. Furthermore, given the incidence of informality, it is possibility that the decile-equivalent of the minimum wage rate is far beyond the lowest earners due to higher potential for noncompliance. Therefore, I calculate the positive of individuals relative to the positive of the minimum wage in the state or sector-state wage distribution for a given year. The results of this analysis are observed in Figure ??, and generally confirm a negative or null income effect for workers earning under, at, or just above the minimum wage. Thus suggesting that there are not redistributive effects in the proximate deciles to the minimum wage rate that are masked by the overall wage distribution irrespective of the level of the minimum wage. Furthermore, while results are generally weaker, Panel D, for instance, looking at the within-sector-state unit effect for all workers suggests a strong negative effect on low-income earners, taking into account the self employed. Such results serve to further confirm the importance of studying the effect on informal workers and understanding the negative income shock they experience.

Finally, I rule out an effect over time in Figure ??, which looks at the effect of a lagged minimum wage on the wage distribution. Taking into consideration that redistribution might require a longer period to take effect, I use 1- and 2- year lags of the minimum wage as the treatment variable, interacted with an indicator for position in the wage distribution. Overall I do not find strong evidence

that there is a delay in redistribution effects, as the results do not differ from the "instantaneous" effect on distribution results presented in Figure **??**.

While the distribution hypothesis proposes an alternative explanation to the baseline results as it predicts divergence between workers by their place in the distribution rather than whether or not they are employed in the formal sector; I do not find it to be a strong counterargument to the informality hypothesis in my analysis. While there is some evidence of divergence, it is consistent with the informality effect, with more significant negative effects at the bottom of the distribution where informal sector workers are more likely to be concentrated. Thus, I conclude that the redistributional effects of this minimum wage policy are limited, and the key source of heterogeneity in the treatment effect stems from the differing outcomes for formal and informal workers.

The following section discusses the robustness of the baseline findings and the findings on informality, formally ruling out a number of competing explanations and questions on identification. The subsequent section seeks to identify the mechanism of divergence between formal and informal workers considering their employment outcomes and the productive differences in formal versus informal employers that may drive their capacity to absorb wage regulation shocks.

6 Robustness Checks

6.1 Alternative Specifications

This section discusses alternative specifications and heterogeneity analyses conducted in confirmation of the baseline results discussed in the previous section. As shown in the discussion of the baseline results, my findings are robust to the variation of the fixed effects specification, omitted variables on the regulatory environment of a sector-state, spillovers and switching from other sectors, and adjustments for inflation. This section notes further tests varying the measurement of labor market insiders in order to confirm the results identified in for informal versus formal workers.

I test the heterogeneity of my findings by the education level of workers as a proxy for worker skill level and employment security. Following the definition of previous papers working on this subject (Khurana et al., 2023, Mansoor and O'Neill, 2021, Soundararajan, 2019); I define high education as completion of post-secondary education. Middle education is defined as greater than primary but less than post-secondary education, while low education includes those with primary-only or no education. The results are reported in Table A5. They show a significant and positive effect of the minimum wage for highly educated workers and ambiguous effects for low- and middle-educated workers. This is consistent with the literature linking educational achievement to wages as I observe positive effects for workers in the upper part of the wage distribution and workers in the formal sector. These categories of workers are more likely to have completed more advanced education

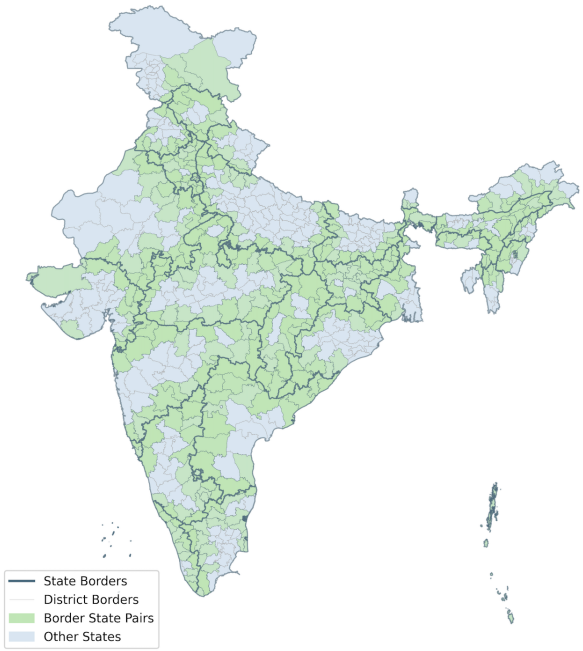
and have more secure employment, strengthening their position as labor market insiders.

I further test variation of the effect by immigration status on a subsample of the data for which an immigration module was conducted (2007-2008). The results reported in Table A6 do not suggest that increases in the minimum wage significantly increase the probability of migrating into the state. Furthermore, I find that migrants experience more wage growth as a result of an increase in the minimum wage, while non-migrants experience a negative response of wages relative to migrants. While potentially counterintuitive, recent research has shown that internal migration rates in India are quite low, and many social programs are contingent on remaining in your state of initial residence, particularly inhibiting the movement of poorer and less-skilled workers (Kone et al., 2018, Bhagat and Keshri, 2020). This in itself implies a strong selection on the individuals who become migrants, and serves to further underscore the positive result for labor market insiders identified in previous sections.

The following section discusses the concern of omitted variables at the sub-state level as indicated by Khurana et al. (2023), workers' conditions are vulnerable to productivity shocks at a more local level. Thus, I test my identification strategy using a district-level subsample to ensure my baseline findings are robust to such concerns following the methodology outlined in Dube et al. (2010).

6.2 Variance of Identification Strategy

Figure 6: Identification of Contigous State-Border District Pairs in India



Following the methodology of Dube et al. (2010), I exploit cross-state border variation in minimum

wages within local labor markets. Figure 6 visualizes the identification of a district level subsample that allows this analysis. I construct a database of district-pairs, defined as a set of two districts which share a border but are located in different states, and therefore are subject to different sectoral minimum wage shocks. Through the inclusion of district-pair, sector, and year fixed effects, I am able to control more effectively for localized productivity shocks that may be omitted in the baseline model and ensure that the previous results are robust to their inclusion.

The identifying assumption of Dube et al. (2010)'s contiguous border district strategy is that the state border provides a policy discontinuity while the geographic proximity of border districts ensures comparability of economic contexts and exposure to shocks. Thus, by looking at the variation in minimum wages across a state border within a sector, I limit omitted variable bias from productivity shocks that would not be fully captured by a state fixed effect. Using fixed effects allows me to create a generalized approach looking across all border district pairs and sectors to calculate the average effect of an increase in the minimum wage. The baseline model is as follows:

$$Y_{i(psk)t} = \alpha + \beta \log(\text{Minimum Wage})_{k(s)t} + X_{i(kp)}\beta + \gamma_{pt} + \delta_{pk} + \lambda_t + \epsilon_{ikpt} \tag{5}$$

Where $Y_{i(kp)t}$ is the wage outcome of a worker in district-pair p, in state s and sector k at year t, which is regression on the log of minimum wage for sector k in state s for year t. γ_{pt} is a fixed effect for district-pair and year, which requires the effect to be identified beyond shocks or trends in a district-pair for a given year, while δ_{pk} controls for the characteristics of sector k within the district pair. The minimum wage can vary within the district pair as each district is located in a different state which is exposed to minimum wage shocks at different times and in different amounts. Similar to the baseline result, and following the interpretation of Callaway et al. (2024), β can be interpreted as the average causal response of wages to an increase in the minimum wage, under the identifying assumption that this set of fixed effects adequately controls for unobserved variation within a border district pair.

Table 4 presents the results of the baseline wage effect and the interaction with informal worker status. The baseline results presented in columns (1) - (3) are similarly ambiguous to the baseline results, though the coefficients are more often small and negative. In the informal interaction, I observe a strong negative effect on informal workers and a less strong positive effect on formal workers, though similar to the baseline results, they show significant evidence of divergence between the types of workers. The stronger negative effect on informal workers for this subsample may increase the likelihood for the average effect across all workers to be negative; however, as it remains a null effect, as in the baseline, I argue that my baseline results are robust to local-level productivity shocks.

This section has demonstrated the robustness of the baseline findings to a number of alternative measures, as well as an alternative identification strategy, demonstrating that there is a robust positive effect on labor market insiders and negative effects for labor market outsiders following an

Table 4: Border District Pair Specification: Effect on Wages

	Log(Daily Wage)			Informality Interaction
	(1)	(2)	(3)	(4)
Log(MW)	-0.101	0.0451	-0.101	0.313**
	(0.0956)	(0.113)	(0.139)	(0.143)
Log(MW) x Informal Worker				-1.466***
				(0.167)
Marginal Effects				
Formal Worker				0.313**
				(0.143)
Informal Worker				-1.154***
				(0.191)
N	353328	353033	352778	352778
FE	Dist. Pair, Sector, Year	Dist. Pair-Sector, Year	Dist. Pair-Sector, Dist.-Pair-Year	Dist. Pair-Sector Dist.-Pair-Year
Controls			Individual	

Standard errors clustered at state border segment level. Individual controls include sex, age, educational achievement, and worker type.
* p<0.10, ** p<0.05, *** p<0.01.

increase in the minimum wage. The following section seeks to explain this result by studying two competing hypotheses: employment adjustment that favors labor market insiders or labor market characteristics and worker sorting.

7 Mechanisms

7.1 Employment Adjustment

Motivated by the results in Table 3, I explore the mechanism of disemployment in Table 5. It is widely predicted that increasing the minimum wage will reduce employment as employers seek to avoid increasing labor costs. Thus, it is crucial to check if there are positive effects on the number of unemployed people present in a sector following an increase in the minimum wage. Furthermore, given the dualistic nature of the labor market in India, there is additionally the possibility of non-compliance and transition to the informal sector. The results in Table 5 explore this mechanism first using the probability of being unemployed following an increase in a worker's former sector-state of employment. To test for adjustments in labor demand outside of firing workers, I then test if hours worked for those employed in a treated sector-state to test if there is an adjustment in the number of hours worked. To complement this, I include a test of the effect on an estimation of hourly wages computed from daily wages reported in the worker survey.

In columns (1) and (2), I do not find evidence that an increase in the minimum wage significantly increases the probability of being unemployed among workers who formerly worked in the exposed

Table 5: Disemployment and Working Hours Adjustment

	Pr(Unemployed = 1)		**Hours Worked in Week**		**Log(Hourly Wages)**	
	(1) Baseline	(2) Interaction	(3) Baseline	(4) Interaction	(5) Baseline	(6) Interaction
Log(MW)	-0.00006	0.0003	0.002	-0.148***	0.0379	0.391***
	(0.00369)	(0.00384)	(0.0384)	(0.0528)	(0.1000)	(0.0985)
Informal Worker × Log(MW)		-0.00108		0.498***		-1.040***
		(0.00310)		(0.0350)		(0.0963)
Marginal Effects						
Formal Worker		0.000303		-0.148***		0.391***
		(0.00384)		(0.0528)		(0.0985)
Informal Worker		-0.000776		0.350***		-0.649***
		(0.00421)		(0.0510)		0.117)
N	1134873	1134873	1134873	1382335	1134873	1382335
Fixed Effects			Sector-State, Year			
Controls			Individual			

Standard errors clustered at the state-sector level. Individual controls include sex, age, educational level, and contract type for baseline models. In interaction models, individual controls include sex, age, and education levels.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

sector-state unit. This effect does not diverge for formal and informal workers. Column (1) shows that informal workers are less likely to be unemployed than formal workers, which is likely due to the flexibility inherent in their status, wherein they can move more quickly between jobs, creating shorter periods of unemployment. However, in the interaction model, when examining the marginal effect of minimum wage for informal and formal workers, they are not significantly different.

However, the results on hours of work suggest that the adjustment does not happen through the hiring and firing of workers, but an adjustment on the number of hours per week workers are hired for. While formal workers experience an ambiguous, negative effect on their hours worked, there is a significant increase of working hours for informal workers. I find that, on average, a 1% increase in the minimum wage leads to a 0.136% increase in hours worked per week. This suggests that there is an increasing use of informal workers. Combining this fact with the decrease in daily wage observed for informal workers, this suggests that employers may substitute cheaper informal working hours to compensate the increase in cost of formal working hours following an increase in the minimum wage. This is consistent with the fact that the results for hourly wage by formality status are contrary to the baseline daily wage results. As informal workers increase their hours worked, there is a small, significant increase in their hourly wage, which is consistent with employers shifting labor demand composition, increasing the use of cheaper workers to avoid an increase in labor cost following minimum wage hikes.

Furthermore, while there is not a significant decrease in working hours on average between formal workers, looking at a gender-split sample of formal workers, I find that there is a decrease for

female workers in the formal sector and an ambiguous effect for men in the formal sector. This is consistent with the results presented in Table 3 showing that there is a decrease in earnings for formal female workers, which suggests a decrease in employment for vulnerable formal-sector workers, which is compensated by an increase in informal labor use. Consistent with the baseline results, the variation is more consistently centered on the worker's gender as opposed to their social group.

In summary, there is evidence that the negative wage effect observed for informal workers is driven by the changing composition of the workforce as employers seek to increase noncompliance through the greater use of informal workers. This results in wage growth for some formal workers; however, more vulnerable workers, such as female workers, are less securely employed and experience disemployment and decreases in wage following a minimum wage increase as workers favor less vulnerable formal workers as they shift the composition of their workforce. This result highlights the complexity of the minimum wage setting system and the various channels through which it can impact workers. However, it is not the only possible explanation for the divergence between formal and informal workers as they may sort into sectors with distinct characteristics that drive the response of worker outcomes to the minimum wage. Thus, in the following section, I consider the possibility that there are differences in their productive activities and labor markets, capturing using surveys of informal and formal firms to understand if there is variation of the minimum wage response per firm characteristics.

7.2 Variation by Sectoral Characteristics

The literature predicts that the minimum wage response may be driven by various characteristics of productive activity within sectors. For example, employers avoiding an increase in labor cost may be able to increase automation and use of machinery for sectors where productive tasks are suited to such substitution. Furthermore, greater exposure to and trade with partners may increase outsourcing, substituting foreign labor for regulated domestic labor. In this case, sectors that are more suited to these adjustments may respond differently to an increase in the minimum wage. Additionally, as shown by Badaoui and Walsh (2022), beyond labor substitution, compliance with the minimum wage may vary by the size and productivity of an employer.

Extending the labor demand argument beyond productive activities, the literature has also shown that firms' behavior on the labor market can influence how the labor market responds to an increase in the minimum wage (Azar et al., 2022). Coming from theories on monopsonistic labor markets, this literature argues that workers in labor markets where a single employer makes up a greater share of total employment for an occupational category will experience more wage growth following an increase in the minimum wage. This is because employers with greater market share and power will tend to set lower wages and minimum wage hikes can provide a balancing effect.

Taken together, these observations on the interactions of the minimum wage with the characteristics of sectoral productive activities and their labor markets proposes an alternative explanation to the divergence of effects. In particular, this might be the case if there were a larger concentration of informal workers in certain sectors, which was the ultimate determinant of the negative wage outcome. Figure ?? and Figure A4 show the average causal response of wage by sector and the average number of informal workers by sector across the sample, respectively. The sectors that experience the most significant positive wage effects are those most likely subject to public management (i.e., public administration, transportation, and electricity), which coincide with lower levels of informal employment. However, the relationship between high informality sectors and lower wage outcomes is not evident; thus, based on the descriptive evidence, pure sectoral differences do not appear to drive the results. Table A8 confirms that the negative response to minimum wage holds across all sectors for informal workers, and in the vast majority of sectors, this effect is significant at the 5% level. Thus, I conclude that it is unlikely that sorting by formality into different more or less productive sectors drives the result.
Table 6 summarizes analyses using data from the Annual Survey of Industries to calculate the average labor market concentration and factor intensity of production within each sector-state unit. Interacting these variables with the minimum wage treatment variable allows me to analyze whether the effect on wages varies with the average intensity of a sector's characteristic.

Column (1) presents the results based on the labor market concentration literature of Azar et al. (2022). In this model, I calculate the Herfindahl-Hirschman Index as the average share of employment of each firm in a sector-state unit. Following the threshold values defined in Azar et al. (2023), I defined low, low-middle, high-middle, and high labor market concentration thresholds. I find that minimum wages increases in high-middle concentration sector-state labor markets have a positive and significant average causal response. This is consistent with the literature stating that higher labor market concentration is associated with better worker outcomes following minimum wage hikes, relative to the least concentrated markets. However, I find a null effect for all other market concentration categories relative to the least concentrated markets. Thus, I conclude that variations in labor market concentration are not the most persuasive.

Columns (2) - (5) present the heterogeneity by average factor use of employers, calculated as the average cost share of each firm in a sector-state unit. I use log average cost information and communication capital (ICT) and machinery (physical capital), as well as the log average foreign capital share and log average labor cost of firms to proxy factor intensity. I do not find significant variation by the majority of characteristics, further suggesting that sorting based on productive characteristics is unlikely to be a major contributing factor to the variation between formal and informal workers. By comparison, the results for informal firms show more significant variation by firm productive characteristics. Informal firms are found to have higher wage growth following minimum wage hikes for more ICT and labor-intensive sectors on average. However, the direction

Table 6: Variation of Wage Effect by Employer Characteristics

	Labor Market Concentration	**Average Employer Factor Use**			
	(1)	(2)	(3)	(4)	(5)
Formal Sector					
Log(MW)	-0.114	-0.454	-1.104**	1.305	-0.654
	(0.133)	(0.446)	(0.440)	(16.08)	(0.480)
× HHI < 2500	0				
	(.)				
× 2500 < HHI < 5000	-0.0344				
	(0.108)				
× 5000 < HHI < 7500	0.438**				
	(0.177)				
× 7500 < HHI	0.0157				
	(0.286)				
× ICT Intensity		0.0386			
		(0.0344)			
× Physical Capital Intensity			0.0716***		
			(0.0264)		
× Trade Intensity				-1.158	
				(14.70)	
× Labor Intensity					0.121
					(0.0818)
N	406057	225202	233115	55633	243055
Informal Sector					
Log(MW)	0.0531	-0.536*	0.534	-0.889	-1.221***
	(0.224)	(0.254)	(0.702)	(0.704)	(0.271)
× HHI < 2500	0				
	(.)				
× 2500 < HHI < 5000	-0.269				
	(0.270)				
× 5000 < HHI < 7500	0.512**				
	(0.280)				
× 7500 < HHI	-0.0154				
	(0.245)				
× ICT Intensity		0.107***			
		(0.0265)			
× Physical Capital Intensity			-0.0356		
			(0.0556)		
× Trade Intensity				0.0698	
				(0.0608)	
× Labor Intensity					0.246**
					(0.0886)
Fixed Effects	Sector-State, Year				
Controls	Individual				

Standard errors clustered at state-sector level. Individual controls include sex, age, educational level, and contract type for baseline models.

* p¡0.10, ** p¡0.05, *** p¡0.01.

of the effect moves, while significant for informal firms, is similar to the ones found for formal firms, which is not coherent with divergence between formal and informal workers, thus while an interesting trend, would not drive the trend observed in previous sections.

Based on the results presented in this section, I conclude that the most convincing mechanism for the minimum wage is the reduction in the use of formal workers to save cost, with an increase in the use of informal workers without a corresponding increase, as illustrated by the findings of in Table 5.

8 Conclusion

This paper provides evidence of the nuanced impact of sector-state minimum wages on workers' outcomes using the unique case of India's wage-regulation system. My findings suggest that while minimum wage can lead to an increase in workers' daily wages, these effects are only experienced by formal sector workers; suggesting that a *lighthouse effect* is not observed. Furthermore, I find evidence that it is accompanied by a reduction in formal working hours hired, suggesting that while they are effective in increasing income; minimum wage increases may limit formal-sector employment opportunities. For informal sector workers, I find a negative effect on daily wages and a positive effect on workers, suggesting that employers increase their use of informal work to avoid increasing labor costs while compensating loss of output. This finding underscores the dualistic nature of India's labor market, where the coexistence of formal and informal labor markets implies unique challenges for regulating labor. This coexistence implies that formal labor is more easily substitutable with informal labor; creating an interesting debate on the labor market competition mechanism relating to minimum wages. The competition with informal labor may introduce a wedge in the ability of minimum wage to restore "competitive" wages, suggested by the results on the adjustment of working hours. Furthermore, the extent of heterogeneity in minimum wage rates by sector and state, initially intended to benefit everyone in an dualistic labor market by promoting adaptability to sector conditions, may come at the price of clarity over the true minimum wage, thus contributing further to the lack of a lighthouse effect.

These results have important implications for India's transition to a universal minimum wage framework under the 2019 Code on Wages. Policymakers must address challenges related to informality in order to ensure its effectiveness in protecting the most vulnerable workers. To this end, more research is needed on the dynamics and characteristics of informal and formal labor markets in order to better understand their interactions, and the ability of single employers to exchange formal labor for informal labor, as well as the wage-setting behavior in these interactions. Beyond insights for the policy context, by showing the complex interactions created by the sector-state minimum wage setting system, this paper contributes to the broader discussion on labor market interventions in developing economies and highlights the critical role of informal labor in such policy decisions.

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Appendix: Additional Results

The following section presents additional results and results for robustness checks not included in the main paper.

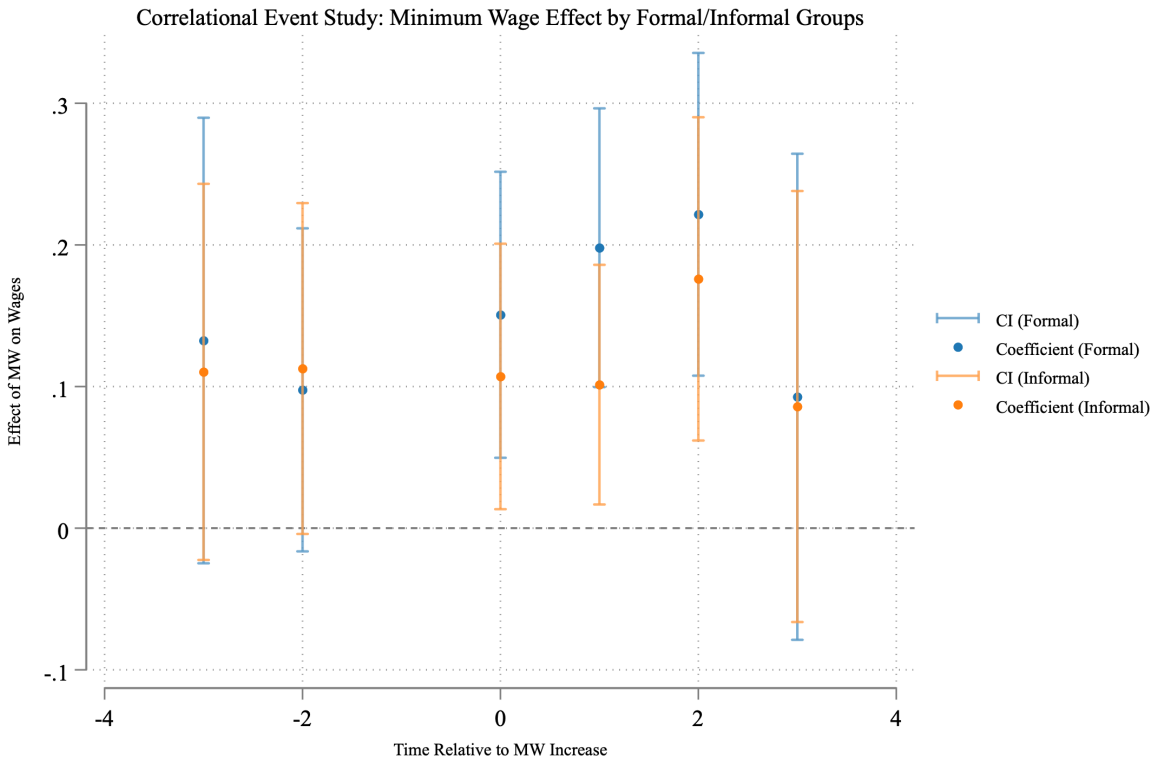


Figure A1: Correlational Event Study of Wage Effect for Formal vs. Informal Workers

Note: These figures represent the effect on wages for 3 periods (years) before an increase in the minimum wage in a state, sector. The figure measures the total effect across sectors for informal and formal workers, including state and year fixed effects.

Table A1: Baseline Effect of Minimum Wage on Wages: Extended FE Specifications

	(1)	(2)	(3)
Log(MW)	-0.0279	-0.183	-0.0498
	(0.129)	(0.142)	(0.0904)
Observations	1,134,874	1,134,874	1,134,874
Fixed Effects	Sector, State, Year	State-Year, Sector	Sector-Year, State
Controls		Individual	

Standard errors clustered at the state-sector level. Individual controls include age, sex, education level, and contract type.
* p<0.10, ** p<0.05, *** p<0.01

Table A2: Minimum Wage Effect: Adjusting and Controlling for Inflation

	Baseline 2011-2019 Sample	**CPI as Control**	**Log(Real Daily Wage)**
	(1)	(2)	(3)
Log(MW)	-0.229	-0.136	
	(0.191)	(0.166)	
CPI		-0.0298***	
		(0.00782)	
Log(Real MW)			-0.00649
			(0.0157)
N	423,627	501,972	509,306
FE		Sector-State, Year	
Controls		Individual	

Standard errors clustered at the state-sector level. Individual controls include age, sex, education level, and contract type.
* p<0.10, ** p<0.05, *** p<0.01

Table A3: Spillover Effects on Wages for Other-Sector Minimum Wages

	(1)	(2)	(3)	(4)
Log (MW)	0.0000129		0.0291	
	(0.142)		(0.0488)	
MW Spillovers	-0.0108	-0.00263	-0.101	-0.0227
	(0.0247)	(0.0180)	(0.0840)	(0.0391)
Observations	1,126,295	1,199,206	1,126,296	1,199,205
Fixed Effects		Sector-State, Year		
Controls		Individual		

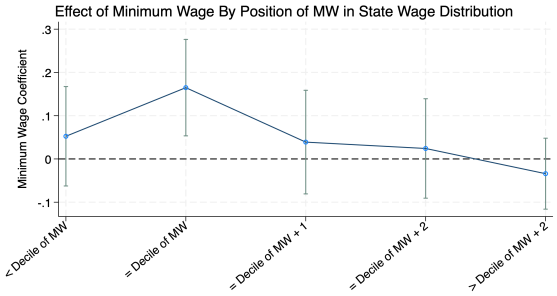
Standard errors clustered at the state-sector level.
* p<0.10, ** p<0.05, *** p<0.01

Table A4: Baseline Wage Effect Controlling for Number of MW in State

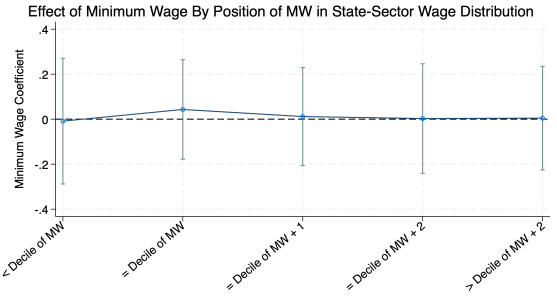
	(1)
Log(MW)	0.0496
	(0.146)
Number of MW	0.00214
	(0.00376)
Observations	1,134,873
Fixed Effects	Sector-State, Year

Standard errors clustered at the state-sector level.
* p<0.10, ** p<0.05, *** p<0.01

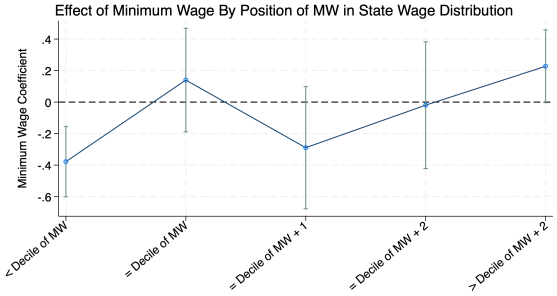
Figure A2: Effect Across the Wage Distribution With Respect to the Level of the Minimum Wage



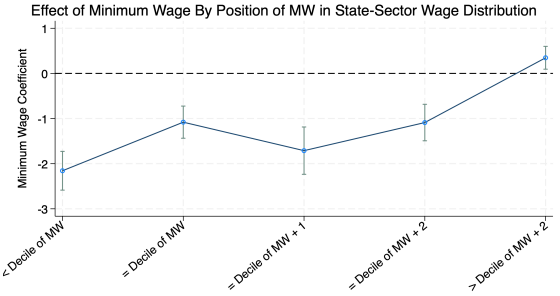
Panel A: Effect on Wage Workers, State Distribution



Panel B: Effect on Wage Workers, Sector-State Distribution



Panel C: Effect on All Workers, State-Distribution



Panel D: Effect on All Workers, Sector-State Distribution

Note: These figures represent the average marginal effect of minimum wages on individual wages within each decile. The coefficients are calculated from regressions interacting the minimum wage variable with an indicator variable for an individual's position in the overall wage distribution. The regression model is described in equation (2) and contains sector-state fixed effects per the baseline specification. Controls for age, sex, education level, and contract type are included in the regression.

Table A5: Heterogeneity of Wage Effect by Education Level

	(1) Dependent Variable: Log Daily Wage
Log(MW) x	
Education Level = 1	-0.107
	(0.138)
Education Level = 2	0.177
	(0.152)
Education Level = 3	0.782***
	(0.177)
Observations	1132948
Fixed Effects	Sector-State, Year
Controls	Individual

Standard errors clustered at state-sector level
* p<0.10, ** p<0.05, *** p<0.01

Table A6: Variation of Wage Effect by Migration Status: 2007-08 Subsample

	Additional Control: Migrant	Interaction Model	Marginal Effect by Migration	Pr(Migrant == 1)
	(1)	(2)	(3)	(4)
Log(MW)	0.127	0.743***		-0.00257
	(0.0864)	(0.192)		(0.00854)
Migrants	0	0	0.743***	
	(.)	(.)	(0.192)	
Non-Migrants	-0.291***	2.555***	0.115	
	(0.0538)	(0.788)	(0.0869)	
Non-Migrants × Log(MW)		-0.628***		
		(0.173)		
Observations	233,459	233,459	233,459	233,459
Fixed Effects		Sector-State, Year		
Controls		Individual		

Standard errors clustered at state-sector level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A7: Effect of Minimum Wage on Informal Workers: Caste and Gender Effects

	(1) Gender	(2) Gender x Informality	(3) Caste	(4) Caste x Informality
Female	0.256	3.332***		
	(0.358)	(0.420)		
Log(MW)	0.126	0.945***	-0.046	-0.026
	(0.158)	(0.152)	(0.069)	(0.071)
Female x Log(MW)	-0.189***	-0.874***		
	(0.071)	(0.082)		
Informal	0.164	8.508***	0.833***	0.927
	(0.192)	(0.776)	(0.163)	(0.868)
Female x Informal		-2.916***		
		(0.915)		
Informal x Log(MW)		-1.755***		-0.067
		(0.157)		(0.181)
Female x Informal x Log(MW)		0.872***		
		(0.189)		
Scheduled Caste Member			0.050	-0.459*
			(0.249)	(0.247)
Sch. Caste x Log(MW)			0.062	0.096*
			(0.053)	(0.054)
Informal x Sch. Caste				1.598*
				(0.824)
Informal x Sch. Caste x Log(MW)				-0.073
				(0.174)
Fixed Effects	Sector-State, Year	Sector-State, Year	Sector-State, Year	Sector-State, Year
Controls	Individual	Individual	Individual	Individual
Observations	1,134,835	1,134,835	889,807	889,807

Standard errors clustered at the sector-state level. Individual controls include age, gender, and level of education.

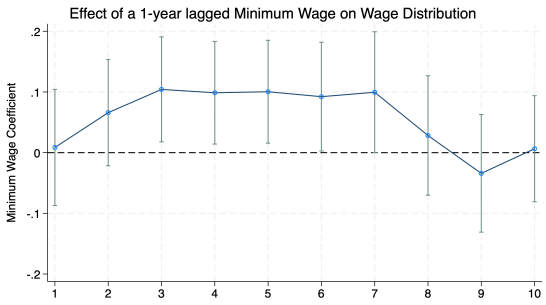
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A8: Effect of Minimum Wage on Informal Workers: Caste and Gender Effects

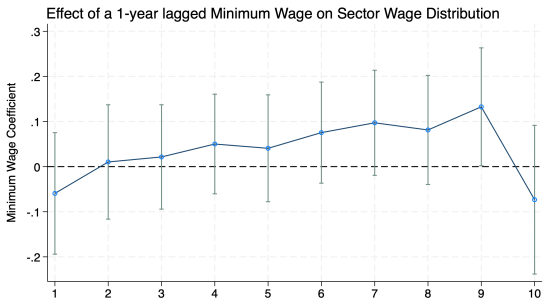
	(1) Gender	(2) Gender x Informality	(3) Caste	(4) Caste x Informality
Male	0.126			
	(0.158)			
Female	-0.063			
	(0.137)			
Male x Formal		0.945***		
		(0.152)		
Female x Formal		0.071		
		(0.131)		
Male x Informal		-0.809***		
		(0.175)		
Female x Informal		-0.812***		
		(0.215)		
Not in Sch. Caste			-0.046	
			(0.069)	
In Sch. Caste			0.016	
			(0.081)	
Formal x Not Sch. Caste				-0.026
				(0.071)
Formal x Sch. Caste				0.070
				(0.090)
Informal x Not Sch. Caste				-0.093
				(0.171)
Informal x Sch. Caste				-0.070
				(0.228)
N	1134835	1134835	889807	889807

Standard errors clustered at the sector-state level. Individual controls include age, gender, and level of education. Marginal effects calculated based on results in Table A7, using sector-state, year FE. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure A3: Effect of Lagged Minimum Wage Across the Wage Distribution at the State and Sector-State Level



Panel A: 1-Year Lagged MW Effect Across State Distribution



Panel B: 1-Year Lagged MW Effect Across the State-Sector Distribution

Panel C: 2-Year Lagged MW Effect Across the State Distribution

Panel D: 2-Year Lagged MW Effect Across the State-Sector Distribution

Note: These figures represent the average marginal effect of minimum wages on individual wages within each decile. The coefficients are calculated from regressions, interacting the minimum wage variable with an indicator variable for an individual's position in the overall wage distribution. The regression model is described in equation (2) and contains sector-state fixed effects per the baseline specification. Controls for age, sex, education level, and contract type are included in the regression.

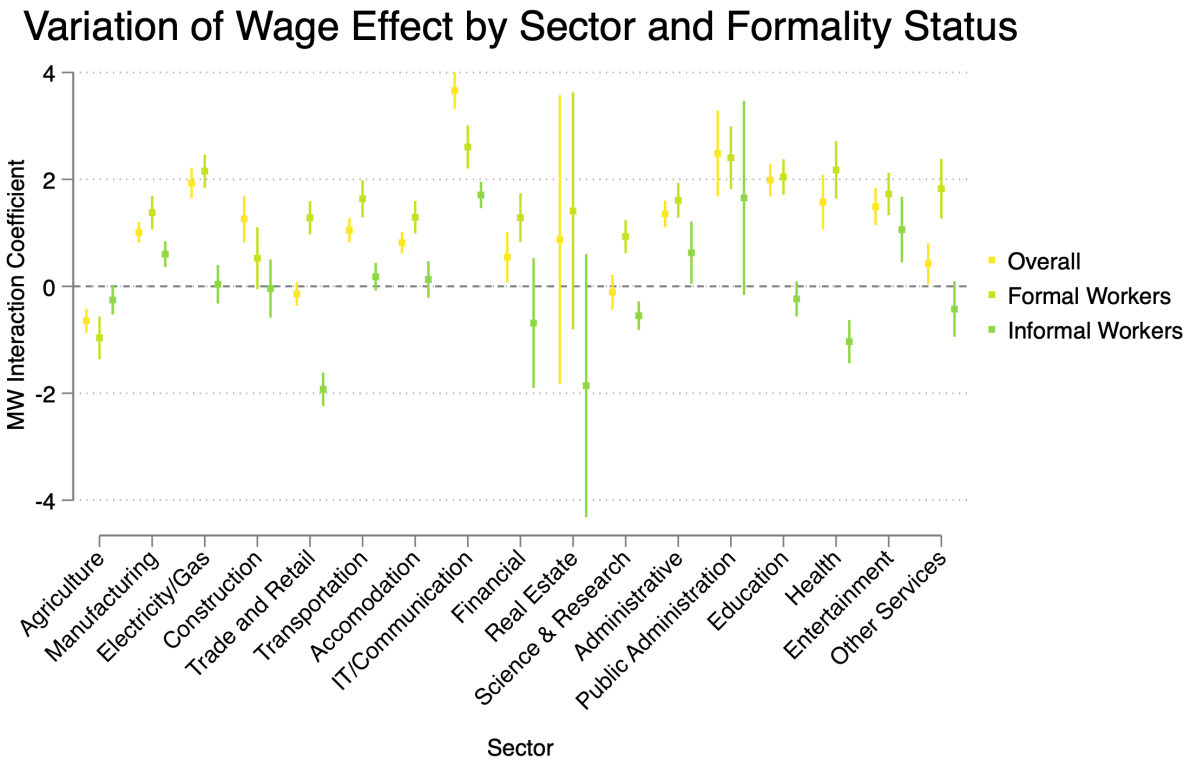


Figure A4: The figure represents the average marginal effect of minimum wages on individual wages for each sector. The coefficients are calculated from regressions interacting the minimum wage variable with an indicator variable for an individual's sector of employment. The regression model is described in equation (2) and contains state and year fixed effects. Controls for age, sex, education level, and contract type are included in the regression.

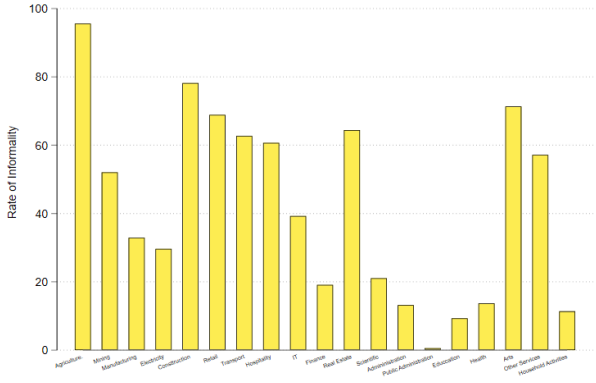


Figure A5: Own Calculation of Average Rate of Informality by Sector